VOLUME
II

भाकृअनुप
ICAR

SIXTH DEANS' COMMITTEE REPORT

(Syllabi of the Undergraduate Programmes in Agriculture and Allied Sciences)

AGRICULTURAL EDUCATION DIVISION
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-II
Pusa, New Delhi-110012

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(Syllabi of the Undergraduate Programmes
in Agriculture and Allied Sciences)

(Volume-II)

Agricultural Education Division
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan II
Pusa, New Delhi 110012

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कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
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MESSAGE

Quality human capital is foundational for inclusive development. The release of the 6th Deans' Committee Report marks a critical milestone in the evolution of agricultural education in India. The report reflects a forward-looking, outcome-based, and student-centric approach to curriculum restructuring. It aligns agricultural education with the principles of the National Education Policy (NEP) 2020, emphasizing flexibility, experiential learning, skill orientation, multiple entry-exit options, academic bank of credits, and integration of Indian Knowledge Systems with modern science.

Indian agriculture today stands at the intersection of unprecedented opportunities and complex challenges. Climate change, biodiversity loss, natural resource degradation, food and nutritional security concerns, market volatility, and emerging employment paradigms are reshaping the contours of research, education, and extension. In this dynamic environment, our human capital must be equipped with cutting-edge knowledge, multidisciplinary competencies, entrepreneurial capabilities, and ethical grounding.

The revised curricula thoughtfully incorporate emerging frontiers such as genome editing, artificial intelligence, data science, precision and digital agriculture, drones, robotics, climate-smart agriculture, carbon farming, natural and regenerative agriculture, bioeconomy, and agribusiness management. At the same time, it reinforces strong foundations in basic sciences, soil health, water management, biodiversity conservation, and sustainable farming systems. The Committee's recommendations provide a strong roadmap for building a vibrant, future-ready agricultural education system that continuously upgrades itself to meet the challenges of the 21st century.

I appreciate the Chairman and members of the Sixth Deans' Committee for their dedication, extensive consultations, and forward-looking contributions. I am confident that this revised curriculum for the 13 agriculture and allied disciplines will serve as an important milestone in developing innovative, skilled, and future-ready human resources, and will significantly contribute to India's agricultural transformation in the years ahead.

(M. L. Jat)

Dated the 3rd March, 2026
New Delhi

सत्यमेव जयते

डॉ. हिमांशु पाठक
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SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)

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Foreword

The Indian Council of Agricultural Research (ICAR) has played the vital role in transforming the agricultural higher education to produce highly skilled human resource equipped with advance knowledge and capable of fulfilling the agricultural needs of the country. National Education Policy (NEP-2020) of India represents a comprehensive and ambitious vision for the future of education in the country. There is an urgent need to revise and align the agricultural education system in the country in line with NEP-2020 norms to build a competent human resource for undertaking education, research and extension activities at diversified, ecologically sustainable and economically viable agricultural and allied sectors with integration of technology and innovation.

The Indian Council of Agricultural Research (ICAR) has been at the forefront of promoting excellence in agricultural education, focusing on the development of a skilled workforce to meet the nation's growing agricultural demands. To ensure that agricultural education stays relevant, the ICAR has regularly revised curricula through various Deans' Committees, with five such committees already having updated the academic standards over the years. These revisions align the education system with both national and international standards ensuring students are prepared for the challenges of modern agriculture.

The Sixth Deans' Committee, constituted in the year 2021, has prudently with congruence of excellence and relevance revised the undergraduate course curriculum, course contents, degree nomenclature including entry-exit options recommending the reforms in admission including lateral entry options and examinations. The committee had updated the course curriculum as per the guidelines of NEP-2020 focussing skill enhancement with integration of digital learning to align with the evolving global requirements and the advent of new technologies with focus on better employability, flexibility in movement from one institution to another, multiple entry and exit options, choice-based credit system. Experiential leaning and entrepreneurship development programs have been included for training student in real work satiations to develop them as future entrepreneurs. Academic Bank of Credits (ABC) introduced to facilitate

Personal

movement from one institution to another with credit transfer. Innovative teaching approaches such as online, open distance learning (ODL) and blended learning have been emphasized to merge traditional and non-traditional educational methods. The continuous updating of course curricula based on recent technological advancements ensures that students remain at the cutting edge of agricultural knowledge.

The Council expresses gratitude to Dr. Tej Partap, Chairman of the Sixth Deans' Committee, for his leadership,as well as to the committee members for their efforts in aligning agricultural education with NEP-2020 and global trends. I appreciate the efforts of Dr. R. C. Agrawal, Deputy Director General (Education) and all the committee members to align,update and contextualise the academic pursuits with NEP-2020 guidelines and to prepare this valuable report. Dr. Ajit Singh Yadav, ADG (EQAR & Member Secretary, Sixth Deans' Committee) has rendered untiring efforts in arranging meetings and facilitating the course of deliberations, drafting and compilation of report.

The ICAR shall strive to implement all the recommendations of the report. I hope it will help to achieve our mission to make agricultural education more accessible, affordable, relevant, practical and professional pursuing national and international quality education standards.



(Himanshu Pathak)

Dated: 10 September, 2024
New Delhi

Overview of 6th Deans' Committee Report

Indian Council of Agricultural Research (ICAR) under the Department of Agricultural Research and Education Government of India, is tasked with the responsibility to aid, impart and coordinate agricultural education to develop high-quality human resources in the country. The National Education Policy-2020 (NEP-2020) presents an opportunity for substantial reforms in the education system, including higher agricultural education. Soon after the announcement of the NEP-2020, ICAR formulated a committee and developed the guidelines "Implementation strategy for National Education Policy-2020 in Agricultural Education system" during September, 2021. Accordingly, all the Agricultural Universities (AUs) started implementing various provision of NEP-2020 in their respective AUs. Following the committee's recommendations, the Sixth Deans' Committee was constituted on August 17, 2021 (orders issued on Sep 15, 2021 vide notification *F. No. Edn.5/24/202/EQR/VI Deans).* The 6th Deans' Committee was mandated to revamp the course curriculum, credit framework, and academic standards for agricultural education. This initiative aims to standardize uniform academic structures across the country both in public and private institutions offering undergraduate (UG) programs in agriculture and allied sciences.

To formulate the guidelines, course curriculum & credit framework, and other aspects, series of meetings and consultations (both off-line and on-line) of committee were held and all aspects were discussed in detail taking into consideration of NEP-2020 provisions. The member of the committee consulted the subject specific experts by holding off-line and on-line meeting. A meeting was also organized with CEO, Agriculture Skill Council of India on modalities of integration of vocational courses in the general agriculture education course framework. Further, a meeting with Chairman, UGC was also held to discuss the UG course curriculum of all agriculture and allied science disciplines as per the NEP-2020 and UGC guidelines. The general guidelines, course curriculum and credit framework was also presented in Vice-Chancellor' Conference held at NASC, New Delhi and suggestions were incorporated in the report. The report was also presented in a meeting chaired by Secretary, who attend the meeting DARE & DG ICAR. All Deputy Director General (DDGs) & Assistant Director Generals (ADGs) of education suggested the changes which were incorporated in the report. The report was also sent to all DDGs for their inputs and suggestions. The draft report was sent all Vice-Chancellors of SAUs/CAUs/DUs/CUs with agriculture faculty for taking views/suggestions of faculty and students. In addition, views of foreign experts were also invited on the draft report. The final report on general guidelines, course curriculum, credit framework of all the UG disciplines was prepared in consultation with stakeholders.

Guided by the principles and philosophy of NEP-2020, the committee developed a comprehensive report outlining a restructured course curriculum and credit framework for 13 UG disciplines in agriculture and allied sciences and necessary provisions have been made in the curriculum to enable an individual to study report major and minor courses along with choice of electives. The 13 UG disciplines for which the course curriculum and credit framework restructured were Agriculture, Agricultural Engineering, Biotechnology, Dairy Technology,

Fisheries Science, Food Technology, Forestry, Community Science, Horticulture, Food Nutrition and Dietetics, and Sericulture, along with two new disciplines namely Natural Farming and Agribusiness Management.

Key features of the report include curriculum revision, modification of academic structure of degrees/diplomas/certificates, the introduction of an academic bank of credits (ABC), a multiple entry-and-exit system, flexible course selection, introduction of skill enhancement courses, making internship as part of UG-certificate, UG-diploma and degree requirements, and the incorporation of industry-oriented internships as part of UG requirements. A course entitled "*Deeksharambh*" has been introduced in the first semester for a duration of two weeks to acquaint students to learn from each other's life experiences, traditional values and traditional cultures and values. Common courses have been proposed developing better communication skills and personality development as well as to have a broader view of agriculture and allied sectors. New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula for preparing student in the era of Digital Technology. Progressive assessment of the student/s is part of course curriculum and the focus is enhancing their critical thinking and creativity rather than rote reading.

During this comprehensive exercise of restructuring the course curriculum and credit framework, the much-needed support, inputs and participation rendered by Hon'ble Vice-Chancellors of SAUs/CAUs/DUs/ CUs with Agriculture Faculty is greatly acknowledged. The support and help extended by all Deputy Director Generals is much appreciated.

I also take this opportunity to express a deep sense of gratitude to Dr. Trilochan Mohapatra, Former Secretary, DARE and Director General, ICAR for his initiatives, guidance and support. I feel extremely happy to take this opportunity to express my deep sense of gratitude to Dr. Himanshu Pathak, Secretary DARE and DG, ICAR for reposing faith in the committee and also constantly providing visionary guidance, cordial support and valuable inputs which helped in completing this task through various stages.

I hope, the educational reforms as suggested by the Sixth Deans Committee shall lead to a complete overhaul, and re-energise the higher agricultural education system to overcome the challenges currently being faced in India and thereby, deliver high quality higher agricultural education with equity and inclusion with focus to make the agricultural graduates as global leaders equipped with skills of better employment.



(R.C.Agrawal)
Deputy Director General (Agricultural Education)

Dated: 10 September, 2024
ICAR, New Delhi

Preface

Enhancing quality of human resource is a pre-requisite for implementing and upgrading research programs, developing technologies, evolving institutional arrangements to face challenges and to harness opportunities in the global perspective. Moreover, in the agriculture and allied sectors, such aspects are still more important due to the rapid changes occurring in challenges as well as in technologies. There is an urgent need of adequate trained manpower, that is professionally competent, socially sensitive and ethically strong to provide the technical backstopping in the changing resource constraints scenario in terms of land and water availability, and sustain agricultural growth with challenges of climatic adversities.

The ICAR having the mandate of guiding, managing and coordinating agricultural education in the country has been working in this regard and the National Agricultural Research, Education and Extension (NAREE) system continues to strive for maintaining and upgrading the quality and relevance of higher agricultural education through the partnership with 76 Agricultural Universities (AUs) comprising State Agricultural Universities (SAUs), ICAR Deemed-to-be-Universities (ICAR DUs), Central Agricultural Universities (CAUs) and Central Universities (CUs) with Agriculture faculty. One such measure that Council has taken periodically is the constitution of Deans' Committee for revising the course curriculum and also to undertake reforms in agricultural education in line with national priority.

National Education Policy (NEP-2020) was launched by the Government of India for transforming India's education system, seeking reforms at school, college, and university levels to build a knowledge-driven society. The NEP-2020 clearly indicates the need for reviving agricultural education which must be aligned with NEP-2020 based on its five pillars, namely, Access, Equity, Quality, Affordability, and Accountability. The NEP-2020 calls for improvement in both the capacity and quality of agricultural education with the aim to develop good, thoughtful, well-rounded, and creative individuals. This policy also focuses on the study of one or more specialized areas of interest at a deep level, and also on developing character, ethical and constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first century capabilities across a range of disciplines.

This report is the outcome of the Sixth Deans' committee, which was constituted by the Council to restructure course curricula of the UG programs and to align these with the NEP-2020 adopting a bottom-up approach involving all stakeholders. The Committee considered the academic aspects needed to be incorporated for the transformation of agricultural education system so as to prepare the youth to take up the challenges and opportunities in this vital and vibrant field. The main responsibility of the committee was the articulation of the knowledge and skills needed among the graduates and reform the course curricula for technological integration-based innovations for enhancing their skills, entrepreneurship, employment potentials, thus transforming them from job-seekers to job providers.

The report is in two parts. The PART-I comprises general recommendations on curriculum and credits as well as other guidelines on admissions, evaluations, etc., that is applicable to all disciplines and institutions involved in imparting higher agricultural education. The PART-II comprises discipline-wise recommended course curricula of undergraduate programs for thirteen ICAR approved disciplines. As per the provisions of NEP-2020, there are options for multiple entry and exit. Provision has been made for exit after the 1st year for award of UG-Certificate and after 2nd year for award of UG-Diploma after completion of internships at each level. Similarly, entry options for UG-Certificate and UG-Diploma holders have been made in 3rd and 5th semesters, respectively. Choice based skill enhancement courses have been integrated in the course programs. The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path through several modes of skill development programs as in-plant training, internship, projects and rural agricultural work experience, etc.

Common courses of multi-disciplinary, value-added, and ability enhancement categories as per NEP-2020 guidelines have been recommended for all the disciplines to enhance the communication skills and development of personality of students and to prepare them for collaboration with other sectors to face the next generation challenges from a holistic point of view. Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the Deeksharambh, NCC, NSS and focus has also been given on health and wellness.

The students will also take online courses, which will be choice based, to groom their passion or strengthen their knowledge and competency in any field beyond the prescribed courses. There are provisions for elective courses, which will also be choice based and the institutions will also have the liberty to develop new elective courses as per local needs and available expertise. As per NEP-2020 guideline, introduction of Academic Bank of Credits (ABC) for the students will be in practice, which can facilitate institutional transfer of students. New age courses like artificial intelligence, robotics, machine learning, nanobiotechnology, renewable energy, information technology etc. have been duly internalized in course curricula.

The committee is grateful to Dr. Himanshu Pathak, Secretary DARE and Director General, ICAR; Dr. Trilochan Mohapatra, former Secretary DARE & DG, ICAR for reposing faith in the Committee and giving opportunity and providing guidance in restructuring the course contents and also for giving their valuable inputs for updating the curricula as per the need of agriculture and allied sectors to face challenges at global level.

The Committee is highly beholden to Dr. R.C. Agrawal, DDG (Agril. Edn.), ICAR for his valued inputs, guidance and constant support. The Committee also puts on record its gratitude to all Deputy Director Generals, ICAR; Vice-Chancellors; Deans and other stakeholders for their constant guidance and support, which were critical in shaping this document and completing this important task. The committee also gratefully acknowledges the contributions of of Dr. P.S. Pandey, Former ADG (EP&HS); Dr. Bimlesh Maan, ADG (EP&HS); Dr. Seema Jaggi, ADG (HRD); Dr. S.K. Sankhyan, Principal Scientists, Dr. Vanita Jain, Dr. Smita Sirohi and Dr. K.P. Tripathi, Principal Scientists of Education Division, ICAR.

The contribution of Subject Matter Specialists as members and special invitees of the Deans' Committee, is gratefully acknowledged.

We also take this opportunity to thank and acknowledge the contributions of Sixth Deans Committee members, namely, Dr. Shanti K. Sharma ADG (Natural Farming); Dr. Sanjaya K. Dash (Agril Engineering); Dr. Jayant Deka (Agriculture); Dr. R. R. B. Singh (Dairy Technology); Dr. R. F. Sutar (Food Technology); Dr. Reeta Raghuvanshi (Food Nutrition and Dietetics); Dr. Meenu Shrivastava (Community Science); Dr. K. T. Parthiban (Forestry); Dr. M.I.S. Gill (Horticulture); Dr. S. Chandrasekhar (Sericulture); Dr. Ramesh Bhat (Biotechnology); Dr. V. R. Kiresur (ABM) and Dr. B. K. Das (Fisheries Science) for their important role in this strenuous task.

The report is expected to stimulate policy innovations and also institutional reforms in academics paving way in building students for more meaningful and satisfying lives and work roles and enabling economic independence of learners capable of global competence. We are confident the guidelines and curriculum in this report would encourage higher agricultural education institutions to shape new generation youth in agriculture and allied fields and motivate all stakeholders, educationists to policy makers in contributing in fulfilling the aspiration of NEW INDIA.



(Ajit Singh Yadav)
Member Secretary
(6th Deans' Committee)



(Tej Partap)
Chairman
(6th Deans' Committee)

ICAR-SIXTH DEANS' COMMITTEE

Task Accomplishment Certificate

The 6th Deans' Committee was set up by ICAR, on the recommendations of the ICAR Expert Committee on Implementation Strategy for executing National Education Policy (NEP-2020) across the 13 disciplines that fall under Agriculture and Allied Disciplines of Agricultural Education system. Under National Education Policy (NEP-2020) regime, ICAR as Professional Standards Setting Body (PSSB) for Agricultural Education in the country, has the primary task of prescribing the course curricula and credit framework that will govern agricultural education in the country. Therefore, as a step towards implementing NEP-2020, ICAR constituted 6th Deans' Committee with a specific mandate of restructuring course curricula and regulations for the degree programs in operation under agricultural education in the country.

The committee members, comprising the Chairman and Deans, representing each academic program, as expert members, held several deliberations and prepared a framework of the restructured academic system, defining credit hours, focus of semesters, integration of skill development opportunities and system of specialization within the degree programs and other provisions of NEP-2020, which will be common to all programs. Thereafter, each Member-Dean, worked with experts within their respective disciplines working across universities/institutions to restructure the course curricula as per NEP-NHEQF, that was considered paramount imperative. Draft notes were circulated among the members and academic experts for their suggestions. Committee also received inputs from ICAR, foreign experts, Vice-Chancellors, DDGs and other stakeholders through the office of Deputy Director General-Agricultural Education. Report of the 6th Deans' Committee is an outcome of these efforts.

This NEP-NHEQF guided restructuring of Undergraduate Programs of Agricultural Science, is expected to help build strong foundation of both knowledge and skills. More emphasis has been given to Skill training and flexibility in choice of courses to adopt the choice-based credit system. It is our belief that the restructured academic programs will help produce new generation of human resources in agricultural domain/disciplines, which will be equipped to meet the needs of new knowledge and skills in agricultural sector.

The committee members draw satisfaction in accomplishing this task and are grateful to ICAR for reposing trust on them to undertake this onerous task, as well as to office of DDG (Agricultural Education) for coordinating the support services during the process. We thank all those academicians across the agricultural education landscape of the country, who were consulted, who offered new ideas, and those who offered constructive criticism. Down the years, we look forward to see the fruits of this work by way of transformed agricultural education system of the country.



(TEJ PARTAP)
Chairman, Sixth Deans' Committee, ICAR

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List of Members of Sixth Deans' Committee

S. No.	Name	Expert
1.	Dr. Tej Partap Former Vice Chancellor, GBPUAT Pantnagar; SKUAST, Srinagar and CSKHPKV, Palampur, HP	Chairman
2.	Dr. Jayant Deka Dean, Faculty of Agriculture, AAU Jorhat, Assam	Member
3	Dr. Sanjaya K Dash Dean, College of Agricultural Engineering and Technology, OUAT, Bhubaneshwar, Odisha	Member
4.	Dr. V R Kiresur, Professor (Agricultural Economics) and Director of Education, UAS, Dharwad, Karnataka	Member
5.	Dr. Ramesh Bhat Professor and Head, Department of Biotechnology, College of Agriculture, UAS, Dharwad, Karnataka	Member
6.	Dr. Meenu Srivastava Former Dean, College of Community Science, MPUAT, Udaipur, Rajasthan	Member
7.	Dr. R R B Singh Vice-Chancellor, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh	Member
8.	Dr. B K Das, Dean, Faculty of Fishery Sciences, WBUAFS, Kolkata, West Bengal	Member
9.	Dr. Rita Singh Raghuvansi Former Dean, College of Home Science, GBPAUT, Pantnagar, Uttarakhand	Member
10.	Dr. R F Sutar Former Dean, Faculty of Food Processing and Bio-Engineering, Anand Agricultural University Anand, Gujarat	Member
11.	Dr. K T Parthiban Dean (Forestry), Forestry College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam, Tamil Nadu	Member
12.	Dr. M I S Gill Dean, College of Horticulture and Forestry, PAU, Ludhiana, Punjab	Member
13.	Dr. S Chandrasekhar Professor and Head, Department of Sericulture, UAS, GKVK, Bellary Road, Bengaluru, Karnataka	Member
14.	Dr. Shanti K Sharma Assistant Director General (HRM), Agril. Education Division, ICAR, KAB-II, New Delhi	Member
15.	Dr. Ajit Singh Yadav Assistant Director General (EQAR), Agril. Education Division, ICAR, KAB-II, New Delhi	Member-Secretary

1. Sixth Deans' Committee: Terms of Reference

1.1 Constitution of Committee for drafting the Implementation Strategy for Higher Agriculture Education

As a follow up to the National Education Policy-2020 (NEP 2020), ICAR, as Professional Standards Setting Body (PSSB) of agricultural education for the NEP-2020, set up a high-level committee comprising the Vice-Chancellors of Agricultural Universities. It was asked to devise a strategy for implementing NEP-2020 in agricultural education. Besides several other recommendations, the high-level committee recommended the constitution of Sixth Deans' Committee for restructuring the course curricula, framed by the Fifth Deans' Committee. Universities have adopted the Fifth Deans' Committee for implementation since 2016. The NEP-2020 required that this course curriculum is restructured to fit into the new academic regime.

1.2 Notification for Setting up the Sixth Deans' Committee

On the Recommendations of ICAR-NEP Implementation Strategy Committee, ICAR constituted the Sixth Deans' Committee on August 17, 2021 (orders issued on Sep 15, 2021) vide notification *F. No. Edn.5/24/202/EQR/VI Deans*. The 6th Deans' Committee was mandated to restructure the existing course curricula so as to enable implementation of NEP-2020 in agricultural education.

1.3 Terms of References of the 6th Deans' Committee

i) Restructuring of all UG Programs, all UG programs to be restructured as per NEP-2020 and NHEQF.

ii) Structure of first year UG Certificate Course, areas, end of course test and criteria for entry into second year Diploma course as per provisions of NEP-2020.

iii) Admission Criteria for UG-Certificate and UG Diploma courses, in view of the multiple entry and exit system provision under NEP-2020.

iv) Guidelines for Entrepreneurship of students.

v) Guidelines on provision for increasing gross enrolment ratio (GER), progressively.

vi) Defining UG and PG degrees for general market needs, as well as for specialist jobs and uniformity in UG and PG degree nomenclature.

vii) Any other point related to NEP-2020.

2. Prologue

2.1 Aim of Restructuring Agricultural Education

Education is at the heart of both personal and community development; its mission is to enable each of us, without exception, to develop all our talents to the full and to realize our creative potential, including responsibility for our own lives and achievement of our personal aim. There is, therefore, every reason to place renewed emphasis on the moral and cultural dimensions, apart from what is taught presently, enabling each person to grasp the individuality of other people and to understand the world's progression towards an uncertain future.

The 21st century is showing all signs of providing unprecedented means for communication and for the circulation and storage of information. Therefore, it will impose on education two demands which at first sight may appear contradictory. Education must transmit, efficiently and on a massive scale, an increasing amount of constantly evolving knowledge and know-how adapted to a knowledge driven civilization, because this forms the basis of the skills of the future. At the same time, it must find and mark the reference points that will make it possible, on the one hand, for people not to be overwhelmed by the flow of information, invading the public and private domains and, on the other hand, to keep the development of individuals and communities as its end in view. Education must, as it were, simultaneously provide maps of a complex world in constant turmoil and the compass that will enable people to find their way in it.

In this view of the future, responses to the demand for traditional education that are essentially quantitatively, and knowledge based are no longer appropriate. It is not enough to supply each student with a store of knowledge to be drawn from the existing one. Instead, everyone must be equipped to seize learning opportunities throughout life, both to broaden her or his knowledge, skills, and attitudes, and to adapt to a changing, complex and interdependent world.

2.2 Four Pillars of Education

The International Commission on Education in its report "Learning: The Treasure Within" (UNESCO, 1996) has defined "why and how" agenda for modifying education for 21st century, globally. It advocated inclusion of the concept of following four pillars of education if education is to succeed in

its task. NEP also has advocated similar perspective of future education system in India. Sixth Deans' Committee would like to lay stress on institutions to reorganize their existing academic system of agricultural education around these four fundamental types of learning. In a way these pillars must remain the pillars of knowledge, throughout a person's life.

1. *Learning to know* -- acquiring the instruments of understanding.
2. *Learning to do* -- to be able to act creatively on one's environment.
3. *Learning to live together* -- so as to participate and cooperate in all human activities.
4. *Learning to be* an essential progression which proceeds from the previous three.

These four paths of knowledge, all form a whole with many points of contact, intersection, and exchange among them.

2.3 Constitution of the report

The report is in two parts. PART-I comprises General Report on curriculum and credits as well as other general guidelines on admissions, evaluations, etc., that is applicable to all disciplines, colleges, universities, institutions, who are involved in imparting higher agricultural education in any of the following ways in the country.

PART-II of the report comprises discipline-wise recommendations, on restructured course curricula of undergraduate degree programs for 13 ICAR approved disciplines, as follows.

1. Agriculture
2. Agricultural Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries Science
6. Food Technology
7. Forestry
8. Community Science
9. Horticulture
10. Food Nutrition and Dietetics
11. Sericulture
12. Agribusiness Management
13. Natural Farming

3. Executive Summary

New Education Policy-2020 (NEP-2020) of India proposed many changes in the education system of India, including higher agriculture education system. A national level Committee was constituted by ICAR to develop an implementation strategy to comply with various provisions of National Education Policy (NEP-2020). ICAR constituted the Sixth Deans' Committee to restructure the existing course curricula so as to enable implementation of NEP-2020 in agricultural education. As per the NEP-2020 recommendations, the Sixth Deans' Committee has incorporated following several new initiatives in the proposed restructured UG curricula.

3.1 Classification of level of courses with targeted outcomes

The courses have been classified as per the level of teaching and also based on targeted outcome.

- The 1st year of the UG programme (NHEQF Level 4.5) includes the foundation courses, introductory courses and skills enhancement courses/training in the chosen area, ability enhancement courses. It is aimed that student/s will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment/ entrepreneurship.
- The 2nd year (NHEQF Level 5) includes the basic core courses and additional skill enhancement in chosen areas/ courses. It is aimed that the student/s will acquire the higher level knowledge in respective disciplines and adequate skills in some selected areas, to enable them employment at middle level/ supervisory level or for entrepreneurship.
- The 3rd year includes the advanced core subjects and their practical applications with an objective that the student will have deeper understanding of the subjects and their major application areas.
- The 4th year (NHEQF Level 6) will have the specialization/ elective courses and advanced skill enhancement through project and internship. The student will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than a job seeker through establishment of enterprises in concerned fields.

3.2 Multiple Entry and Exit

There is provision of multiple entry and exit at different levels. The student/s will have the option to exit after the 1st year. He/ she/ ze has to complete 10 weeks of internship (10 credits) after 1st year (2 semesters) to be eligible for award of UG-Certificate. The student has another option to exit after the 2nd year. The student has to complete another 10 weeks of internship (10 credits) after 2nd year (4 semesters) to be eligible for award of UG-Diploma.

After four years of study, the student will be awarded UG degree in concerned discipline. No exit after 3 years (6 semesters) is recommended considering the professional nature of the courses.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in recognised HAEIs. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

3.3 New courses for acquiring advanced knowledge and skill and for strengthening their cultural and ethical values and through choice based programs

3.3.1 Deeksharambh (Induction–cum-Foundation Course)

A course entitled "*Deeksharambh*" (0+2) (Non-gradial) will be offered at the start of first semester for a duration of two weeks. This will create a platform for students to learn from each other's life experiences, help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instilling life and social skills, social awareness, ethics and values, team work, leadership, creativity, etc. It will also help in identifying the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario. There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic and research managers.

3.3.2 Common courses

The following common courses have been proposed to be offered across the disciplines. This will enable the student for better communication skills and personality development as well as to have a broader view of agriculture and allied sectors, which will allow them for future collaboration with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade
- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics and Artificial Intelligence

In addition to these common courses and *Deeksharambh*, the courses such as Physical Education, First Aid, Yoga Practices, Meditation, NCC and NSS have also been made compulsory for students for better social awareness and health of the future generation.

3.3.3 New age courses

New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. Besides an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his/her interest. Due emphasis has been given to include the latest topics and subjects in both core and elective courses. Practical exercises and teaching methodology are proposed to make the young generation more imaginative, innovative, ingenious, creative and competent.

3.3.4 Online courses

The students will have to take a minimum of 6-10 credits of online courses, comprising one or more courses, as a partial requirement for the UG programme. The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from any online portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

3.3.5 Elective courses

The institutions will offer a bouquet of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report. The institutions will also have the liberty to develop new Elective courses as per local needs and available expertise.

3.4 Imparting Traditional Knowledge, Values and Ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the *Deeksharambh*, NCC/ NSS. It is proposed that Study tours shall be conducted across the country to make the student aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

3.5 Entrepreneurship development as a career path

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP- 2020, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

Skill enhancement courses are included in different modes as follows:

- Skill enhancement courses in the 1st year and 2nd year as part of the course programs;
- Internship for exit programs after 1st year/ 2nd year; and
- Advanced skill enhancement through Student READY programs such as in-plant training/ internship/hands-on-training/projects in 4th year.

The skills acquired must make the students proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field. It will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

3.5.1 Skill Enhancement Courses

Skill enhancement courses are essential requirements for any programme (UG-Certificate/ UG-Diploma or Degree). These will be choice based; student can choose the areas of skill enhancement from a bouquet of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/companies/NGOs/progressive entrepreneurs/ farmers for running various skill enhancement programs.

The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/capabilities/resources. In addition, the skill enhancement courses suggested by the UGC (Chapter 6), may also be offered.

3.5.2 Internship

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after 2nd year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/research institution/ project or with a progressive farmer/agri enterprise, etc.

3.5.3 Projects

For some disciplines, Projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications. They will be able to choose appropriate career in research or employment/ entrepreneurship, discover their interests, aptitudes and potentialities and maximise their potentialities and self-confidence. It will also add to creativity and critical thinking of the students.

3.6 Introduction of new degree programs

Two new degree programs have been proposed in this report in two important areas.

1. Considering the natural strength of the country and future opportunities, a new UG course on Natural Farming has been included. The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farm-land ecosystem, and reducing the market inputs. These important aspects of natural farming are considered as cost-effective and suitable for livelihood of large number of farmers and sustainable rural development.
2. A new degree programme on Agribusiness Management has been included. These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.

3.7 Light but tight educational programme

As per the norms of the NEP-2020, the programme has been made light but tight for the students. The total credit hours have been kept at 166 considering the specific need of the professional courses, however, in some of the disciplines, viz. Agril Engineering, Food Technology and Dairy Technology, the total credit hours ranged from 172 to 174. At the same time, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning experience more pleasurable and learning efficient.

3.8 Progressive evaluation

In the course programme, 20% has been kept for progressive assessment of the student within the semester in form of quizzes/ group assignments. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in the form of group assignments (which should encourage creativity, critical thinking and problem-solving attitude).

3.9 Academic Bank of Credit

As per NEP-2020 guidelines, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/NEP-2020 recommendations.

3.10 Migration of students from one institution to other

It has been proposed for inter-institutional transfer of students with accumulation of the ABC. The University/ HAEI may admit students either by holding its own admission test or use merit as criteria or by following any of the existing norms of both transferring and accepting Universities/HAEIs. The migration shall be subject to availability of seats at the accepting HAEI. It is recommended to make institutional migration after 4th semester. HAEIs are at liberty to put in place rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students.

3.11 Minimum requirement for establishing colleges for agriculture and allied disciplines

The minimum requirements for establishing colleges for 13 agriculture and allied sciences disciplines shall be as per the ICAR Model Act-2023 and various guidelines and orders being issued by ICAR from time to time.

3.12 Making implementation of the recommendations of the Deans' Committee mandatory

Efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programs and academic institutions by the National Agricultural Education Accreditation Board (NAEAB) of ICAR.

4. Restructuring of Undergraduate Programmes

4.1 Restructuring of UG Programs

The restructuring has been done based on the following NHEQF levels:

- Year 1, Certificate Course, NEP-NHEQF Level 4.5
- Year-2, Diploma Course, NEP-NHEQF Level 5.0
- Year 4, B.Sc. (Hons.)/ B. F. Sc. (Hons.)/ B. Tech., NEP-NHEQF Level 6.0

The restructured program for the undergraduate agriculture education with multiple entry and exit options is illustrated in Figure 4.1.

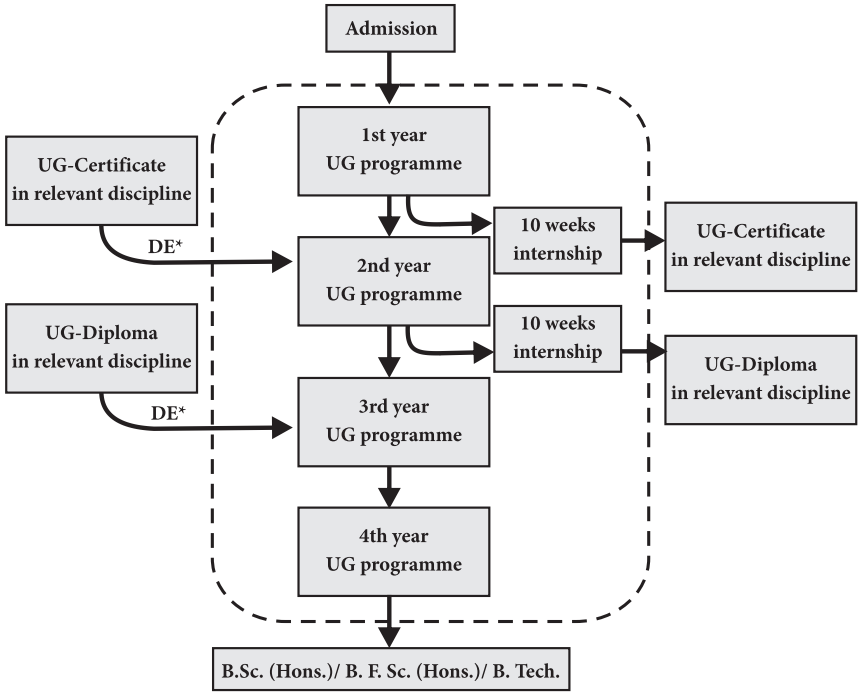


Fig. 4.1 Framework of Undergraduate Programmes
DE* Direct Entry in the respective year

The eligibility for entry into the UG programs will be + 2 Science; the students will be admitted as per norms of ICAR/ SAUs/CAUs. The 1st year of the programme will be having the foundation, introductory and skill enhancement courses. The 2nd year will be having basic core courses with

some more options for skill enhancement. The 3rd year of the programme will have advanced core courses. The 4th year programme will emphasize more on the specialisation and elective courses as well as advanced skill enhancement through internship.

There will be exit options after 1st year and 2nd year for UG-Certificate and UG-Diploma. However, the students opting to exit with UG-Certificate or UG-Diploma will have to take up 10 weeks internship after the 1st year (2 semester) and 2nd year (4 semesters), respectively.

Table 4.1 shows the restructured undergraduate programs for the higher agricultural educational institutions (HAEIs).

Table 4.1 Types of courses and learning outcomes for the restructured undergraduate programs for the HAEIs

Year	Types of courses	Learning outcome	Exit option
YEAR 1 NHEQF Level 4.5	Foundation courses, introductory courses and skills enhancement training/ training in the chosen area, ability enhancement courses	Students will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment/ entrepreneurship	A student must complete 10 weeks of internship (10 credits) after 1st year if exit with UG-Certificate is opted
YEAR-2 NHEQF Level 5	Basic core courses and additional skill enhancement in chosen areas/ courses	Students will acquire the higher level knowledge in respective disciplines and adequate skill in some selected areas, to enable them for employment at middle level/ supervisory level or for entrepreneurship	A student must complete 10 weeks of internship (10 credits) after 2nd year if exit with UG-Diploma is opted
YEAR-3	Advanced core subjects and their practical applications	Students will have deeper understanding of the subjects and their major application areas	No exit after 3rd year
YEAR-4 NHEQF Level 6	Specialization/ Elective courses and advanced skill enhancement through project and internship	Students will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than being a job seeker through establishment of enterprises in concerned fields.	UG degree in concerned discipline

4.2 Credit Hours Allocation

A total of 166-174 credit hours is recommended for the four years of UG programs. The credit distributions for the different courses have been specified for individual disciplines. The general structure is given in Table 4.2.

Table 4.2 General Credits Allocation Scheme of UG Programs (Credit hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)	
II	10	3(5)	3(6)	1(3) + 2(7)	4	-	23	-	
Post-II semester						10(12)			
III	16	----		2(8)	2	-	20		
IV	12	3(9)	3 (10)	----	2	-	20	-	10
Post-IV semester						10(13)			
V	21	-	-	-	-	-	21	2(11)	
VI	21	-	-	-	-	-	21	-	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	112	9	6	8	12	20	167	4	10

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).

(2) Farming based Livelihood systems

(3) NCC/NSS; (4) Communication Skills; (5) Entrepreneurship Development and Business Management

(6) Environmental Studies and Disaster Management;

(7) Personality Development; (8) Physical Education, First Aid, Yoga Practices and Meditation.

(9) Agriculture Marketing and Trade; (10) Agricultural Informatics and Artificial Intelligence

(11) Study tour (10-14 days).

(12) Only for those opting for an exit with UG-Certificate. (13) Only for those opting for an exit with UG-Diploma

One multidisciplinary course in Agricultural Engineering discipline is different from the above common courses keeping in view the discipline specific requirement.

Note:

- The credit hours mentioned in the Table 4.2 include both theory and practical.
- The total credit allocation and the allocation for different types of courses including on-line courses for some disciplines such as Agricultural Engineering, Dairy Technology and Food Technology are slightly different than those mentioned in the Table 4.2, so as to accommodate the specific need of these disciplines.
- Also, some minor deviations in the courses and credits allocations are allowed across disciplines considering the specific nature of the courses.
- The three-year course curricula of all disciplines of agricultural and allied sciences do not cover the teaching of elective/ specialized courses, that in fact qualify the students in specializing in

a particular subject in which the student intends to do further studies. These courses have been presently listed under the 7th and 8th semesters (in IV year). Therefore, the Sixth Deans' Committee is of the view that the option of B. Sc. (Hons.) with research may lead to deficiency of the knowledge and learning of the elective / specialized subjects needed for PG studies. For B. Tech. programs, the framework prescribed by AICTE/ UGC may be applicable. Under such circumstances, the Committee recommends that the launching of UG degree with research should be deferred for the time being. ICAR may consider about this aspect along with considering restructuring PG/ Ph.D. programs. Also considering the professional nature of the courses, the exit after at the end of 3rd year (at the end of 6th semester) is not recommended.

- Each class (contact hour) will be of 50 min duration and one practical will be of two contact hours.
- If the student has to take up any deficiency course(s), that has to be satisfactorily completed within the first year.

4.3 Deeksharambh (Introduction- cum-foundation course)

The goal of higher education is to nurture students by blossoming their hidden potentials to pursue the academic and professional studies in a diligent, honest and responsible manner. It is possible by facilitating them to develop a sense of integrity with diverse faculties and build linkages with peers, society and community as a whole and lastly be proficient in earning livelihood independently along with sustaining society and nature.

A course entitled Deeksharambh (0+2) (Non-gradial) will be offered at the start of first semester for a duration of two weeks. This will be a part of first semester for all purposes including the calculation of Net Instruction Days (NIDs).

The goal of Deeksharambh is to inculcate life skills, develop bonding with mentors, peers and seniors, familiarize with institutional academic framework and functioning, It must educate students to explore their potentials and understand the purpose of their life with reference to serving the community, nation and global society.

Often the incoming undergraduate students are influenced by their parents and relatives to join higher studies, without understanding their own interests and talents. Therefore, the very purpose of initiating Deeksharambh: the induction-cum-foundation course is to acclimatize the student with the new surroundings, develop bond with fellow students and teachers. It is the time when a student should become clear as to what he/she/ze is going to study in a particular discipline, or even it is time to quit and join another discipline of his/ her choice. They must develop sensitivity towards various issues of social relevance and imbibe human values to become responsible citizens.

Thus, ensuring a well-designed Induction-cum-foundation program by the institutions shall be designed to become helpful to both teachers and students for setting the pace of productive teaching and learning experiences.

Four Pillars of Deeksharambh

Socializing: Meeting new students, senior students, attend lectures by Eminent People.

Associating: Visits to university / college, visits to Dept./Branch/ Program of study and important places on campus, local area, city and so on.

Acclimatizing with rules and regulations, student support system, etc.

Experiencing: Subject lectures, study skills, small-group activities, physical activity, creative and performing arts, literary activities, universal human values, etc.

Deeksharambh will create a platform for students to:

- learn from each other's life experiences
- help for cultural integration of students from different backgrounds
- know about the operational framework of academic process in university
- instilling life and social skills
- social awareness, ethics and values, team work, leadership, creativity, etc., and
- identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic and research managers.

Steps will be taken by the institutions to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural integration of students from different backgrounds.

4.4 Common courses

The following common courses have been proposed to be offered across the disciplines, which in addition to giving the students a broader view of agriculture and allied sectors, will enable them for better communication skills and personality development. Besides, this will also help them to look beyond the boundaries of their own subject/ discipline, and collaborate in future with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade
- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics and Artificial Intelligence

In addition to these common courses and Deeksharambh, the courses such as Physical Education, First Aid, Yoga Practices and Meditation, NCC and NSS have also been made compulsory for students for improving social awareness, ethics, moral values and health of the future generation.

4.5 New age courses

Keeping in view the modern science needs, courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. In addition, an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his interest. Emphasis has also been given to include the latest topics and subjects

in both core and elective courses. Practical exercises and pedagogy are proposed to make the next generation more imaginative, innovative, ingenious, creative and competent.

4.6 Deficiency courses

If the student has to take up any deficiency course(s), it has to be completed within the first year.

4.7 Entrepreneurship development

Entrepreneurship is a key driver of the economy of a nation, which has been encouraged through NEP-2020. Expectation is that an early orientation of the young minds towards skill enhancement and entrepreneurship will inculcate entrepreneurial mind set, allowing them to have first-hand experience of working with institutions, organizations, companies, industrial setup and investors so as to understand their dynamics in the real-world setting.

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP-2020, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

Skill enhancement courses are included in following different modes:

- skill enhancement courses in the 1st year and 2nd year as part of the course programs;
- internship for exit programs after 1st year/ 2nd year; and
- advanced skill enhancement through Student READY: RAWE/Experiential Learning/Hands on Training/Skill development/Industrial attachment/In-plant training/student project/Internship etc. in 4th year.

Internship can be seen as a mini capsule of intense learning for a student, a way to apply the theory into practice, expand their knowledge base and a platform to integrate all learnings of formal classroom setup.

Addition of new age courses related to Agriculture, Forestry, Fisheries, Agricultural Engineering, Community Science, Food Nutrition and Dietetics, etc., and incorporation of choice based online courses, which can be taken up from NPTEL, moo KIT, edX, Coursera, SWAYAM or any other portal in open digital learning environment. Practical exercises and teaching methodology are so designed to make the young generation more imaginative, innovative, ingenious, creative and competent.

The skill set acquired must make them proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field. This will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

4.7.1 Skill Enhancement Courses

The skill enhancement programs will be choice based; student can choose the areas of skill enhancement from a bouquet of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs/ farmers for running various skill enhancement programs.

In the report, for each discipline the list of Skill Enhancement Courses (SEC) has been suggested. The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources. In addition, the skill enhancement courses suggested by the UGC, as listed, may also be offered.

The evaluation of the skill enhancement programs will be as per the evaluation criteria of courses with only practical. However, for the internship programs, the evaluation will be done jointly by the host and parent organisations/ institutions.

4.7.2 Internship

The internship proposed under NEP-2020 have been an integral part of agricultural education (as proposed by Fifth Deans' Committee) under the broad category of Student READY programs. It includes various activities such as Experiential Learning/ Hands-on Training, Skill Development Training, Rural Agriculture Work Experience (RAWE), In-Plant Training/ Industrial Attachment and Students' Projects. Therefore, in the recommended structure, the student READY is further strengthened as per NEP-2020 guidelines.

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after second year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/ research institution/ project or with a progressive farmer/ agri enterprise, etc.

HAEIs will ensure that the Internship program is aligned with the course that the student has chosen. It is recommended that each HAEI appoints one or more Coordinators for the internship programs. The coordinator must plan/execute/ monitor internship programme implementation at the institution level.

4.7.3 Projects

For some disciplines, projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications, choose appropriate career in research or employment/ entrepreneurship, discover their interests, aptitudes and potentialities and maximise his/ her/ze potentialities and self-confidence. It will also add to creativity and critical thinking of the students. This will also help the students gain research skills and be more innovative in planning, executing, reporting and presenting the things.

4.8 Study tour

There will be a study tour of 10-14 days duration during the 5th semester of the UG programme. The students will preferably visit the leading industries/ enterprises/ institutions/ organisations and

other places of academic interest outside the state (of location of the institution). This, in addition to exposing the students to the indigenous as well as the latest technologies in their related fields, will also help the students to know about the socio-economic-cultural variations within the country. The course will be of 0+2 credits, non-gradial.

4.9 Online courses

The students will have to take a minimum of 6-10 credits of online courses, which will comprise of one or more courses, as a partial requirement for the UG programme.

(As per UGC guideline, a 1- to 3- credit SWAYAM course is expected to be covered in 4-12 weeks' duration including the assessment component, in which it should be 40 hours for 3- credit courses to 80 hours for a 6-credit course for the learning from e-content, reading references material, discussion forum posting and assignment.)

The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc., and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. These can be taken any time during the duration of UG program, but preferably during the 3rd and 4th years.

The University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

The requirement of credits for online courses for B. Tech. programs is different due to the specific need of the disciplines.

4.10 Elective courses

The institutions will offer a bouquet of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report. The institutions will also have the liberty to develop and offer more Elective courses relevant to the subject as per local/regional needs and available expertise. The elective courses can be offered from other disciplines in a University/HAEI.

4.11 Imparting traditional knowledge, values and ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the Deeksharambh, NCC and NSS. It is proposed the Study tour shall be conducted across the country to be aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

4.12 Introduction of new degree programs

Among the 13 UG disciplines, two new degree programs have been proposed in the emerging areas. Considering the opportunities natural farming of the country and future opportunities, a new UG course on Natural Farming has been included. The syllabus is based on Bhartiya Prakartik Krishi Paddhati (BPKP) in India to enhance production, sustainability, saving of water, improvement in soil health and farmland ecosystem and reducing the market inputs. As this programme covers important aspects of natural farming which are considered as cost- effective and suitable for livelihood of large number of farmers and sustainable rural development.

Another, new degree programme on Agribusiness Management has also been included. By studying this programme, students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.

4.13 Light but tight educational programme

The course curriculum of all 13 UG programmes has been made light but tight for the students with total credit hours varying from 166-174 considering the need of the professional courses. Besides, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning outcome more employment, oriented and more efficient.

4.14 Moderation of courses at institution level

The following flexibility is allowed to the institutions for offering the courses:

A. Maximum 30% modification in the syllabus for any individual subject. It is recommended the HAEI should consider updating the course curricula around 5% every year. That would enable addition of new contents replacing obsolete/ old contents in the courses.

B. Formulation /addition/ change of Skill Enhancement modules as per needs/ facilities available.

C. Interchange of courses in between semesters within a year (but no change of course shall be normally allowed in between years).

D. Change of maximum two core courses (If any course is removed from the list of core course, it should be kept as elective), However, the total credit hours should not be lower than the prescribed.

E. Inclusion of any number of courses as Electives and freedom to offer the Elective courses.

F. Modification/ change of credit hours for any four courses (however, total credit hours should not differ by more than four).

G. In case the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

4.15 Central Assistance for strengthening higher agricultural education

The central Assistance for strengthening higher agricultural education, as proposed by the Fifth Deans' Committee, may be continued.

4.16 Admission criteria

The eligibility and mode of admission for entry into the UG programs will be as per the prevailing ICAR/ SAU norms.

Agricultural universities/ colleges and other general universities offering agricultural disciplines, will fall under the umbrella of ICAR, as PSSB for agricultural education, as mandated by NEP-2020.

Institutions are at liberty to assess their student intake capacity, and announce the number of seats available in the first semester, and for lateral entries at 3rd semester and 5th semester.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in recognised institutions. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

There cannot be guarantee for migration to another HAEI. Institutions are at liberty to make their own decisions/ norms/guidelines on the matter of seats and admissions in 3rd and 5th semesters.

4.17 Provision of lateral entry for Diploma holders from recognised institutions

Candidates having a Diploma from polytechnics (after completion of 3 years course after 10th in related disciplines) will be entitled to take admission in the 2nd year (3rd semester) program. The HAEI may admit students either by holding its own admission test or use merit as criteria for by following any of the existing norms of the University/HAEI.

4.18 Migration from one University to other

The UG-Certificate/ UG-Diploma passed candidate from a HAEI will be eligible for admission into any agricultural university/institution in the country at appropriate level, provided the admitting university has provision of seats to admit them.

It is recommended to make institutional migration after 4th semester more convenient. HAEIs are at liberty to put in place rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students. The migration shall be subject to availability of seats at the accepting HAEI.

Provided further, any such rule/ regulation that is notified by UGC regarding changes in admission criteria, migration, etc., these notifications will be considered/ examined by ICAR and re-notified to make them applicable to agricultural education falling under its domain.

4.19 Exit option

There will be three exits during the restructured UG programme.

Exit after 1st year: A student may opt to exit after the 1st year of UG programme. However, he/she has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 2nd year: A student may opt to exit after the 2nd year of UG programme. However, he/she has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-

Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 4-years programme leading to B.Sc. (Hons.)/ B.F.Sc. (Hons.)/ B. Tech. degree.

4.20 Maximum residential period

Students who exit with a UG-Certificate or UG-Diploma are permitted to re-enter within three academic years and complete the degree programme.

Students may be permitted to take a break from the study during the period of study but the total duration for completing the programme shall not exceed 7 years.

4.21 Examination and Evaluation system

There will be a uniform system of the evaluation and grading to be followed with Grade point average (GPA) system. The following pattern of examination is recommended.

Table 4.3 Evaluation system

Courses detail	Theory	Mid-term	Quiz/progressive assessment	Final Practical
For courses having one credit under practical	40%	15%	15%	30%
For courses having more than one credit under practical	40%	10%	10%	40%
For courses with theory only	50%	30%	20%	-
Courses with practical only	-	30%	20%	50% (Internal)

For the external theory examinations, the question paper will be obtained from external experts. The HoDs of the respective departments will ensure due coverage of the syllabus with the provision of moderation, if necessary. Paper evaluation to be done by a faculty other than the course instructor(s).

The external theory examinations should be of 2 to 2.5 hours duration and the mid-term examinations should be normally of 1-hour duration. The format of assessment and duration of quizzes/ progressive assessment duration will depend upon the course teacher.

Internal practical examination to be conducted by the course instructor and one faculty nominated by the HoD of the concerned department.

The evaluation of the skill enhancement courses will be done as courses with practical only.

Usually for any subject, there will be two quizzes within the semester, one before the mid-term and one after mid-term. There will be provision of corrections in between, i.e. the students scoring lower than 50% marks in any one quiz can opt for appearing for a third quiz to improve their grades. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in form of group assignments (which should encourage creativity, critical thinking and problem-solving attitude).

The evaluation of internship will be done both by the parent institute and the host industry/ organisation. It should be 50% weightage for each. The student shall submit a report to the parent

institute and present the learnings before the other students and faculty after the internship programme. The format of evaluation may be developed by the parent institute.

The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' remark.

When students take deficiency course(s), they will be assessed as 'Satisfactory' or 'Un-satisfactory' without any grade points.

The evaluation will be done on a 10-point scale.

10 point = 100 marks

The per cent of marks in a subject will be divided by 10 to obtain the grade point.

The grade point average for a semester will be calculated as follows.

$$GPA = \frac{\sum (Grade\ \ p\ \ \text{int} \times credit\ \ hours)_{in\ \text{one semester}}}{Total\ \ credit\ \ hours\ \text{in the semester}}$$

The Cumulative grade point earned at any stage of the course will be calculated as cumulative grade point average (CGPA) as follows.

$$\text{CGPA} = \frac{\sum (\text{Grade}\ \ \mathbf{p}\ \ \text{int} \times \text{credit}\ \ \text{hours})_{\text{until last semester}}}{\text{Total credit hours until last semester}}$$

If a student passes in a subject in a second attempt, for calculation of CGPA, the grade point for the subject in the second attempt will only be considered. The final CGPA will be named as overall grade point average (OGPA), which will be mentioned in the final transcript of the students.

4.22 Award of Divisions

The award of the divisions will be as follows

Table 4.4 Award of the divisions

OGPA	Division
5 to <6	Pass
6 to <7	II division
7 to<8	I Division
>=8	1st division and distinction

4.23 Uniformity in Nomenclature of Degrees

To ensure hassle free movement of students throughout the country, it is important that nomenclature of degrees awarded is same, across all HAEIs. The nomenclature will be as follows.

a. UG-Certificate with mention of discipline

e.g. UG-Certificate in Agriculture, UG-Certificate in Horticulture, UG-Certificate in Agricultural Engineering

Note: If any institution is at present offering any certificate course of the duration of one year lower, it may continue to do so, but this certificate course will not be considered at par with

the UG-Certificate, if the student has not taken admission through the appropriate entrance examination for entry into the 4-year UG program.

b. UG-Diploma with mention of discipline

e.g. UG-Diploma in Agriculture, UG-Diploma in Horticulture, UG-Diploma in Agricultural Engineering

Note: If any institution is at present offering any Diploma course of two years or less than two years' duration after +2 Science, it may continue to do so, but this diploma course will not be considered at par with the UG-Diploma, if the student has not taken admission through the appropriate entrance examination for entry into the 4-year UG program.

The nomenclature of undergraduate degrees will be as per the recommendations of the 5th Deans' Committee as follows:

B. Sc. (Hons.)/ B. F. Sc. (Hons.)/ B. Tech. followed by discipline

e.g. B. Sc. (Hons.) Agriculture/ B. F. Sc (Hons.)/ B. Tech. (Agricultural Engineering)

The nomenclature of degrees may change in case any such revision is suggested by the UGC.

4.24 Increasing Gross Enrolment Ratio (GER)

Keeping in view the NEP-2020 call for increasing GER, it is recommended that provision is made by institutions to launch stand-alone UG-Certificate and/ or UG-Diploma courses in specific subjects/ disciplines. The entrance examinations for such programs will be separate. The students completing the UG-Certificate will have to appear separate entrance test for continuing to higher level as per University/HAEI norms. Similarly, the students completing the UG-Diploma will have to appear separate entrance test for continuing to higher level as per University/HAEI norms.

4.25 Academic Bank of Credits (ABC)

As per NEP-2020 guidelines, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/ NEP-2020 recommendations.

4.26 Blended Learning

Blended learning has gained tremendous popularity as it combines the benefits of traditional classroom teaching with emerging technology and online educational resources to make learning more real-time, contextual, and engaging. This provision will enable blended learning to expand the open /distance learning options and to promote extensive use of technology in learning and skilling. This would help in overcoming the constraints of physical infrastructure and scalability while enhancing access, equity, and affordability and ensuring quality and accountability. The blended learning option shall also enhance accessibility of learning for Divyangs.

4.27 Minimum requirement for establishing colleges for agriculture and allied disciplines

The minimum requirements for establishing colleges for 13 agricultures and allied disciplines shall be as per the ICAR Model Act-2023 and various guidelines and orders being issued by ICAR from time to time.

The new NEP-2020 has been introduced in the country to formalize changes in the system, from school to college/ university level. Keeping in mind the concurrent developing scenario and stakeholders' demands, especially in agriculture education, research and extension systems across the regions, delivery of education content henceforth, will focus on key-concepts, ideas, applications and problem-solving angles so as to empower students to become employment ready.

The Indian Council of Agricultural Research has been declared Professional Standards Setting Body (PSSB) for agriculture and allied subjects under NEP-2020. The Council has been coordinating with all agricultural universities since 1960s or so for addressing the issues of quality agricultural education. Primary focus of national coordination in agricultural education was given to update course curricula periodically and concerned universities to adopt them. As a result of long term persuasions by ICAR and realization of stakeholders' demand, agricultural universities have been implementing ICAR recommended Course Curricula for 13 undergraduate programs, 80 Post Graduate programs and 79 Ph. D. programs.

Later on, it was perceived that merely changing the course curricula would not be sufficient to address the quality education, but a sound framework suggesting minimum requirements for degree programs especially requirements of teaching and non-teaching staff, instructional laboratory and instructional farms and supporting units of the following disciplines are also equally essential:

1. Agriculture
2. Agricultural Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries Science
6. Food Technology
7. Forestry
8. Community Science
9. Horticulture
10. Food Nutrition and Dietetics
11. Sericulture
12. Agribusiness Management
13. Natural Farming

4.28 Making implementation of the recommendations of the Deans' Committee mandatory

Efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programs and academic institutions by the National Agricultural Education Accreditation Board (NAEAB).

5. COMMON COURSES

***Deeksharambh* (Induction-cum-Foundation Course)-Non-gradial 2(0+2)**

Objectives

- To give a broad view and application areas of the subject of study
- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in university
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

Activities

The details of activities/ schedules will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University/institute

ii. Creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario

iii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iv. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming-based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework; Definition of farming systems and farming based livelihood systems. Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems-Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry-cum-Fish, Dairy cum-Fish, Piggery-cum-Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers; Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country; Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems; Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural-based livelihood enterprises, Study of components of important farming- based livelihood models/ systems in different agro-climatic zones; Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models); Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis; Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Dixon J, Gulliver A and Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World.* FAO and World Bank, Rome, Italy and Washington, DC, USA

2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK, Volume 7*. [Google Scholar]

3. Reddy S R. 2016. *Farming System and Sustainable Agriculture*. Kalyani Publishers, New Delhi.

4. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.
5. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa*. Consultation Document, FAO, Rome, Italy
6. Evenson R E. 2000. *Agricultural Producitivity and Production in Developing Countries.* In FAO, The State of Food and Agriculture, FAO, Rome, Italy
7. Agarwal A and Narain S. 1989. *Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development*. Center for Science and Environment, New Delhi, India

Entrepreneurship Development and Business Management **3 (2+1)**

Objectives

i. To provide student an insight into the concept and scope of entrepreneurship.
ii. To expose the student to various aspects of establishment and management of a small business unit.
iii. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation; Enterprise management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, material management. Production management–raw material costing, inventory control. Personal management–manpower planning, labour turn over, wages / salaries. Financial management /accounting–funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath, P M. 2009. *Entrepreneurship Development and Small Business Enterprises.* Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management*. Himalaya Publishing House.
3. Desai Vasant. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House
4. Grover Indu. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Publishing Academy.
5. Gupta C B. 2001. *Management Theory and Practice.* Sultan Chand & Sons.
6. Khanka S S. 1999. *Entrepreneurial Development*. S. Chand & Co.
7. Mehra P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
8. Pandey M and Tewari D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
9. Singh D. 1995. *Effective Managerial Leadership.* Deep & Deep Publ.
10. Singhal R K. 2013. *Entrepreneurship Development & Management*. Katson Books.
11. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill.

Agriculture Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity–meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions-CWC, SWC, FCI, CACP and DMI – their

objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA), and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Pub, N Delhi.
3. Dominic Salvatore. 2017. *Micro Economic Theory (3rd Edn)*. McGrow Hill Education India.
4. Kohls Richard L and Uhl Josheph N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2005. *Principles of Marketing*. Pearson Prentice-Hall.
6. Lekhi R K and Singh Joginder. 2006. *Agricultural Economics*. Kalyani Publishers, Delhi.
7. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari Deepali. 2004. *Rural and Agricultural Marketing*. International Book Distributing Co. Ltd, New Delhi.
9. Sharma R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii. To provide basic knowledge of computer with applications in agriculture
iii. To make the students familiar with agricultural-informatics, its components and applications in agriculture and Artificial intelligence

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri-information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Rajaroman V. 2022. *Fundamentals of Computer*.PH(I)
2. Pearson. 2005. *Introduction to Information Technology*. I. T. L. Education Solutions Limited.
3. C J Date. 2000. *Introduction to Database Management System*. Addison-Wesley.
4. Dhabal Prasad Sethi and Manoranjan. 2017. *Concepts and Techniques of Programming in C*. Techsar Pvt. Ltd.
5. Russell Stuart. 2013. *Artificial Intelligence: A Modern Approach*. Pearson Edition.
6. Nilson N J. 2001. *Principles of Artificial Intelligence*. Narosa.

Environmental studies and disaster management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art-skill and expertise on management of disasters.

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources. Introduction to Environment - Environmental studies-Definition, scope and importance -Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act.

Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest

fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill/hydro power/solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site - Urban/Rural/ Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De A K. 2010. *Environmental chemistry. Published* by New Age International Publishers, New Delhi.
2. Dhar Chakrabarti P G. 2011. *Disaster management - India's risk management policy frameworks and key challenges*. Published by Centre for Social Markets (India), Bangalore.
3. Erach Bharucha. *Text book for Environmental studies*. University Grants Commission, New Delhi
4. Parthiban K T, Vennila S, Prasanthrajan M Umesh and Kanna, S. 2023. *Forest, Environment, Biodiversity and Sustainable development.* Narendra Publishing House, New Delhi
5. Prasanthrajan M and Mahendran P P. 2008. *A text book on Ecology and Environmental Science.* ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur
6. Sharma P D. 2009. *Ecology and Environment*. Rastogi Publications, Meerat, India
7. Tyler Miller and Scot Spoolman. 2009. *Living in the Environment* (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, US

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/ Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Allport G W. 1937. *Personality: A Psychological Interpretation*. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. *How to Interview and be Interviewed*. Sheldon Press. London.
3. Carnegie Dale. 1997. *The Quick and Easy Way to Effective Speaking*. Pocket Books, New York.
4. Francis Peter S J 2012. *Soft Skills and Professional Communication*. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. *Communication Skills*. Oxford University Press.
6. Neuliep James W. 2003. *Intercultural Communication A Contextual Approach*. Houghton Mifflin Co Boston.
7. Pease Allan. 1998. *Body Language*. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. *Business Communication*. Oxford University Press.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press.
10. Thomson A J and Martinet A V. 1977. *A Practical English Grammar*. Oxford University

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1) Andrews Sudhir. 1988. *How to Succeed at Interviews. (21st Reprint)*. Tata McGraw-Hill, New Delhi.
2) Heller Robert. 2002. *Effective Leadership*. Essential Manager series. DK Publishing.
3) Hindle Tim. 2003. *Reducing Stress. Essential Manager Series*. DK Publishing.
4) Kumar Pravesh. 2005. *All about Self- Motivation*. Goodwill Publishing House, New Delhi.
5) Lucas, Stephen. 2001. *Art of Public Speaking.* Tata - Mc-Graw Hill, New Delhi.
6) Mile D J. 2004. *Power of Positive Thinking*. Rohan Book Company, Delhi.
7) Smith B. 2004. *Body Language*. Rohan Book Company, Delhi.
8) Shaffer D R. 2009. *Social and Personality Development (6th Edn).* Belmont, CA: Wadsworr

Physical Education, First Aid, Yoga Practice and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices
ii. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general well being through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga:

- Asanas: Definition and Importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

NCC-I **1 (0+1)**

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.

- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NCC-II **1 (0+1)**

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water

supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- I **1 (0+1)**

Objective

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

NSS-II **1 (0+1)**

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilled in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

6. UGC Skill Courses

UGC recommended list of skill development training areas

In addition to skill development training courses identified by respective universities from respective disciplines of study, such as agriculture, agribusiness, horticulture, forestry, etc. Skill development courses may also be selected by universities from the following list of skill trainings advised in the UGC notification. "Guidelines for the Introduction of Short -Term Skill Development Courses in Higher Educational Institutions". The university/ college may select any number of short-term skill development courses from the broad areas as mentioned below, in which they will have built institutional capacity for training or joined partnership with specialized institution capable of imparting such training program. The courses may be planned as integrated part of the UG-Certificate and UG-Diploma Programmes (after suitable planning of the contents) or they may be offered in stand-alone mode leading to award of certificates on the skill areas.

i. Artificial Intelligence, and machine learning
ii. Artificial Intelligence, and Robotics
iii. IoT (Internet of Things)/ Industrial IoT/Smart Cities
iv. Data Science and Analytics
v. Cloud Computing
vi. Virtual Reality, Augmented Reality and Extended Reality
vii. Cyber Security and Digital Forensics
viii. 5G Connectivity
ix. Digital Fluency/ Digital transformation
x. Industrial Automation and Robotics Process Automation (RPA)
xi. Electronic System Designs/ VLSI Designs
xii. Electronic Manufacturing
xiii. Basic Coding in Computing Languages
xiv. Computer-Aided Design (CAD)/Computer-Aided Manufacturing (CAM)
xv. Mechanical Tooling and Processes/ Mechatronics
xvi. Architectural Drafting, Basic 3D Design
xvii. Building Information Modelling (BIM)
xviii. 3D Printing
xix. Electrician/Electrical and Electronics
xx. Mobile Communication, Mobile Repairing and Basics of DTH Installation

xxi. Digital Marketing - courses in Search Engine Optimization (SEO), social media marketing, content marketing, and e-commerce management

xxii. Health and Wellness - courses focusing on mental health counselling, nutrition and dietetics, and fitness training in response to the growing awareness of personal well-being and holistic health and wellness

xxiii. Financial Technology (FinTech) - courses in digital payments, blockchain technology, digital currencies, and financial regulations

xxiv. Fashion Technology, Fashion design, stitching, etc. (home science colleges)

xxv. Yogic Sciences

xxvi. Soft skills and courses in effective communication, critical thinking and problem-solving, creative thinking and innovation, novel and adaptive thinking, design thinking and mindset, computational thinking, virtual collaboration, cross-cultural competency, new media literacy, team building, etc.

xxvii. Basics of start-ups and Entrepreneurship – leadership, project planning, management, Event Management, marketing, financing, and agri-business entrepreneurship, etc.

The university / college may also offer short-term courses in any other areas identified by it, based on the skill gap studies as well as institutional expertise, e.g. agriculture, horticulture, home science etc. The skill courses run by various Sector Skill Councils can also be adopted.

Syllabi of Different Disciplines

DAIRY TECHNOLOGY

Course Curricula for Undergraduate Programme in Dairy Technology; UG-Certificate in Dairy Technology; UG-Diploma in Dairy Technology; B. Tech. Dairy Technology

INTRODUCTION

The syllabus for undergraduate program in Dairy Technology has been restructured to fulfil the requirements of National Education Policy–2020 (NEP–2020), which envisages to build strong foundation of theoretical understanding of the subject and give adequate hands on experience to the students to develop competence and confidence to successfully embark on their journey to professional life.

The restructured syllabus therefore has provision for skill enhancement modules and students will get opportunities to choose from a basket of offered modules to develop proficiency in practical aspects of the technology. Besides, there are opportunities for holistic improvement in their personality through Foundation course *(Deeksharambh)*. Students will also have liberty to choose limited number of online courses in areas such as art, humanities or modern technologies etc. for broadening their vision.

The restructuring exercise for the common syllabus of the three identified programs viz., UG-Certificate in Dairy Technology; UG-Diploma in Dairy Technology and B. Tech Dairy Technology has been carried out after consultations and incorporation of inputs from Deans of Colleges offering UG courses. Many senior and young faculty members at different colleges involved in teaching these courses, alumni in the industry and other stakeholders have provided valuable inputs at various stages of the restructuring exercise.

HIGHLIGHTS

- The B. Tech. (Dairy Technology) program will be of 172 credit hours and 08 credit hours (online) spread over eight semesters.
- Adequate weightage has been given to skill development courses in the first two years, semesters I to IV. Students have been given flexibility and choice in selection of skill enhancement courses from a basket of multiple 'SEC modules' offered in all the four semesters of the first two years.
- In the first year, after completing the course requirement of minimum 40 credits as per UGC guidelines in both the semesters, there is compulsory provision of extra 10 credits for internship of 10 weeks duration through Industry placement/Industry exposure/Hands-on-training with the Dairy/Food Industry in related domain to become eligible on exit for the award of UG Certificate in Dairy Technology in one of the three chosen areas.
- After completion of two years, an internship of 10 weeks is necessary for those exiting after two years to become eligible for the award of UG Diploma in Dairy Technology. Students will thus complete requirement of minimum 80 credits as per UGC guidelines plus 10 weeks of Internship.
- These students are expected to acquire competency and confidence to not only become employable but also self motivated to start their own enterprise.
- More emphasis has been given to proper amalgamation of theory and practical to provide them in-depth knowledge of the B. Tech (Dairy Technology) syllabus.
- Students will also have the flexibility to complete these online courses of 08 credits spread over the entire four years of the UG Program. Students can select the online courses on varying topics of their interest ranging from advanced sciences, computing, data sciences, AI, machine learning to humanities. The course can be chosen from various online platforms available such as SWAYAM, edX, Coursera etc.
- In eighth semester of the degree program students will be offered Internship (Industrial training) of 20 credits. On successfully completing the four years degree requirement, the student will be awarded undergraduate degree B. Tech (Dairy Technology).

Entry and Exist Options

The entry and exit options for the B. Tech. (Dairy Technology) Programme are shown in the Figure 1 below:

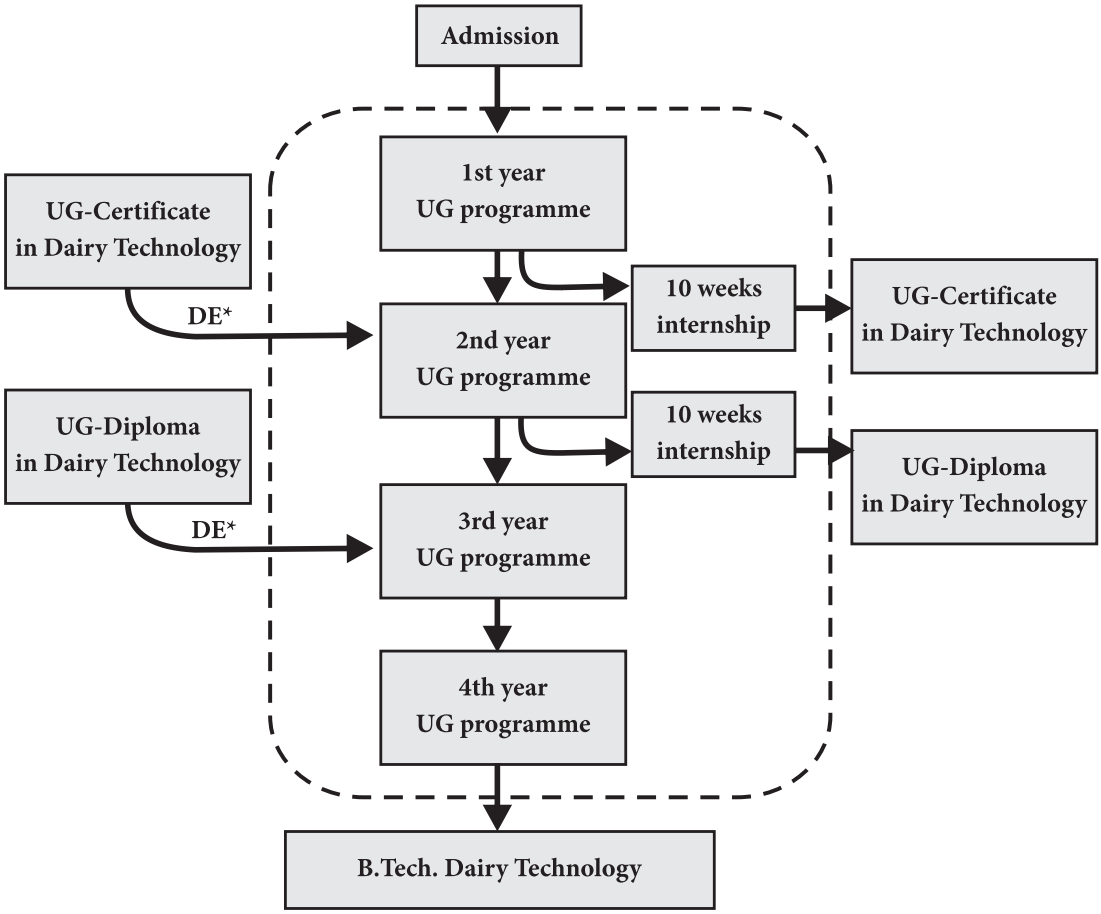


Fig.1 Entry and Exit options for the UG program in Dairy Technology

DE* Direct Entry in the respective year

Exit options

- **UG-Certificate (Dairy Technology)** (Exit after first year and completion of 10 weeks internship)
- **UG-Diploma (Dairy Technology**) (Exit after second year and completion of 10 weeks internship)
- **B.Tech. (Dairy Technology)** (On successful completion of four-year degree requirements):

  UG-Certificate (Dairy Technology) in one of the following three areas- Exit after First Year and completion of 10 weeks' internship

- Dairy Products Processing
- Dairy Plant Maintenance
- Milk Quality Testing/Quality Assurance of milk and milk products

Admission Eligibility in 1st year UG Programme: 10+2 Science with Mathematics as one of the subjects as per the criteria decided by or as per ICAR/SAU/HAEI.

- The candidates having UG- Certificate (Dairy Technology) or UG- Diploma (Dairy Technology) will be allowed admission to the B. Tech (Dairy Technology) program in III semester or V semester, respectively.
- The students will register for a maximum of two modules of Skill Enhancement Course/Skill for Employment and Entrepreneurship Development (SEC) during each semester in the first year. Thus, the name(s) of modules taken by the student will be reflected in the UG certificate award, such as UG-Certificate (Dairy Technology) in XXX (names of the modules).

ACADEMIC PROGRAMME

Semester-Wise Course Distribution

S. No.	Course Title	Credit Hours	Total Credit hours
First Year			
Semester-I			
1.	*Deeksharambh* (Induction-cum-Foundation Course)-Non-gradial	2 (0+2)	**22 (9+13) + 2 (Non-gradial)**
2.	Workshop Practice	2 (1+1)	
3.	Fluid Mechanics	2 (1+1)	
4.	Engineering Drawing	1 (0+1)	
5.	Fundamentals of Microbiology	2 (1+1)	
6.	Physical Chemistry of Milk	2 (1+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Communication Skills	2 (1+1)	
9.	Farming Based Livelihood System	3 (2+1)	
10.	NCC-I / NSS-I	1 (0+1)	
11.	****Skill Enhancement Course (SEC)- I	2 (0+2)	
12.	****Skill Enhancement Course (SEC)- II	2 (0+2)	
09 Credit for Core (Basic) Courses (2,3,4,5,6) 09 Credit for Common Courses: (7,8,9,10) 4 Credit for Skill Enhancement Course (SEC) (11&12)			

S. No.	Course Title	Credit Hours	Total Credit hours
	Semester-II		
1.	Market Milk	4 (3+1)	**25 (13+12)**
2.	Heat & Mass Transfer	3 (2+1)	
3.	Basic Electrical Engineering	3 (2+1)	
4.	Microbiology of Fluid milk	2 (1+1)	
5.	Chemistry of Milk	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Personality Development	2 (1+1)	
8.	NCC-II / NSS-II	1 (0+1)	
9.	****Skill Enhancement Course (SEC)-III	2 (0+2)	
10.	****Skill Enhancement Course (SEC)-IV	2 (0+2)	
15 Credit for Core (Basic) Courses (1, 2, 3, 4, 5) 6 Credit for Common Courses (6, 7, 8) 4 Credit for Skill Enhancement Course (SEC) (9 & 10)			
Post-Semester II (Only for exit option for award of UG-Certificate in Dairy Technology)			
1.	Internship (10 weeks)	10 (0+10)*	**10 (0+10)***
Student taking various modules will get a Certificates with Nomenclature as follows-			
Nomenclature of Certificate			
Milk and Milk Products Processing			
Dairy Plant Maintenance			
Milk Quality Testing			
*Compulsory Internship for students exercising exit option (UG-Certificate) after Ist Year			
Second year			
Semester-III			
1.	Thermodynamics	3 (2+1)	**21 (11+10)**
2.	Traditional Indian Dairy Products	3 (2+1)	
3.	Dairy Engineering	3 (2+1)	
4.	Refrigeration & Air-conditioning	3 (2+1)	
5.	Starter Culture and Fermented Dairy Products	2 (1+1)	
6.	Physical Education, First Aid, Yoga Practices, and Meditation	2 (0+2)	
7.	Agriculture Marketing & Trade	3 (2+1)	
8.	****Skill Enhancement Course (SEC)-V	2 (0+2)	
14 Credit for Core (Basic) Courses (1,2,3,4,5) 5 Credits for Common Courses (6 & 7) 2 Credit for Skill Enhancement Course (SEC) (8)			

S. No.	Course Title	Credit Hours	Total Credit hours
	Semester-IV		
1.	Cheese Technology	5 (3+2)	**22 (12+10)**
2.	Fat Rich Dairy Products	3 (2+1)	
3.	Ice-cream & Frozen Deserts	3 (2+1)	
4.	Chemistry of Dairy Products	2 (1+1)	
5.	Microbiology of Dairy Products	2 (1+1)	
6.	ICT in Dairy Industry	2 (1+1)	
7.	Entrepreneurship Development and Business Management	3 (2+1)	
8.	****Skill Enhancement Course(SEC)-VI	2 (0+2)	
17 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6) 3 Credits for Common Course (7) 2 Credit for Skill Enhancement Course (SEC) (8)			
	Post-Semester IV* (Only For exit option for UG-Diploma in Dairy Technology)		
1.	Internship (10 weeks)	10 (0+10)**	**10 (0+10)****
	Third Year		
	Semester-V		
1.	Condensed & Dried Milks	4 (3+1)	**22 (15+7)**
2.	Dairy By-products Technology	3 (2+1)	
3.	Quality and Safety Monitoring in Dairy Industry	3 (2+1)	
4.	Chemical Quality Assurance	2 (1+1)	
5.	Instrumentation and Process Control	3 (2+1)	
6.	Dairy Process Engineering	3 (2+1)	
7.	Operations Research	2 (1+1)	
8.	Economic Analysis	2 (2+0)	
Study tour*		**2 (0+2) NG**	**2 (0+2) NG**
22 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8) **2 credit (Non gradial) for Study tour (10-14 days during semester break)**			
	Semester-VI		
1.	Dairy Plant Management and Pollution Control	2 (1+1)	**20 (12+8)**
2.	Strength of Materials & Dairy Machine Design	3 (2+1)	
3.	Financial Management & Cost Accounting	3 (2+1)	
4.	Food and Industrial Microbiology	2 (1+1)	
5.	Packaging of Dairy Products	2 (1+1)	
6.	Food Technology - I	3 (2+1)	
7.	Food Chemistry	3 (2+1)	
8.	Energy Conservation and Management	2 (1+1)	
20 Credit for Core (Basic) Courses (1, 2, 3, 4, 5, 6, 7, 8)			

S. No.	Course Title	Credit Hours	Total Credit hours
Fourth Year			
Semester-VII			
1.	Food Engineering	3 (2+1)	**20 (15+5)**
2.	Dairy Plant Design and Layout	2 (1+1)	
3.	Food Technology-II	3 (2+1)	
4.	Sensory Evaluation of Dairy Products	2 (1+1)	
5.	Biochemistry and Human Nutrition	2 (1+1)	
6.	Elective Courses	8***	
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses may be opted to complete total 20 credits)			
Semester-VIII			
1	Student READY[RAWE/Industrial Attachment /Experiential Learning/ Hands-on Training/Skill Development/Project Work/Internship etc.]	One Semester (0+20)	**20 (0+20)**
Online Courses			
	Online Courses	**08**	**08**

****SEC-I, SEC-II, SEC-III, SEC-IV, SEC-V and SEC-VI to be selected from the list of the basket available under SEC-II module.

Department/Section-wise Course Breakup

S. No.	Course Title	Credit hours	Total
Foundational courses (two week)			
	Deeksharambh (Induction-cum-foundation)	0+2 (NG)*	2 (0+2)
Common Courses			
MDC	Farming Based Livelihood System	3 (2+1)	09 (6+3)
	Agriculture Marketing & Trade	3 (2+1)	
	Entrepreneurship Development and Business Management	3 (2+1)	
VAC	Agricultural Informatics and Artificial Intelligence	3 (2+1)	06 (4+2)
	Environmental Studies and Disaster Management	3 (2+1)	
AEC	Communication Skills	2 (1+1)	08 (2+6)
	NSS/ NCC –I	1 (0+1)	
	Personality Development	2 (1+1)	
	NSS/ NCC – II	1 (0+1)	
	Physical Education, First Aid, Yoga Practices & Meditation	2 (0+2)	
Department/ Section			
	Study Tour	2 (0+2) NG*	02

• Non- Gradial

Dairy Technology

Course category	Course title	Credit Hours
Core Courses	Market milk	4 (3+1)
	Traditional Dairy Products	3 (2+1)
	Fat Rich Dairy Products	3 (2+1)
	Condensed and Dried Milks	4 (3+1)
	Cheese Technology	5 (3+2)
	Ice Cream and Frozen Desserts	3 (2+1)
	Dairy By Products Technology	3 (2+1)
	Packaging of Dairy Products	2 (1+1)
SEC modules****	Sensory Evaluation of Dairy Products	2 (1+1)
	Dairy Plant Management and Pollution Control	2 (1+1)
	Food Technology I	3 (2+1)
	Food Technology II	3 (2+1)
	Operation of dairy evaporators and dryers	2 (0+2)
	Operation of liquid milk processing system	2 (0+2)
	Operation of ice cream freezers, ice candy making unit and their packaging	2 (0+2)
	Packaging of milk and milk products	2 (0+2)
	Technology of heat and acid coagulated milk products	2 (0+2)
	Canning and Sterilization systems for Dairy and Food Applications	2 (0+2)
	Extrusion Processing in Dairy and Food Industry	2 (0+2)
	Calibration of Dairy Equipments/Instrument	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Engineering

Course category	Course title	Credit Hours
Core Courses	Workshop Practice	2 (1+1)
	Fluid Mechanics	2 (1+1)
	Engineering Drawing	1 (0+1)
	Thermodynamics	3 (2+1)
	Heat and Mass Transfer	3 (2+1)
	Basic Electrical Engineering	3 (2+1)
	Refrigeration and Air conditioning	3 (2+1)
	Dairy Engineering	3 (2+1)
	Dairy Process Engineering	3 (2+1)
	Instrumentation and Process Control	3 (2+1)
	Food Engineering	3 (2+1)
	Strength of Materials and Dairy Machine Design	3 (2+1)
	Dairy Plant Design and Layout	2 (1+1)
	Energy Conservation and Management	2 (1+1)

Course category	Course title	Credit Hours
SEC modules****	Electrical Power supply and distribution in Dairy plant	2 (0+2)
	Introduction to AutoCAD/Solids works, Ansys, CFD for Design of Dairy machines and Layout	2 (0+2)
	Electrical and Control Systems in Dairy Plant	2 (0+2)
	Design, Operation and Maintenance of Cold Storage, Ice Bank tanks, Ice silo and refrigeration plant in Dairy plant	2 (0+2)
	Capacity Design, operation and Maintenance of steam Boilers, Air compressor, DG set, Soft water plant, and other utilities in Dairy plant	2 (0+2)
	Hygiene and Safety Engineering	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Chemistry

Course category	Course title	Credit Hours
Core Courses	Biochemistry and Human Nutrition	2 (1+1)
	Physical Chemistry of Milk	2 (1+1)
	Chemistry of Milk	3 (2+1)
	Chemistry of Dairy Products	2 (1+1)
	Chemical Quality Assurance	2 (1+1)
	Food Chemistry	3 (2+1)
SEC modules****	Basic aspects of milk and milk products testing	2 (0+2)
	Nutritional evaluation of milk and milk products	2 (0+2)
	Malpractices in dairy industry: detection & control	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Microbiology

Course category	Course title	Credit Hours
Core Courses	Fundamentals of Microbiology	2 (1+1)
	Microbiology of Fluid Milk	2 (1+1)
	Microbiology of Dairy Products	2 (1+1)
	Quality and Safety Monitoring in Dairy Industry	3 (2+1)
	Starter Culture and Fermented Dairy Products	2 (1+1)
	Food and Industrial Microbiology	2 (1+1)
SEC modules****	Food safety and hygiene	2 (0+2)
	Preparation and management of starter cultures for fermented milk products	2 (0+2)
	Basic microbiological tests for quality of milk and milk products	2 (0+2)
	ISO 22000 : Food Safety Management System	2 (0+2)
	FSSAI rules and regulations	2 (0+2)
	NABL Accreditation of laboratory	2 (0+2)
	BIS certifications for the dairy industry	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Dairy Business Management

Course category	Course title	Credit Hours
Core Courses	Farming based Livelihood System	2 (1+1)
	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Environmental Science and Disaster Management	3 (2+1)
	Communication Skills	2 (1+1)
	Personality Development	2 (1+1)
	ICT in Dairy Industry	2 (1+1)
	Operations Research	2 (1+1)
	Economic Analysis	2 (2+0)
	Agriculture Marketing & Trade	3 (2+1)
	Entrepreneurship and Business Management	3 (2+1)
	Financial Management and Cost Accounting	3 (2+1)
SEC modules****	International dairy trade	2 (0+2)
	Brand awareness : Major dairy companies and their brands	2 (0+2)
	Understanding operations of a sweet shop	2 (0+2)
	Market Survey on dairy and related aspects	2 (0+2)
	Market research : tools and techniques	2 (0+2)

****These are only indicative. Depending on the facilities available, opportunities for employment and interest of the students.

Table 1: Credits Allocation Scheme of B.Tech. (Dairy Technology) Program (Credit Hours)

Semester	Core Courses- (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	09	3(2)	3(10)	1(3) + 2(4)	4	-	22	2(1)		
II	15	-	3(6)	1(3) + 2(7)	4	-	25	-	10(12)	
III	14	3(9)	-	2(8)	2	-	21			
IV	17	3(5)	-	----	2	-	22	-	10(13)	08
V	22	-	-	-	-	-	22	2(11)		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**117**	**9**	**6**	**8**	**12**	**20**	**172**	**4**		**08**

Note: The credit hours mentioned in the table includes both theory and practicals.

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration), non-gradial

(2) Farming Based Livelihood Systems

(3) NCC/NSS (I& II)

(4) Communication Skills

(5) Entrepreneurship Development and Business Management

(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices & Meditation
(9) Agriculture Marketing & Trade
(10) Agricultural Informatics and Artificial Intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		**Credits**
Core courses (major & minor/s)	:	117
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Student READY (RAWE/Industrial Attachment /Experiential Learning/Hands-on Training/Skill Development/Project Work/Internship etc.)	:	20
**MOOCS	:	08
Total	:	**172 + 08****

*Massive Open Online Courses

The credits of *Deeksharambh* (0+2) and Study tour (0+2) have not been included in the total 172 credit hours.

Credits allocation scheme of UG Agricultural Engineering program is given in Table-1

Detailed Syllabi
Semester-I

Deeksharambh (Induction-cum-Foundation Course)(02 week)- Non-Gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Workshop Practice 2 (1+1)

Objectives

i. To understanding the basic requirements of workshop activities

ii. To description of various tools, equipment and processes used in various workshops

iii. To developing general machining skills involved in production of machine elements

Theory

Introduction: workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry. Heat treatment process: Hardening, tempering, annealing and normalizing etc.

Metal work: Metal cutting. Soldering, Brazing. Welding: Electric arc and Gas welding.

Smithy and forging operations: tools and equipment.

Bench work: The bench, flat surface filing, chipping, scrapping, marking out, drilling and screwing.

Introduction to following tool machines: (a) Lathe Machine, (b) Milling Machine, (C) Shaper and Planner, (d) Drilling and Boring machines, (e) Grinder, (f) CNC Machines etc.

Practical

To study different types of measuring tools used in metrology and determine least counts of vernier calipers, micrometers and vernier height gauges. Job work on filing and chipping. To study different types of fitting tools and marking tools used in fitting practice. To study various types of carpentry tools and prepare simple types of at least two wooden joints. Job work on hand hack and power hack saw. Job work on metal sheet working. Job work on butt and lap welding. To study different types of machine tools (lathe, milling, drilling machines etc). To prepare a job on a lathe involving facing, outside turning, taper turning, step turning, radius making, threading etc.

Suggested Readings

1. Black B J. 2015. *Workshop Processes, Practices and Materials. Routledge*. England, United Kingdom.
2. John K C. 2010. *Mechanical workshop practice*. Phi learning pvt. Ltd. New Delhi, India.
3. Rajput R K. 2009. *Workshop Practice*. Laxmi Publications, Ltd. Chennai, India.
4. Sarathe A K. 2021. *Engineering Workshop Practice* | AICTE Prescribed Textbook—English. Khanna Book Publishing Co. Pvt. Ltd. New Delhi, India.
5. Arora R P. *Basic Mechanical Engineering*. Charotar Publishing House Pvt. Ltd., Anand (Guj.).
6. Chapman W A J. and Martin SJ. 1998. *Workshop Technology. Part-III*. Viva Books Private Ltd, New Delhi.
7. Raghuvanshi B S. 2002. *Workshop Technology*. Vol. II. Dhanpat Rai & Co. (P) Ltd, Delhi.

Fluid Mechanics 2 (1+1)

Objectives

i. To understand the properties of fluid at rest and in transit
ii. To understand how fluids move in response to differences in pressure
iii. To derive and apply general equations for various fluid flows
iv. To know working principles of pumps and evaluation of their performance

Theory

Units and dimensions, Properties of fluids. Compressible and non-compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gauges, Piezometer.

Fluid flow: Classification, steady uniform and non-uniform flow, Laminar and turbulent, continuity equation, Bernolli's theorem and its applications. Flow through pipes: Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity.

Flow through mouthpieces, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge.

Dimensional analysis: Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. Pumps: Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Pump selection and sizing.

Practical

Study of various types of pipes and pipe fittings. Study of different types of valves. Study of reciprocating pump. Study of rotary gear pump. Study of piezometer. Study of U tube Manometer. Study of inclined tube Manometer. Study of Venturimeter. Determination of frictional coefficient of given pipe. Determination of minor head loss. Study of Pitot tube. Study the construction and working principle of centrifugal pump. Study of Reciprocating pump. Study and measurement of flow of liquid by V-notch.

Suggested Readings

1. Bansal R K. 2004. *A Textbook of Fluid Mechanics and Hydraulic Machines*. Laxmi Publications. Chennai, India.
2. Bar-Meir G. 2009. *Basics of Fluid Mechanics*. University Press of Florida. Florida, United States.
3. Kumar K L. 2008. *Engineering Fluid Mechanics*. S. Chand Publishing. New Delhi, India.
4. Kundu P K. & Cohen IM. 2001. Fluid Mechanics. Elsevier. Amsterdam, Netherlands.
5. Morrison F A. 2013. An Introduction to Fluid Mechanics. Cambridge University Press. Cambridge, England, United Kingdom.
6. Jain A K. 1995. *Fluid Mechanics*. (8th Edn.) Khanna Publishers, New Delhi.
7. Kumar K L. 1996. *Engineering Fluid Mechanics*. S. Chand & Co., New Delhi.
8. Kumar D S. 1998. *Fluid Mechanics*. S K. Kataria and Sons, New Delhi.
9. Rajput R K. 1998. *A Textbook of Fluid Mechanics*. S. Chand & Co., New Delhi.

Engineering Drawing 1 (0+1)

Objectives

i. To impart knowledge about different types of lines, representation of letters and numbers in drawing sheet
ii. To learn to draw projections of lines, planes and solids etc.
iii. To understand and draw isometric projections
iv. To learn to convert the isometric view to orthographic view and vice versa

Practical

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale.

Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of vivet heads, types of riveted; joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

Suggested Readings

1. Agrawal B. 2008. *Engineering Drawing*. McGraw-Hill Education (India) Pvt Limited. Uttar Pradesh, India.
2. Gupta B V R. 2013. *Engineering Drawing*. I. K. International Pvt Ltd. New Delhi, India.
3. Jha A K. 2021. *Fundamentals of Engineering Drawing*: A to Z of SCALES. Independently Published. New Delhi, India.
4. Dhawan R K. 2012. *A Textbook of Engineering Drawing* (In First Angle Projection). S. Chand Publishing. New Delhi, India.
5. Shah M B. and Rana B C. 2009. *Engineering Drawing. Pearson Education India*. New Delhi, India.
6. Shah P J. 2010. *A Textbook of Engineering Drawing*. S Chand & Company Limited. New Delhi, India.
7. Simmons C H and Maguire D E. 2003. Manual of Engineering Drawing: To British and International Standards. Elsevier. Burlington, MA, USA.

1. Bhatt N D. and Panchal V M. 2006. Engineering Drawing: Plane and Solid Geometry. Charotar Publ. House Pvt. Ltd., Anand.
2. Bhatt N D. and Panchal V M. 2004. Machine Drawing. Charotar Publ. House Pvt. Ltd., Anand.
3. Narayana K L, Kannaiah P and Reddy K V. 2011. Machine Drawing. New Age International Publ., New Delhi.
4. Reddy K V. 2010. Textbook of Engineering Drawing. B.S. Publ., Hyderabad.

Fundamentals of Microbiology 2 (1+1)

Objectives

i. To understand the structural and functional differences among microorganisms
ii. To understand the different systems used to classify microorganisms
iii. To explicate the principles of microbial growth, nutrient requirements, and growth control methods
iv. To explore microbial diversity and their ecological roles
v. To comprehend the fundamentals of microbial genetics and host-microbe interactions

Theory

History of Microbiology: Discovery of microorganisms and microscopy (types, principles, and applications). Early Microbiologists: Contributions of Leeuwenhoek, Pasteur, Tyndall, Lister, Koch, Jenner, and Fleming. Scope of Microbiology: Applications in dairy, food, pharmaceutical, industrial, medical, and agricultural fields.

Classification of Microbes: Microbial Classification Systems: Traditional and numerical taxonomy. Classification Schemes: Whittaker›s five kingdoms and Woese›s three-domain system. Bacterial Classification: Berge's Manual of Systematic Bacteriology, phylogenetic trees. Prokaryotic vs. Eukaryotic Cells: Structure and function of prokaryotic cells. Cell Wall Differences: Gram-positive vs. Gram-negative bacteria; Archaeal cell walls.

Microbial growth and nutrition: Bacterial growth curve; factors affecting growth of bacteria, direct and indirect methods of measurement of bacterial growth; Bacteriostatic and bactericidal agents; Common nutrient requirements and nutritional types of microorganisms.

Microbial Ecology: Micro flora of air, soil, and water; extremophiles (archaea). Basics of Microbial Genetics and Host-Microbe interactions: DNA as the genetic material, Structure of DNA/ RNA, Genetic code, Central Dogma, DNA replication, transcription and translation.

Practical

General instruction for microbiological laboratory. Microscope -- simple and compound; Microbiological equipment; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Preparation of commonly used growth media (liquid and solid): simple and differential media. Isolation techniques for microorganisms – Streak, spread and pour plate. Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN). Visit to Microbiology Laboratory of Dairy/Food Industry.

Suggested Readings

1. Doyle M P. and Buchanan R L. 2013 *Food Microbiology: Fundamentals and Frontiers*. (4th Edn.) ASM Press, Washington, D.C.
2. Jay J M, Loessner M J. and Golden D A. 2005 *Modern Food Microbiology*. (7th Edn.). Springer New York.
3. Tortora G J, Funke B R. and Case C L. 2020 *Microbiology: An Introduction*. (13th Edn.) Pearson, New York.
4. Montville T J, Matthews K R. and Kniel K E. 2012 *Food Microbiology: An Introduction*. (3rd Edn.) ASM Press, Washington, D.C.
5. Batt C A. and Tortorello M L. 2014 *Encyclopedia of Food Microbiology*. (2nd Edn.) Academic Press, London.
6. Forsythe S J. 2020 *The Microbiology of Safe Food*. (3rd Edn.): Wiley-Blackwell Oxford.
7. Black J G. and Black L J. 2018. Microbiology: principles and explorations. John Wiley & Sons.
8. Pelczar M J. Chan ECS, and Kriec N R. 2017. Microbiology. Mc Graw Hill Education.
9. Pommerville Jeffrey C. 2021. Fundamentals of Microbiology, 12th eEdition**.** by Jeffrey C. Pommerville (2021).
10. Powar C B. and Daginawala H F. 2004. General microbiology. Himalaya Publishing House.
11. Tortora G J. Case C L., Bair III WB, Weber D, and Funke, B R. 2004. Microbiology: an introduction.
12. Willey J M, Sherwood L and Woolverton C J. 2011. Prescott's microbiology (Vol. 7). New York: McGraw-Hill.

Physical Chemistry of Milk 2 (1+1)

Objectives

i. To learn about compositional difference in milk of different species and breeds of milch animals
ii. To develop comprehensive understanding of physical properties of milk and their role in stabilizing milk system

iii. To understand how temperature and concentration of milk affect physical properties of milk and impact its stability
iv. To acquire knowledge about instrumental methods of measurement of different physical properties of milk

Theory

Constituents and gross composition of milk of different species and breeds of milch animals, Colloidal State: Distinction between true and colloidal solution, lypophilic and lypophobic solution, properties of colloidal system. Gels-their formation and properties, Milk as a colloidal system and its stability, Elementary idea about emulsion.

Density: Density and specific gravity, pyknometer method, hydrometer lactometer, Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk, viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Liquid State: Surface tension, surface energy interfacial tension, Surface tension of milk and the factors affecting it.

Refractive index, Colligative Properties of Dilute Solution: Vapour pressure, Raoults Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk, Osmosis and Osmotic pressure, Inter-relation of colligative properties, Electrical conductance of milk, Buffer solutions. Derivation of Henderson – Hasselbach equation and its application, buffer capacity and buffer index, milk as a buffer system, Equilibrium of electrolytes. pH indicators.

Oxidation- Reduction: Redox potential, Nernst equation, Redox system of milk, Occurrence of radio nuclide in milk and milk products, Molecular Spectroscopy: The spectrum of electro-magnetic radiation, the laws of Lambert and Beer, visible, and ultra-violet Spectroscope.

Practical

Determination of density and specific gravity of milk using pyknometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

Suggested Readings

1. Fox P F, Uniacke-Lowe T, McSweeney P L H and O'Mahony J A. 2015 *Dairy chemistry and biochemistry*. (2nd Edn.) Cham: Springer.
2. Fox P F and McSweeney P L H. 2013 *Advanced dairy chemistry: Volume 1A: Proteins: Basic aspects*. (4th Edn.) Boston: Springer.
3. Fox P F and McSweeney P L H 2013 *Advanced dairy chemistry: Vol. II : Lipids*. (4th Edn.) Boston: Springer.

4. Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy science and technology*. (2nd Edn.) Boca Raton: CRC Press.
5. Singh H and Thompson A. 2006. *Milk proteins: From expression to food*. London: Elsevier.
6. McSweeney P L H and O'Mahony J A. 2016. *Milk proteins: From expression to food*. (2nd Edn.) London: Elsevier.
7. Ling, E R. 2008. *A Textbook of Dairy Chemistry*. J V. Publ. House, New Delhi.
8. Mathur Datta R D and Dinakar P. 2005. *Textbook of Dairy Chemistry.* ICAR Publication, New Delhi.
9. Noble P Wong, Robert Jenness, Mark Keeney and Elmer H Marth. 1996. *Fundamentals of Dairy Chemistry. (*3rd Edn.). Springer New York, USA.
10. Walstra P Jenness, R and Badings, H T 1984. *Dairy Chemistry and Physics.* (1st Edn.). Wiley-Inter Science, New York.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii. To provide basic knowledge of computer with applications in agriculture
iii. To make the students familiar with agricultural-informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A*

algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Date C J. 2005. *Database in depth: relational theory for practitioners.* O'Reilly Media, Inc.
2. Dhabal Prasad Sethi and Manoranjan. *Concepts and Techniques of Programming in C.* Wiley India.
3. Education Solutions Limited, I.T.L. 2005. *Introduction to Information Technology*. India: Pearson Education.
4. Mahapatra Subrat K, Mishra P and Pradhan J S. *Introductory Agri-Informatics*. Jain Brothers Publication MN.
5. Rajaraman V and Adabala N. 2014. *Fundamentals of computers*. PHI Learning Pvt. Ltd..

Communication Skills 2 (1+1)

Objectives

i. To acquire competence in oral, written and non-verbal communication

ii. To develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Brown Michele & Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.
2. Carnegie Dale 2018. *The Quick and Easy Way to Effective Speaking*. Finger Print.
3. Francis Peter S J. 2012. *Soft Skills and Professional Communication*. Tata McGraw Hill, New Delhi.
4. Kumar S and Pushpa Lata. 2011. *Communication Skills*. Oxford University Press.
5. Napolean Hill. 2014. Think & Grow Rich. Finger Print.
6. Neuliep James W. 2003, *Intercultural Communication a Contextual Approach*. Houghton Mifflin Co Boston.
7. Raman M and Singh P 2000 *Business Communication*. Oxford University Press.
8. Seely J 2013 *Oxford Guide to Effective Writing and Speaking*. Oxford University Press.
9. Shital Kakkar Mehra. 2002. Executive Presence. Harper Business.
10. Thomson A J and Martinet A V. 1977. *A Practical English Grammar*. Oxford University

Farming Based Livelihood System 3 (2+1)

Objectives

i. To make the students aware about farming- based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems.

Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood.

Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry, duckry etc.), Horticultural crops, Agro-forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large-enterprises including value chains and secondary enterprises as livelihood components for farmers,

Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country,

Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and program by Central and State Government.

Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises; Study of components of important farming based livelihood models/ systems in different agro-climatic zones; Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models; Field visit of innovative farming system models; Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors(Value Chain Models); Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis; Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7.
3. Carloni A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon J, Gulliver A and Gulliver D. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA.
5. Evenson RE. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by BP Bhatt, Abhay Kumar, PK Thakur, Amitava Dey, Ujjwal Kumar, Sanjeev Kumar, BK Jha, Lokendra Kumar, KN Pathak, A Hassan, SK Singh, KK Singh and KM Singh. ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar A S, Ravisankar N, Prusty A K, Shamim M, Singh R, Bhaskar S, Malik S K, Tomar R K, Arunachalam A and Alagusundaram K. 2019. *Integrated Farming System Models for Agricultural Diversification, Enhanced Income and Employment*. ICAR, New Delhi, India.
8. Reddy SR. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.

9. Singh J P, Ravisankar N, Prusty A K, Sikka A K and Gangwar B. 2016. *Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition* (Series 1). IIFSR Bulletin No. 2016-1, AICRP on Integrated Farming Systems, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, pp. 1-88.

10. Walia SS and Walia US. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

NCC-I **1 (0+1)**

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness program

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline; Drill- aim, general words of command, attention, stands at ease, stand easy and turning; Sizing, numbering, forming in three ranks, open and close order march, and dressing; Saluting at the halt, getting on parade, dismissing, and falling out.

Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march; Marking time, forward march, and halt. Changing step, formation of squad and squad drill; Command and control, organization, badges of rank, honors, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.

Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NSS-I **1 (0+1)**

Objective

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness program

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS;

Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.

Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.

Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.

Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester-II

Market Milk 4 (3+1)

Objectives

i. To learn about the salient features of the Indian and international dairy industry
ii. To study procurement of milk and its reception in the processing plant
iii. To learn homogenization, bactofugation and pasteurization of milk for retail distribution
iv. To understand relevance and type of UHT plants, sterilization, processing induced changes in milk and aseptic packaging
v. To understand cleaning and sanitization practices followed in liquid milk processing plants

Theory

Dairy industry in India and abroad: Salient features. Collection and transportation of milk: (a) Organization of milk collection routes, (b) Practices for collection of milk, preservation at farm, refrigeration and natural microbial inhibitors.

Reception and treatment (pre-processing steps) of milk in the dairy plant: (a) Reception, chilling, clarification and storage: General practices, (b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) (c) Effect of homogenization on physical properties of milk, (d) Bactofugation: Theory and microbiology.

Thermal processing of milk: (a) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing, (b) Product control in market milk plant, (c) Defects in market milk, (d) Manufacture of special milks: toned, doubled toned, reconstituted, recombined,

flavoured, homogenized, vitaminised and sweet acidophilus milk, (e) Manufacture of sterilized milk, (f) Distribution systems for market milk.

UHT processing of milk**:** (a) Relevance of UHT processing in the tropical climate, (b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants, (c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems, (d) Technical control in the UHT plant, (e) Shelf life of UHT milk and tests for UHT milk. Nutritive value of milk. Effect of heat processing on nutritive value. Cleaning and sanitization of dairy equipment.

Practical

Familiarization with equipment for reception of milk in plant; Pretreatments: Chilling, clarification, filtration; Standardization and numericals relating to it; Cream separation: parts of separator and the process; Operation of LTLT, HTST pasteurizer, laboratory steriliser; Preparation of special milks; toned, double toned, standardised, flavoured, sterilised; Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP; Detection of adulterants and preservatives in milk; Assessment of homogenisation efficiency in milk; Strength of common detergents and sanitizers used in market milk plant.

Suggested Readings

1. Chandan R C, Kilara A and Shah NP (Eds.). 2008. *Dairy processing and quality assurance*. Wiley-Blackwell, New Jersey, USA.
2. De S. 2001. *Outlines of Dairy Technology*. Oxford University Press, New Delhi, India.
3. Singh S. 2014. *Dairy Technology-Vol. 01: Milk and Milk Processing* (Vol. 1). New India Publishing. New Delhi.
4. Rajagopal Sand Roy S K. 2021. *Milk and milk products technology.* (2nd Edn.). BS Publications, Hyderabad, India.
5. Singh S. 2014. *Dairy technology*: Set of 2 volumes. New India Publishing Agency, New Delhi, India.
6. Thompkinson D K and Sabikhi L 2012. *Quality milk production and processing technology*. New India Publishing Agency, Delhi.
7. Walstra P, Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology* (2nd Edn.) CRC Press, New York, USA.
8. Robinson R K. (Ed.). 1994. *Modern dairy technology: Vol. I : Advances in milk processing* (2nd Edn.). Springer, New York, USA.

Heat and Mass Transfer 3 (2+1)

Objectives

i. To develop basic understanding of modes of heat transfer under steady and transient conditions
ii. To acquire knowledge to apply basic principles of heat transfer to derive transfer co-efficients
iii. To understand design and working of various heat transfer equipment
iv. To acquire knowledge about basic concepts of mass transfer phenomenon and calculate mass transfer co-efficients

Theory

Basic heat transfer process: thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature.

One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines.

Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction.

Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient.

Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry.

Mass transfer: Fick's Law of diffusion, steady state diffusion of gases and liquids through solids. Equimolal diffusion. Mass transfer co-efficient and problems on mass transfer.

Practical

Determination of thermal conductivity: milk, solid dairy and food products. Determination of overall heat transfer co-efficient of: Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy and Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteurizer. Design problems on heat exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer Heat transfer in tubular heat exchanger: co current/ counter flow Heat transfer through composite wall. Heat transfer through legged pipes. Heat transfer through natural and forced convection.

Suggested Readings

1. Domkundwar S. 2008. *A Course in Heat and Mass Transfer*. Dhanpat Rai Publ., Delhi.
2. Eduardo Cao. 2010. *Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA*.
3. Green Don W Green and Robert H Perry. 2008. P*erry's Chemical Engineers' Handbook*. McGraw-Hill Co., Inc., NY, USA.
4. Holman J P Holman. 2010. *Heat Transfer.* (10th Edn.) McGraw-Hill Book Co., Boston, USA.
5. Baehr H D and Stephan K. 2006. *Heat and Mass Transfer. Springer Science & Business Media*. Berlin, Germany

6. Cengel Y. 2004. *Heat Transfer: A Practical Approach.* McGraw-Hill Education. New York, United States.
7. Rajput R K. 2019. A *Textbook of Heat and Mass Transfer,* (7th Edn.). S Chand Publishing. New Delhi, India.
8. Sachdeva R C 2009. *Fundamentals of Engineering Heat and Mass Transfer.* New Age Science. New Delhi, India.

Basic Electrical Engineering 3 (2+1)

Objectives

i. To learn about the basics of electrical circuits and networks
ii. To understand the working, construction and characteristics of Electrical Motors
iii. To develop understanding of operating principle and characteristics of DC machine and alternators
iv. To acquire basic understanding of principles involved in power generation, transmission and distribution
v. To understand economics of electric power generation and its management

Theory

Alternating current fundamentals: Generation of alternating current or voltage, magnitude of induced E.M.F. Alternating current, R.M.S value and average value of an alternating current. Phase relation and vector representation. Cycle, Time period, Frequency, Amplitude, Phase and Phase Difference, Root – Mean Square Value, Average value, Form Factor, Crest or Amplitude Factor. Poly-phase Circuit: - Generation of Poly-phase Voltage, Phase Sequence, Interconnection of Three Phases such as Star Connection and Delta Connection and their respective value of current and voltages, Energy Measurement by using Single and Two Watt-meters.

Transformers: Working Principle of Transformer, Construction features of Core and Shell type transformer, Elementary theory of an Ideal Transformer, E.M.F. Equation of a Transformer, Vector diagram of transformer with and without load, Transformer losses, voltage regulation and efficiency of transformer, Construction and working on an Single Auto-transformer, Different parts of a 11/0.4 KV, Distribution Transformer.

Three Phase Induction Motor: Fundamental working principles, Production of rotating magnetic fields, construction, Different types of Rotor such as Squirrel Cage and Phase wound rotors, starting of induction motors using Direct on Line (DOL) and Star-Delta Starter. Soft starter and variable frequency drives.

Single Phase Induction Motors: Introduction, Different types of single phase induction motors such as Split Phase, Capacitor type, Shaded Pole type, Universal or AC series motors, Repulsion start induction run motor, Repulsion – induction motor.

DC Machine: Construction and operation of DC generator, types of generators and their various characteristics. DC motors: Torque speed characteristics of DC motors, Starting and speed control of DC motors by using 3-point DC Starter.

Alternators: Elementary working principles, Different parts of an Alternators, Relation between Speed and Frequency, E.M.F. equation in an Alternators. Different types of Circuit Breaker and its use. Introduction to DG set system.

Electric Power Economics: Economics of Generation of electrical energy and related important terms such as, load curve, connected load, Maximum Demand, Demand Factor, Average load or demand, Load Factor, Diversity factor and its significance, Capacity Factor or Plant factor, Utilization Factor, Plant Operating Factor and Selection of Units and related numerical, Various types of Tariff used for calculation of electricity bill.

Lighting system: Introduction to industrial lighting system. Energy Management and Power Factor Corrections: Types of energy, Energy Management, Concept of Energy Audit. Concept of Power Factor, Disadvantages of low power factor, causes of low power factor, Various methods of improving low power factor, Location of power factor correction equipment, Advantages of power factor improvement.

Practical

Introduction to various basic circuits of parallel wiring, stair case wiring, fluorescent light fitting; Study of voltage and current relationship in case of Star connected load; Study of voltage and current relationship in case of Delta connected load; Measurement of power in 3-phase circuit; for a balanced load, using watt meters. Measurement of power in 3-phase circuit; for a unbalanced load, using watt meters. Measurement of iron losses of Single Phase transformer by conducting open circuit test; Measurement of Copper losses of Single Phase transformer by conducting short circuit test. Starting and reversing the speed of a single phase induction motor; Starting and reversing the speed of a three phase induction motor using Direct on Line (DOL) Starter; Starting and reversing the speed of a three phase induction motor using manual Star Delta Starter; Starting and reversing the speed of a DC shunt motor using 3-point DC Starter; Starting of slip-ring induction motor by manual and automatic Slip-ring Induction Motor Starter; To determine the relation between induced armature voltage and speed of separately /self excited DC Shunt Generator.

Suggested Readings

1. Bhattacharya S K. 2011. *Basic Electrical and Electronics Engineering*. Pearson Education New Delhi, India.
2. Nagsarkar T K and Sukhija M S. 2017. *Basic Electrical Engineering*. Oxford University Press. Oxford, United Kingdom
3. Rajput R K. 2012. *Basic Electrical and Electronics Engineering*. Laxmi Publications. Chennai, India.
4. Mehta V K and Mehta R. 2008. *Basic Electrical Engineering*. S. Chand Publishing. New Delhi, India.
5. Sahdev S K 2015. *Basic Electrical Engineering*. Pearson Education India. New Delhi, India.

Microbiology of Fluid Milk — 2 (1+1)

Objectives

i. To learn about the types of microorganisms present in milk and sources of contamination
ii. To study the types of microbial spoilage of milk and mechanisms of spoilage

iii. To understand measures required for clean milk production and natural antimicrobial substances present in milk

iv. To acquire knowledge about thermal processing of milk for enhancing quality and safety of milk

v. To learn about public health concerns arising out of microbial contaminants present in milk

Theory

Microbes associated with raw milk: Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their morphological and biochemical characteristics and classification. Significance of spore and spore-forming bacteria in milk, Microbial contaminants in raw milk, their sources during various stages of production - milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms; Microbiological changes in bulk refrigerated raw milk.

Concept of clean milk production: Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipment and dairy farm environment; Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoproxidase (LP) system. Somatic cells in raw milk: Significance and measurement.

Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavors and discolouration. Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health.

Microbiological aspects of fluid milk: Pasteurization, boiling, sterilization, ultra high temperature (UHT), non thermal (pulsed field) micro-filteration, bactofugation, standardization and homogenization. Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk. Bio-film formation during processing and their control measures.

Public health aspects of fluid milk: Microbial zoonotic diseases transmitted through fluid milk; Milk borne diseases -food infection, intoxication and toxi- infection caused *E. coli, Salmonella typhi, Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes, Shigella species, Campylobacter* etc. Microbiological grading and legal standards of raw and processed milk.

Practical

Morphological examination of common dairy microorganisms (size and shape, arrangement and sporulation); Estimation of microbial load in raw milk by standard plate count (SPC) and dye reduction tests (MBRT, RRT); Grading of processed/ market milk by Aerobic plate count (APC), coliform and methylene blue reduction time; Enumeration of psychrotrophic, thermophillic, thermoduric and spore forming bacteria in raw and market milk; Detection of sources of contamination: Air, water, utensils, equipment and personnel, line testing; Spoilage of milk caused by microorganisms: souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discolouration; Detection of mastitis milks: pH, SLST,

somatic cell count, chloride content, Hotis test and CAMP test. Detection and estimation of coliforms: presumptive, rapid coliform and IMViC Test.

Suggested Readings

1. Robinson R K. 2002 *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*. (3rd Edn.). Wiley-Interscience, New York.
2. Varnam A H and Sutherland J P. 1994. *Milk and Milk Products: Technology, Chemistry, and Microbiology*. Springer, London.
3. Doyle M P and Beuchat L R. 2013. *Food Microbiology: Fundamentals and Frontiers*. (4th Edn.) ASM Press. Washington DC.
4. Griffiths M W. 2010 *Improving the Safety and Quality of Milk: Milk Microbiology and Safety*. Vol. 1. Cambridge: Woodhead Publishing.
5. Hutkins R W. 2018 *Microbiology and Technology of Fermented Foods*. (2nd Edn.) Hoboken, NJ: Wiley-Blackwell.
6. Jay J M, Loessner M J and Golden D A. 2005. *Modern Food Microbiology*. (7th Edn.) Springer, New York.
7. Tamime A Y. 2009. *Dairy Processing: Improving Quality*. Woodhead Publishing. Cambridge.
8. Prajapati J B and Behare P V. 2018. *Textbook on Dairy Microbiology*. Directorate of Knowledge Management in Agriculture (DKMA), ICAR, New Delhi. ISBN: 978-81-7164-182-6.

Chemistry of Milk 3 (2+1)

Objectives

i. Learn about the chemical constituents present in milk and factors affecting its composition
ii. Develop understanding about different fractions of milk proteins, their properties, methods of estimation and genetic polymorphism
iii. Acquire knowledge about milk carbohydrates, their properties and changes brought about by processing interventions
iv. Learn about milk lipids, structure of glycerides and factors affecting fatty acids composition
v. Understanding of importance of minor milk constituents such as phospholipids, vitamin D and minerals present in milk

Theory

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins: α-Lactalbumin and β-Lactoglobuline. Properties of α-Lactalbumin and β-lactoglobulin, Immmunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins.

Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase.

Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re-arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose.

Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins.

Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

Practical

Sampling techniques of chemical examination of milk; Determination of pH and titratable acidity of milk; Determination of fat in milk by different methods; Determination of total solids and solids not fat in milk; Determination of total milk proteins by Kjeldahal method; Determination of casein, whey proteins and NPN in milk; Estimation of alkaline phosphatase and lipase in milk; Determination of lactose in milk; Determination of ash in milk; Determination of phosphorus and calcium in milk; Determination of chloride in milk; Determination of temporary and permanent hardness of water; Estimation of available chlorine from bleaching powder.

Suggested Readings

1. Fox P F and McSweeney P L H. 2013 *Advanced Dairy Chemistry*: (Vol. IA): Proteins: Basic Aspects. Springer, Boston.
2. Fox P F and McSweeney, P L H. 2013 *Advanced dairy chemistry*: (Vol. IB). Proteins: Applied Aspects. Springer, Boston.
3. Fox P F and McSweeney P L H. (2013) *Advanced Dairy Chemistry*: (Vol. II): Lipids. Springer, Boston.
4. Fox P F, Uniacke-Lowe T, McSweeney PLH. and O'Mahony J A. 2015. *Dairy Chemistry and Biochemistry*. (2nd Edn.). Springer, Cham.
5. Mathur M P, Datta D R and Dinakar P. 1999. *Text book of Dairy Chemistry*. Directorate of Information and Publs., ICAR, New Delhi.
6. Singh H and Thompson A. 2006. *Milk Proteins: From Expression to Food*. Elsevier, London.
7. Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology*. CRC Press, Boca Raton.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

i. To understand different resources such as mineral resources, food resources, water resource, energy resources, natural resources and land resources

ii. To gather knowledge about environmental pollution, soil pollution, air pollution and thermal pollution

iii. To acquaint themselves with waste land reclamation, ecosystems and their management

iv. To learn regarding biodiversity and its conservation, natural disaster and manmade disaster along with their management

Theory

Multidisciplinary nature of environmental studies; definition, scope and importance; Natural resources: renewable and non-renewable resources, natural resources and associated problems; Forest resources: use and over-exploitation, deforestation, case studies; Timber extraction, mining, dams and their effects on forest and tribal people; Water resources: use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems; Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies; Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles; Ecosystems: concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of ecosystems as forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: introduction, definition, genetic, species and ecosystem diversity and biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, national and local levels; India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Environmental pollution: definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards; Solid waste management: causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution.

Social issues and the environment: from unsustainable to sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management.

Environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust; Dies, wasteland reclamation; Consumerism and waste products; Environment protection act; Air (prevention and control of pollution) act; Water (prevention and control of pollution) act; Wildlife protection act. Forest conservation act; Issues involved in enforcement of environmental legislation; Public awareness.

Human population and the environment: population growth, variation among nations, population explosion, family welfare programme; Environment and human health: human rights, value education, HIV/ aids; Women and child welfare; Role of IT in environment and human health.

Natural disasters- meaning and nature of natural disasters, their types and effects; Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves; Climatic change: global warming, sea level rise, ozone depletion.

Man-made disasters- nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster management- effect to migrate natural disaster at national and global levels; International strategy for disaster reduction; Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community based organizations and media, Central, state, district and local administration; armed forces in disaster response; disaster response; police and other organizations.

Practical

Pollution case studies; Case studies- visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain; Visit to a local polluted siteurban/rural/industrial/ agricultural; Study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.; Collection of polluted water/ effluent sample, sampling of polluted water/ effluents; Estimation of solids, pH, EC, DO, COD, BOD, Cl^-, F^-, CO_3^{2-}& HCO_3^-, Ca^{2+}& Mg^{2+}, K^+ and $Na^{+.}$

Suggested Readings

1. Anjaneyulu Y. 2004. I*ntroduction to Environmental Science*. BS Publications. Hyderabad.
2. Asthana D K and Asthana M. 2007. *Environment Problems and Solution*. S. Chand & Company, New Delhi.
3. Chauhan A S. 2014. *Environment Studies*. Jain Brothers. Karol Bagh, New Delhi.
4. Dhaliwal G S and Kukal S S. 2005. *Essentials of Environment Science*. Kalyani Publishers. Ludhiana.
5. Etherington J R. 1982. *Environment and Plant Ecology*. (2nd Edn.). Wiley–Blackwell.
6. Kukal S S and Kingra P K. 2019. *Introduction to Environment and Disaster Management*. Kalyani Publishers. Ludhiana.
7. Mahi G S and P K Kingra. 2018. *Fundamentals of Agrometeorology and Climate Change*. Kalyani Publishers. New Delhi.
8. Saha A K. 2006. *Text Book of Soil Physics*. Kalyani Publishers. Ludhiana.
9. Sharma P D. 2010. *Ecology and Environment*. Rastogi Publishers. New Delhi.
10. Singh M P. 2004. *Environment and Pollution*. Anmol Publications Pvt Ltd.
11. Status of Forest Report. 2019. *Forest Survey of India*. Dehradun.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of

personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution.

Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence-types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Andrews Sudhir. 2008. *How to Succeed at Interviews*. Tata McGraw-Hill.
2. Heller Robert. 2002. *Effective Leadership. Essential Manager Serie*s. DK Publishing.
3. Hindle Tim. 2009. *Reducing Stress*. Essential Manager Series. DK Publishing.
4. Lucas Stephen. 2001. *Art of Public Speaking*. New Delhi. Tata - Mc-Graw Hill.
5. Mile D J. 2004. *Power of Positive Thinkin*g. Delhi. Rohan Book Company.
6. Pravesh Kumar. 2005. *All about Self-Motivation*. New Delhi. Goodwill Publishing House.
7. Smith B, 2004, *Body Language*. Delhi: Rohan Book Company.
8. Shaffer D R. 2009. *Social and Personality Development*. (6th Edn.) Belmont, CA: Wadsworth.

NCC-II 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness program

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.

Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding:

Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

Introduction to map, scales, and conventional signs. Topographical forms and technical terms.

The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.

Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- II 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness program

Importance and role of youth leadership; Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies; Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations;

Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-Semester II (Only for exit option for award of UG-Certificate in Dairy Technology)

S. No.	Course Title	Credit Hours
1.	Internship (10 weeks)	10 (0+10)

Semester-III

Thermodynamics 3 (2+1)

Objectives

i. To acquire fundamental understanding of the principles of thermodynamics and heat transfer
ii. To understand mathematical and practical aspects of heat transfer by conduction, convection and radiation
iii. To develop understanding of thermodynamic properties of substances in gas and liquid states
iv. To learn about the concept, type and working principle of different systems of internal combustion engines
v. To understand the classification, design and operation of steam generators

Theory

Importance and applications of thermodynamics in Dairy/Food processing. Basic concepts: Thermodynamic systems, properties, state, processes, cycles, energy, The Zeroth Law of Thermodynamics.

Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. Analysis of non-flow and flow processes. The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, heat engine, entropy, reversibility, availability.

Air Cycles: Otto, Diesel, dual cycles and their efficiencies, Plotting the air cycles on p-V, T-S, p-h diagram etc. I.C. Engines: Concepts, Classification, Working of two stroke and four stroke cycle S.I. engines and C.I. engines. Parts of I.C. engine, Performance of IC engines. Fuels.

Chemical properties, Calorific value and its determination, Fuel Burners, Fuel combustion analysis. Properties of steam: Properties of wet, dry saturated, superheated steam, Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption.

Steam generators: Definition, classification, fire tube boilers, water tube boilers, Boiler performance parameters, Boiler mountings and Boiler accessories. Layout of steam pipe-line and expansion joints. Introduction to Indian Boiler Regulation Act. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, Draught analysis.

Air Compressors: Definition, classification, Reciprocating, Single and multi-stage reciprocating compressors and their theoretical analysis.

Practical

A visit to dairy/ food processing plant showing the thermodynamics applications/ devices; Study of 2-stroke and 4-strokes IC engines working; Study of S.I. and C.I. engines working; Study of modern fuel injection systems of I.C. engines; Study of diesel fuel supply system (pump and fuel injector) of I.C. engine; Study of fuel supply system of a petrol engine; Study of cooling system of an I.C. engine (air cooling and water cooling); Study of lubrication system of I.C. engine; Study

of Solar water heater and biogas plants and appliances; To study different types of boilers with the help of Lab models; To study Boiler mountings and steam-line layout and steam traps; Industrial exposure visit to plant with steam utilization; Study of Fire tube low pressure boiler installed in a dairy processing plant; Study of water softening plant installed with boiler in a dairy processing plant; Study the construction and working of Cochran boiler. Study of Babcok and Wilcox boiler. Study of different Boiler accessories.

Suggested Readings

1. Ansermet J P and Brechet S D. 2019. *Principles of Thermodynamics*. Cambridge University Press. Cambridge, United Kingdom.
2. Fermi E. 2012. *Thermodynamics*. Courier Corporation. Massachusetts, United States.
3. Gupta S K. 2019. *Engineering Thermodynamic*s. S. Chand Publishing. New Delhi, India.
4. Manna. 2011. *Heat and Thermodynamics*: Pearson Education India. New Delhi, India.
5. Nagaraj P B. 2007. *Basic Thermodynamics*. *New Age International*. Delhi, India.
6. Venkanna B K, Venkanna B K and Swati B V. 2010. *Basic Thermodynamics*. PHI Learning Pvt. Ltd. Delhi, India.

Traditional Indian Dairy Products 3 (2+1)

Objectives

i. To understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
ii. To learn about the chemical composition and legal standards for traditional Indian sweets
iii. To acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
iv. To learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milk-cake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield, physico-chemical changes during manufacture.

Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process.

Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti Dahi: Product description method of manufacture and packaging process.

Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakand, Milk cake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, Misti Dahi, Chhana and Shrikhand; Visit to industry.

Suggested Readings

1. Aneja R P, Mathur B N. Chandan R C and Banerjee A K. 2002. *Technology of Indian Milk Products*. A Dairy India Publ., Delhi, India.
2. De S. 2015. *Outlines of Dairy Technology*. Oxford University Press., New Delhi
3. Khamrui K and Devaraja S C. (Eds.). 2012. *Technological innovations in production of traditional Indian dairy products.* Lecture Compendium of National Training on Innovative Trends in Dairy and Food Products Formulation organized by the Centre for Advanced Faculty Training programme during October 10-30, 2012, Dairy Technology Division, National Dairy Research Institute, Karnal, Haryana.
4. Khamrui K, Devaraja H C and Rathod G. 2014. *Technological advancement in production of traditional Indian Dairy Products*. In: Dairy and Food Processing Industry. B K Mishra (Ed.). pp 18-29. Biotech Tech Books, New Delhi.
5. Devaraja H C, Khamrui K, and Sathishkumar M H. 2014. *Technological Advancement in Production of Traditional Indian Dairy Products. In:* Dairy and Food Processing Industry. B K Mishra (Ed.). pp 162-171.Biotech Tech Books, New Delhi.

Dairy Engineering 3 (2+1)

Objectives

i. To learn about sanitary pipes and fittings and systems used for cleaning operations in dairy plants
ii. To understand design and operation of various mechanical separations systems and devices used in the dairy industry
iii. To acquire knowledge of design and operation of thermal processing systems such as pasteurizer, sterilizer and UHT processing plants
iv. To learn about pouch filling and aseptic packaging machines for packaging of processed liquid milk

Theory

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes and fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system.

Mechanical Separation: Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers.

Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.

Thermal Processing: (a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, Arrhenius equation, D value, Z value, F value, Q_{10} value. (b) Factors affecting thermal destruction of microorganisms.

Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers.

Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers.

Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance.

Mixing and agitation: Theory and purpose of mixing. Equipment used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

Practical

Study of S. S. pipes, fitting and gaskets; Study and selection of pump; Study of different types of milk filter; Study of equipment at raw milk reception dock; Constructional details, operation and maintenance of straight through can washer; Constructional details, operation and maintenance of C.I.P. system; Constructional details, operation and maintenance of homogenizers; Constructional details, operation and maintenance of batch pasteurizer; Constructional details, operation and maintenance of HTST pasteurizer; Comparison of conventional and modern pasteurizer; Constructional details, operation and maintenance of cream separators; Constructional details, operation and maintenance of sterilization systems; Constructional details, operation and maintenance of pouch filling machine; Constructional details, operation and maintenance of different types of agitators; Constructional details, operation and maintenance of bottle filling and capping machine; Visit to a dairy processing plant.

Suggested Readings

1. Ahmad T. 1985. *Dairy Plant Systems Engineering*. Kitab Mahal Publ., New Delhi, India.
2. *Dairy Processing Handbook*. 1995. Tetra Pak Processing Systems AB, Sweden.
3. Kessler. 1981. *Food Engineering and Dairy Technology*. V.A. Kessler Publ., Freising, Germany.
4. McCabe W, Smith, J and Harriott P. 1993. *Unit operations of Chemical Engineering*. Mc-Graw Hill Inc. New York.

5. Towler G and Sinnott, R. 2008. *Chemical Engineering Design*. Elsevier, New York.
6. Coimbra J S dos R and Teixeira J A. 2016. *Engineering Aspects of Milk and Dairy Products*. CRC Press. Florida, United States.
7. Kutz M. 2019. *Handbook of Farm, Dairy and Food Machinery Engineering*. Academic Press. New York, United States.
8. Meghwal M, Goyal M R and Chavan RS. 2017. *Dairy Engineering: Advanced Technologies* and *their Applications*. (9th Edn.). CRC Press. Florida, United States.
9. Ahmad T. 2003. *Dairy Plant Engineering and Management.* (9th Edn.). Kitab Mahal. New Delhi.

Refrigeration and Air Conditioning 3 (2+1)

Objectives

i. To understand the fundamental principles of refrigeration and air conditioning
ii. To make comparative study of different refrigerants with respect to properties and applications
iii. To learn to calculate the cooling/heating load for different applications
iv. To understand the principle of psychometric processes and air conditioning
v. To design and implement refrigeration and air conditioning systems as per the recommended standards

Theory

Basic refrigeration cycles and concepts: Standard rating refrigerating machines; Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle; Departure from theoretical vapour compression cycle, representation on T-S and p-h diagrams; Mathematical analysis of vapour compression refrigeration system.

Refrigerants: Primary and secondary refrigerants; common refrigerants (Ammonia, Freon, HFC, HCFC etc.); Brine, their properties and comparison. Multi-Pressure Refrigeration Systems: Applications; Multi-evaporators with single stage and multi-stage compression and expansion systems; Working, Control and mathematical analysis of above systems.

Refrigeration Equipment and Controls: Introduction to the types, construction, operation and maintenance of Refrigeration Components, Controls and Safety Devices as used in different refrigeration applications. Capacity control methods, Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation.

Design and Balancing of Refrigeration System: Basic elements of design of individual components and a complete refrigeration system. Input and Output design parameters, Balancing of components of refrigeration system for optimum performance. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Actual Vapour absorption refrigeration system, Refrigerant absorbent pairs, Absorption cycle analysis.

Cryogenic Freezing: Cryogenics, cryogens, properties, applications, cryogenic freezers. Psychrometry: Definition, properties of moist air, psychrometric charts, psychrometric processes; Cooling/ Heating coils, humidifiers and dehumidifiers, Temperature and humidity measurements and controls.

Air-conditioning Systems: Types of cooling loads and their calculation, Design conditions for Human and Industrial air conditioning systems, Analysis of different air-conditioning systems with the help of psychrometric chart. Cold Storage: Types of cold storages, Types of cooling loads in cold storages used for food/ dairy products; Construction and operation of cold storage. Insulating materials and vapour barriers.

Practical

Study of different types of Refrigeration tools generally used in installation and maintenance of a refrigeration plant/ equipment including charging and leakage-detection tools; Study of specification, components, operation, control, maintenance and precautions taken during working of a Domestic refrigerator; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Water cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Bulk milk cooler; Study of specifications, components, operation, control, maintenance and precautions taken during working of a Walk-in-cooler; Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant; Estimation of installed cooling capacity with the help of observed working pressures; Study of specifications, components, operation, control and maintenance of Ice Bank Tank (IBT); Study of specifications, components, operation, control and maintenance of a Cold Storage; Study of the Evaporative Cooling Devices like Cooling Tower, Spray Pond, Air-Washer or Room air-cooler etc.; Study of the parts and components of different types of refrigerant compressors used in various refrigeration applications; Study of different types of capacity control devices used with compressors in a refrigeration plant; Experimental study of a simple refrigeration system on refrigeration tutor or an experimental set-up (Comparison of actual and theoretical performance); Experimental study of a year-round air-conditioning system on an air-conditioning tutor or an experimental set-up; Determination of SHF and By-pass factor etc; Study and plotting of psychrometric processes using refrigeration/air-conditioning tutor; Measurement of psychrometric properties using psychrometric meters/gadgets; Industrial exposure visit to refrigeration/air-conditioning plant.

Suggested Readings

1. Ananthanarayanan P N. 2005. *Basic Refrigeration and Air Conditioning*. McGraw-Hill Education. Uttar Pradesh, India.
2. Chandra A and Ramesh. 2012. *Refrigeration and Air Conditioning*. PHI Learning Pvt. Ltd. Delhi, India.
3. Gupta R K. 2006. *Textbook of Refrigeration and Air Conditioning*. S. Chand Publishing. New Delhi, India.
4. Hundy G F. 2016. *Refrigeration, Air Conditioning and Heat Pumps*. Butterworth-Heinemann. Oxford, United Kingdom.
5. Prasad M. 2011. *Refrigeration and Air Conditioning. New Age Internationa*l. Delhi, India.
6. Wang S K. 2000. *Handbook of Air Conditioning and Refrigeration*. McGraw-Hill Education. Uttar Pradesh, India.

Starter Culture and Fermented Dairy Products 2 (1+1)

Objectives

i. To understand basic aspects of different types of starter cultures, their metabolism, storage and propagation

ii. To understand preservation of starter cultures, tests for evaluating activity and purity as also factors affecting their survival and activities

iii. To learn about the role of starter cultures in preparation of various fermented milk products and defects appearing as a result of improper starter activities

iv. To acquire knowledge about cheese starter cultures and their role in development of desirable properties during processing and ripening

Theory

Types, metabolism and propagation of starter cultures: History, classification and importance of starter Cultures in dairy industry; Single, multiple, defined and mixed strain starters; Probiotics and special cultures like exopolysaccharide, vitamin and low calorie sugar producing cultures; Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, factors affecting propagation; Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits. Prebiotic, postbiotic and symbiotic concepts.

Activity, Purity, Preservation of Starters and Starter Failure: Quality and activity tests for dairy starters and their preservation- methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation; Defects in starters and their control; Starter failures-effect of antibiotic residues, sanitizers and bacteriophages. Phages-life cycle, sources, prevention, chemical and mechanically protected systems for starter culture production.

Role of Starters in fermented milks: Role of starters in the preparation of various fermented milks; Types of fermented milks-dahi, yoghurt, acidophilus milk; different types of dahi and yoghurt; preparation; defects and their control. Kefir and koumiss: origin and characteristics; microbiology of kefir grains; Other fermented milks such as Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Microbiology of fermented milk products; their nutritional and therapeutic significance.

Chesse Starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; Rennet: rennet substitutes, microbial rennet and recombinant chymosin.

Practical

Testing purity of starter cultures by gram's staining, catalase test; creatine test; Testing starter activity by dye reduction tests, Horrall-Elliker, White Head and Cox test; Preparation of single and mixed starter cultures; Evaluation of homo-fermentation and hetero-fermentation separately and in combination; Preservation of starter cultures by freeze-drying techniques; Preparation of concentrated starter (DVS); Effect of physical factors (temperature, pH, Salt and Sugar) on dairy

starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Preparation and microbial examination of dahi, *lassi*, *shrikhand*, yoghurt, cultured butter milk, acidophilus milk and kefir; Analysis of cheese for total spore and anaerobic spore count; Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening).

Suggested Readings

1. Doyle M P and Beuchat L R. 2013. *Food Microbiology: Fundamentals and Frontiers*. (4th Edn.) ASM Press, Washington DC.
2. Prajapati J B and Behare P V. 2018. *Textbook on Dairy Microbiology. Directorate of Knowledge Management in Agriculture* (DKMA), ICAR, NewDelhi. ISBN:978-81-7164-182-6.
3. Griffiths MW. 2010. *Improving the Safety and Quality of Milk: Milk Microbiology and Safety*. Vol. 1. Woodhead Publishing, Cambridge.
4. Hutkins R W. 2018 *Microbiology and Technology of Fermented Foods*. (2nd Edn.). Wiley-Blackwell, Hoboken, NJ.
5. Jay J M, Loessner M J and Golden D A. 2005 *Modern Food Microbiology*. (7th Edn.) Springer, New York.
6. Robinson R K. 2002 *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*. (3rd Edn.) Wiley-Interscience, New York.
7. Tamime A Y. 2009 *Dairy Processing: Improving Quality*. Woodhead Publishing. Cambridge
8. Varnam A H and Sutherland J P. 1994 *Milk and Milk Products: Technology, Chemistry, and Microbiology*. Springer, London.
9. Puniya A K. 2015. *Fermented Milk & Dairy Products*; CRC Press/Taylor & Francis (ISBN 9781466577978).

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices

ii. To disseminate the knowledge and skill how to perform physical training, perform first-aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Swimming: History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke). Competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving-styles of diving, rules, regulations, and precautions. Methods of life saving in water; Boating, canoeing, and sailing: types, maintenance, skill development, rules and regulations and practice. Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques. First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with the Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Agriculture Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of

agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits and demerits.

Marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark).

Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs.

Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India,* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna SS 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Pub, New Delhi.
3. Kohls Richard L and Uhl Josheph N. 2002. *Marketing of Agricultural Products*, Prentice-Hall of India Private Ltd., New Delhi.

4. Kotler and Armstrong. 2005. *Principles of Marketing*, Pearson Prentice-Hall.
5. Lekhi R K and Jogindr Singh, 2006. *Agricultural Economics.* Kalyani Publishers, Delhi.
6. Memoria C B, Joshi R L and Mulla N I. 2003 *Principles and Practice of Marketing in India*, Kitab Mahal, New Delhi.
7. Pandey Mukesh and Tewari Deepali. 2004. *Rural and Agricultural Marketing.* International Book Distributing Co. Ltd, New Delhi.
8. Sharma R. 2005. *Export Management,* Laxmi Narain Agarwal, Agra.

Semester-IV

Cheese Technology 5 (3+2)

Objectives

i. To learn about history of cheese making and evolution of different varieties of cheeses with distinctly different attributes
ii. To understand how quality of milk and various additives play critical role in good cheese making
iii. To acquire knowledge about the role of rennet and starter cultures in progression of chemical and biochemical processes responsible for desirable cheese quality attributes
iv. To develop skills to manufacture good quality cheeses of both fresh and ripened varieties
v. To learn about new processing interventions for improving yield and accelerating ripening for improving economics of production of cheese

Theory

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese.

Milk quality in relation to cheese making. Pre-treatment of milk for cheese making; Physical and chemical additives and preservatives for cheese making. Rennet preparation and properties, milk clotting enzymes as rennet substitutes: plant, animal and microbial origin. Action of rennet on milk in relation to cheese making. Biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi soft, semi hard, hard, acid coagulated cheese.

Cheese starters: Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese; Manufacture of different choice-based varieties of cheese: Cheddar, Gouda, Swiss Mozzarella, Cottage, Cream and Quarg. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Practical

Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters; Testing milk for presence of inhibitory substances using *B. stearothermophilus* and *S. thermophilus* as indicator organisms; Effect of presence of antibiotic residues in milk on cheese starter activity; Evaluation of associative growth of Starter cultures in milk; Detection of Bacteriophages in cheese whey by plaque assay method; Familiarization with equipments, accessories and standardization numericals; Study of factors affecting rennet action; Determination of Rennet Cogaulation Time (RCT) of milk, Manufacture of Cheddar cheese; Manufacture of Gouda cheese; Manufacture of Mozzarella cheese; Manufacture of Swiss cheese; Manufacture of Cottage cheese; Manufacture of Processed cheese; Manufacture of Processed cheese spread; Manufacture of Processed cheese food.

Suggested Readings

1. McSweeney PLH, Fox, PF Cotter PD and Everett D W (Eds.). 2017. *Cheese: Chemistry, physics and microbiology* (4th Edn.). Academic Press, UK.
2. Fox P F, Guinee T P, Cogan T M and McSweeney P L H. 2017. *Fundamentals of cheese science.* (2nd Edn.). Springer, New York.
3. Kapoor R and Metzger L E. 2008. *Process Cheese: Scientific and Technological Aspects—A Review*. Comprehensive Reviews in Food Science and Food Safety. 7, 194-214.
4. Singh S. 2011. *Production and Marketing of Cheese – A Global Perspective*. Lecture Compendium on Advances in Cheese and Fermented Products (Centre of Advanced Faculty Training), 1-8http://www.strategyr.com/Cheese_Market_Report.asp
5. Paul McSweeney, Paul Cotter, David Everett *(Eds.*). 2017. *Cheese: Chemistry, Physics and Microbiology.* (4th Edn.). Elsevier Publications, USA.
6. Fox P F, Guinee T P, Cogan T M and McSweeney, 2018. *Fundamentals of Cheese Science*. Springer New York, NY.

Fat-Rich Dairy Products 3 (2+1)

Objectives

i. To understand manufacture of different types of creams, its packaging, marketing and quality control
ii. To learn about the processes involved in making butter and spreads using batch and continuous methods, their packaging and quality
iii To learn ghee making methods, factors affecting its quality, packaging and legal standards required for marketing

Theory

Status of fat-rich dairy products in India and abroad. Cream: (a) Definition and Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. (b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. (c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. (d) factors affecting quality of cream; ripening of cream. (e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: (a) Introduction to the butter making process; theory of churning, Legal standards. (b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine.

Special butters and related products: (a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. (b) Manufacture, packaging, storage and characteristics of margarine of different types.

Ghee and butter oil: (a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. (b) Ghee: Composition and changes during manufacture fat constants. (c) Butteroil: Manufacture of butteroil, packaging and storage.

Practical

Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

Suggested Readings

1. Thompkinson D K and Kumar M H S. 2015. *Fat Rich Dairy Products*. New India Publishing Agency, New Delhi.
2. Aneja R P, Mathur, B N, Chandan R C and Banerjee A K. 2002. *Technology of Indian Milk Products*. A Dairy India Publication, Delhi.
3. De S. 2015. *Outlines of Dairy Technology*. Oxford University Press, Delhi.
4. Rangappa K S and Acharya K T. 1974. *Indian Dairy Products*. Asia Publishing House, New Delhi.

Ice-Cream and Frozen Desserts 3 (2+1)

Objectives

i. To understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
ii. To learn about design and working of Ice cream freezers including cleaning and sanitization
iii. To aquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
iv. To learn about the defects that appear in ice cream, causative factors and measures to control them

Theory

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts.

Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture.

Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant.

Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention.

Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Suggested Readings

1. Thompkinson D K and Sabikhi L. 2012. *Quality milk production and processing technology*. New India Publishing Agency, Delhi.
2. Walstra P, Walstra P, Wouters, J T M and Geurts T J. 2006. *Dairy Science and Technology* (2nd Edn.). CRC Press, New York, USA.
3. Robinson R K. 2002. *Dairy Microbiology Handbook*. (3rd Edn.). John Willey and Sons, New York, USA.
4. Arbuckle W S. 1991. *Ice Cream*. AVI Publ., Co. Inc., West Port, Connecticut.
5. Hall C W and Hedric T T. 1975. *Drying of Milk and Milk Products*. AVI Publ. Co. Inc., West Port, Connecticut.
6. Hui Y H. 1993. *Dairy Science and Technology Handbook 2*-Product Manufacturing. Wiley – VCH Inc., USA.
7. *Ice Cream Alliance and Ice Cream Federation*. 1992. Code of Practice for the Hygienic manufacture of Ice Cream.
8. NDRI. 1998. *Advances in Ice Cream and Frozen Desserts*. Lecture compendium, Sixth short course, Dec 15, 1998- Jan 4, 1999. NDRI, Karnal.
9. Robinson R K. 1986. *Modern Dairy Technology.* Vol II. Elsevier Sci. Publ. Co., Inc., New York, USA.
10. Robinson R K. 2002. *Dairy Microbiology Handbook*. (3rd Edn.). John Willey and sons, New York, USA.
11. Sommer HH. 1951. *The Theory and Practice of Ice Cream Making*. (6th Edn.) Madison Wisconsin.

Chemistry of Dairy Products 2 (1+1)

Objectives

i. To acquire knowledge about composition and legal standards for different types of dairy products

ii. To understand about the physico-chemical changes that take place during manufacture of dairy products as a function of processing variables

iii. To learn about various deteriorative reactions that occur during storage of dairy products and measures to control them

Theory

Chemical composition and legal standards of milk products. Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants.

Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, Shrikhand.

Chemistry of cheese: milk clotting enzymes, enzymatic coagulation of milk, biochemical changes during ripening. Physico-chemical changes during preparation and storage of concentrated and dried milk products.

Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.

Practical

Cream: estimation of fat and acidity; Butter: estimation of fat, moisture, curd and salt content; Ghee: estimation of moisture, acid value, Butyro refractive reading and Reichert Meissl value / Polanske value; Determination of lactose and sucrose in sweetened condensed milk; Milk powder: moisture, fat, ash, solubility, acidity and bulk density; Ice cream: estimation of fat and total solids; Estimation of moisture, fat and salt content in cheese; Khoa/paneer: estimation of moisture and fat; Estimation of protein content in milk products and protein rich dairy products using Kjeldahl method.

Suggested Readings

1. Walstra P, Wouters J T M and Geurts, T J. 2006 *Dairy Science and Technology*. CRC Press, Boca Raton.
2. Fox P F, Uniacke-Lowe, T, McSweeney P L H. and O'Mahony J A. 2015 *Dairy Chemistry and Biochemistry*. Springer, Cham.
3. Fox P F and McSweeney P L H. 2013 *Advanced Dairy Chemistry: (Vol. 1A)*: Proteins: Basic Aspects. Springer, Boston.
4. Fox P F and McSweeney P L H. 2013 *Advanced Dairy Chemistry*: (Vol. 1B): Proteins: Applied Aspects. Springer, Boston.

5. Webb B H, Johonson, A H and Alford, J.A. (Eds). 2008. *Fundamentals of Dairy Chemistry*. CBS Publ. and Distributors Pvt. Ltd., New Delhi.
6. Fox P F and McSweeney P L H. 2013. *Advanced Dairy Chemistry: (Vol. II): Lipids*. Springer, Boston.
7. McSweeney P L H and O'Mahony J A 2016. *Milk Proteins*: *From Expression to Food*. Elsevier, London.
8. Singh H. and Thompson, A. 2006. *Milk Proteins: From Expression to Food*. Elsevier, London.

Microbiology of Dairy Products 2 (1+1)

Objectives

i. To learn about entry of spoilage and pathogenic microorganisms vis-à-vis micro environment of processed dairy products, their spoilage mechanism and preventive measures
ii. To understand the type of microorganisms that could enter fat rich dairy products, condensed or dried milk, frozen and traditional dairy products
iii. To learn about micro environment of each of the dairy products and how they influence growth of these microorganisms which in turn cause spoilage
iv. To understand critical processing factors that impact presence of different types of microorganisms and control measures to prevent spoilage and health hazards
v. To learn about microbial safety concerning to potential pathogens and their public health significance

Theory

Microbiology of Cream and Butter - Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/un-ripened cream), sterilized and UHT cream; Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. Fungal spoilage of Ghee.

Microbiology of Condensed, Evaporated and Dried products: Type of microorganisms associated with condensed and evaporated milk, their growth/ survival during manufacture and storage; Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/ bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavour in evaporated milk; pre-heating/DSI temperature and their impact on microflora of dried products.

Microbiological aspects of milk powder with respect to manufacturing steps and types of powder (heat classification of powders), Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. Microbiology of Infant Milk Formula (IMF).

Microbiology of Ice Cream and Frozen desserts: Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of

pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards.

Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfietc.; Factors affecting the microbiological quality in reference to production, processing, storage and distribution; Comparison of dairy sweets made at sweet shops vs. commercially manufactured sweets. Microbial safety in relation to potential pathogens and their public health significance; Microbial defects, control measures and legal standards.

Practical

Microbiological examination of raw, pasteurized, sterilized and UHT cream for Standard plate count (SPC) as well as lipolytic and coliform counts, direct microscopic count (DMC), dye reduction tests and sterility test ; Microbiological examination of salted and unsalted butter for SPC, psychrotrophic, lipolytic, coliforms and yeast and mold count; K.Q test; Microbiological examination of concentrated milk for SPC, coliforms, spores, yeast and mold, thermoduric and thermophilic counts; Microbiological examination of dried milks for SPC, coliforms, *Staph. aureus*, *B. cereus, E. coli, Salmonella*, Sulphite reducing clostridia and Staphylococcal enterotoxins; Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms and Staphylococcal counts; Detection of *Salmonella* spp./*E. coli*; Microbiological examination of khoa for SPC, coliforms and staphylococcal counts besides yeast and mold counts; Microbiological examination of paneer and shrikhand for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts; Microbiological examination of Kheer for SPC, Spores, coliforms, yeast and molds and Staphylococcal counts.

Suggested Readings

1. Robinson R K. 2002. *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*. (3rd Edn.) Wiley-Interscience, New York.
2. Fox P F, McSweeney, P L H, Cogan T M and Guinee T P 2017. *Cheese: Chemistry, Physics, and Microbiology*. (4th Edn.) Vol. 1.: Academic Press, London.
3. Doyle M P and Beuchat L R 2013. *Food Microbiology: Fundamentals and Frontiers*. (4th Edn.) ASM Press, Washington DC.
4. Forsythe SJ 2020. *The Microbiology of Safe Food*. (3rd Edn.) Wiley-Blackwell, Oxford.
5. Griffiths M W. 2010. *Improving the Safety and Quality of Milk: Milk Microbiology and Safety*. (Vol. I). Woodhead Publishing. Cambridge.
6. Hutkins R W. 2018. *Microbiology and Technology of Fermented Foods*. (2nd Edn.). Wiley-Blackwell, Hoboken
7. Jay J M, Loessner M J and Golden D A. 2005. *Modern Food Microbiology*. (7th Edn.) Springer, New York.
8. Tamime A Y. 2009. *Dairy Processing: Improving Quality*. Woodhead Publishing, Cambridge.

ICT in Dairy Industry 2 (1+1)

Objectives

i. To learn about computers and its operating environment for organizing, storage and retrieval of data

ii. To understand application of computer as dairy management tools to describe, document and control all processes in the dairy industry

iii. To learn about project management tools for project scheduling and monitoring for timely completion and implementation of information system

iv. To develop competence in process modelling and simulation for product design and manufacturing to deliver good quality dairy products

v. To learn about newer applications of AI and Robotics in the dairy plant operations

Theory

Importance of Computerization and IT in dairy industries. Computers, Operating. Environments and Information Systems for various types of dairy Industries.

Principles of communication. Role of Computer in Optimization; Introduction to Operation. Research.

A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modelling and Simulation.

Introduction to SCADA and INTELUTION. CAD and CAM in Dairy Industries: Instrumentation, Process control, Inventory control, Automation, Robotics, Expert Systems and Artificial Intelligence, Instrumentation.

Practical

Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food. Chemical kinetics in dairy processing. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in dairy industries: Milk plant, Dairy units, Fruit and Vegetable processing unit. Familiarization with software related to dairy industry.

Suggested Readings

1. Balagurusamy E. 2009. *Fundamentals of Computers*. Tata Mcgraw-Hill, New Delhi.
2. Britz T J and Robinson RK. 2008. *Advanced Dairy Science and Technology*. Blackwell Publication, UK.
3. Elmasri R and Navathe SB. 2008. *Fundamentals of Database Systems*. (5th Edn.). Pearson Education, New Delhi.
4. Forouzan B A. 2012. *Data Communication and Networking*. (4th Edn.). Tata McGraw-Hill, India.
5. Goyal D P. 2000. *Management Information Systems*. (2nd Edn.) Macmillan Publishers, India.
6. Mishra TN and Kirmani M M. 2004. *System Analysis and Design*. CyberTech Publishers, India.
7. Obrien J A and Marakas GM. 2006. *Management Information System*. (7th Edn.). Tata McGraw-Hill, New Delhi.

8. Patterson D W. 2007. *Introduction to Artificial Intelligence and Expert Systems*. Prentice Hall, India.
9. Rajan E G. 2003. *Information Technology*. B S Publication, Hyderabad.
10. Rajaraman V. 2002. *Fundamentals of Computers*. (3rd Edn.). Prentice Hall of India, New Delhi.
11. Shmulei G, Patel NR and Bruce P C. 2008. *Data Mining for Business Intelligence*. Wiley Interscience, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To expose the student to various aspects of establishment and management of a small business unit
ii. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development.

Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product/service – starting a project; factors influencing sensing the opportunities.

Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution.

Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs; Visit to financial institutions and support agencies; Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises*. Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management.* Himalaya Publishing House.
3. Grover Indu. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Publishing Academy.
4. Gupta C B. 2001. *Management Theory and Practice*. Chand & Co.
5. Khanka S S. 1999, *Entrepreneurial Development*. S. Chand & Co.
6. Mehra P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
7. Pandey M and Tewari D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
8. Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ, New Delhi.
9. Singhal R K. 2013. *Entrepreneurship Development* and *Management*, Katson Books.
10. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill, New Delhi.
11. Vasant Desai 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House, New Delhi.

Post-Semester IV* (Only For exit option for UG-Diploma in Dairy Technology)

S. No.	Course Title	Credit Hours
SDE 221	Internship (10 weeks)	10 (0+10)

*Mandatory requirement for UG-Diploma.

Semester-V

Condensed and Dried Milk 4 (3+1)

Objective

To learn manufacture of condensed milk and milk powders and understand factors affecting its quality as a function of raw milk quality and processing variables

Theory

Condensed milks: History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques; (a) Manufacture of evaporated milk including pilot sterilization test, (b) Manufacture of sweetened condensed milk, (c) Recombined sweetened condensed milk.

Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention. Recent advances with reference to freeze concentration and membrane concentration.

Dried milks**:** History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders.

Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk.

Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.

Practical

Manufacture of plain skim concentrated milk; Manufacture of Sweetened Condensed Milk; Manufacture of Evaporated Milk; Concentration of milk by membrane processing; Manufacturing of Skim Milk Powder by spray drying/roller drying; Manufacture of instant milk powder.

Suggested Readings

1. Karel M and Lund D B. 2003. *Principles of Concentration and Drying of Foods. In: Physical Principles of Food Preservation* (2nd Edn.). Marcel Dekker, New York.
2. Walstra P. 2003. *General Aspects of Water Content and Activity and the Effects on Food Properties and Stability. In: Physical Chemistry of Foods.* Marcel Dekker, New York.
3. Caric´ M. 1994. *Concentrated and Dried Dairy Products*. VCH, New York.
4. Fox P F and McSweeney. 2003. *Advanced Dairy Chemistry, Vol. 1*, Proteins, (3rd Edn.). Kluwer Academic, New York.
5. Fox P F and McSweeney P L H. 2006. *Advanced Dairy Chemistry, Vol. 2*, Lipids. Birkhäuser.
6. Goff D. 1995. *Concentrated and Dried Dairy Products*. Dairy Science and Technology Education Series. University of Guelph, Canada.
7. Hall C W and Hedrick T I. 1971. *Drying of Milk & Milk Products*. AVI Publishing Co., Inc., Westport, Connecticut, USA.
8. Hanzikar O F. 1920. *Condensed Milk and Milk Powder*. (3rd Edn.) La Grange, Illinois, USA.
9. Heldman, D R. and Lund D B. 1992. *Handbook of Food Engineering.* Dekker, New York.
10. *International Dairy Federation Bulletins-Recombined Milks*.
11. Masters K. 1991. *Spray Drying Handbook*. (5th Edn.) Longman, Harlow.
12. http://www.niro.com/NIRO/

Dairy By-Product Technology 3 (2+1)

Objective

To develop skills to process dairy by products to manufacture value added products

Theory

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems, Physico-chemical characteristics of whey, butter milk and ghee residue

By-products from skim milk: (a)Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. (b) Industrial and food uses of caseins (c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications. (d) Manufacture of casein hydrolysates and its industrial application. (e) Co-precipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications.

Whey processing: (a) Fermented products from whey, (b) Beverages from whey, (c) Deproteinized and demineralized whey, (d) Condensed whey, (e) Dried whey, types and their specification, manufacturing techniques, (f) Utilization of whey products. Application of membrane processing for whey processing.

Whey protein concentrates: (a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates, (b) Functional properties and food applications of WPC.

Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: (a) Condensed butter milk, (b) Dried butter milk, (c) Utilization of butter milk products.

Ghee residue: Composition, processing and utilization. Nutritional characteristics of by-products.

Practical

Manufacture of edible casein from cow and buffalo milk; Manufacture of rennet casein; Manufacture of sodium caseinate; Manufacture of calcium caseinate; Manufacture of co-precipitate; Isolation of whey proteins by cold precipitation technique; Manufacture of whey proteins, concentration by ultra filtration process; Manufacture of whey drinks; Manufacture of dried whey; Manufacture of lactose; Incorporation of whey protein concentrates in processed cheese foods; Manufacture of coffee whitener.

Suggested Readings

1. Gupta V K. 2007. *Utilization of Whey*. Monograph Indian Dairy Association, New Delhi.
2. Walstra P, Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology (2nd Edn.)*. CRC Press, New York, USA.
3. Caric M. 1994. *Concentrated and Dried Dairy Products*. VCH Publishers, Inc., New York.
4. Fox PF. (Ed.). 1992. *Advanced Dairy Chemistry*. Vol.1: Proteins, (3rd Edn.) Elsevier Applied Science, London.
5. Fox PF and McSweeney PLH. 2003. *Advanced Dairy Chemistry*. (3rd Edn.) Vol.I, Part B. Kluwer Academic/Plenum Publishers, New York.
6. Gupta V K and Mathur B N. 1989. *Current Trends in Whey Utilization*. Indian Dairyman, 41: 165-169.
7. Gupta V K. 1997. Compendium of Short Course on "*Technological Advances in Dairy By-products*", NDRI, Karnal.
8. Gupta V K. 2007. *Utilization of Whey*. Monograph, Indian Dairy Association, New Delhi.

9. Gupta V K. 2008. Course Compendium on *"Technological Advances in the Utilization of Dairy By-products"*. NDRI, Karnal.
10. Zadow JG. 1992. *Whey and Lactose Processing*. Elsevier Applied Science, London.

Quality and Safety Monitoring in Dairy Industry 3 (2+1)

Objectives

i. To learn about the domestic and global food safety standards and regulations that are in place to ensure microbial safety of dairy foods
ii. To develop understanding of principles and concept of food safety management system for adequately implementing strategy to control critical points and prevent hazard
iii. To understand concepts of microbiological risk analysis and learn handling of dairy pathogens
iv. To learn rapid enumeration techniques for indicator organisms critical from the perspective of plant and equipment hygiene

Theory

Concepts of Quality: Quality as defined by various authors and organizations, History of Quality, Seven tools of quality, Quality Assurance vs. Quality Control, Total Quality Management (TQM); Concepts of Quality Management System (QMS)–ISO: 9001:2015; Principles of QMS; Standard requirements for QMS. Concept of Six sigma and lean sigma. Kaizen; Toyota Production System (TPS).

Global quality and food safety standards, Role and activities of International organizations involved in food regulation (CAC, WHO, FAO, INFOSAN, FDA, EFSA, ICMSF, GFSI, ISO etc.). Codex Alimentarius Commission (CAC): Working, History of CAC- GATT-Uruguay Round, WTO Regime, Sanitary and Phytosanitary (SPS) Standards, CAC in International food trade. National Organizations involved in food safety and quality (FSSAI, BIS, Agmark), FSSAI: Mandate, Role, Activities, Online services (FLRS, InFOLeT), Integrated food law, its main features and functions. Integrated food law of India (FSS 2006).

Food Safety: Good Manufacturing Practices (GMPs and cGMPs) and Good Hygienic Practices (GHPs); Pre-requisite programs (PRPs); HACCP: history, concept, principles and steps, with special reference to biological hazards in dairy foods, Concept of Food safety management system (FSMS)- ISO 22000:2018, principles and requirements; FSSC 22000; Comparison of ISO 22000 and FSSC 22000. Food safety auditing.

Microbiological Risk Analysis Concepts: Risk assessment, risk management and risk communication; risk profiling of dairy products; Microbiological criteria (Standards, Guidelines and Specifications), ICMSF two and three class sampling plan / guidelines; Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant.

Tests and Microorganisms in process hygiene criteria and food safety criteria for dairy products as per FSSAI. Enumeration principles and procedure for conventional and rapid detection of predominant hygiene indicator organisms; Conventional and rapid techniques for isolation and identification of safety indicator organisms like *E. coli* (*E.coli*0157:H7), *Salmonella, Shigella, Bacillus cereus*, Sulphite reducing Clostridium and *Listeria monocytogenes*.

Plant and equipment hygiene: Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of waste water and effluents.

Practical

Conventional techniques for evaluation of milk and milk products for Hygiene and safety. Rapid detection of pathogenic bacteria based on antigen antibody principle: *Staphylococcal enterotoxins, E. coli* O157:H7, *Listeria monocytogenes* and *Salmonella* using VIDAS system; Rapid detection of total plate count, yeast and mold counts, Coliform, *E. coli*, Enterococci, Enterobacteriacae count using D-count and 3M Petrifilm kits; Preparation of GMP/GHP report; Designing of HACCP plan for milk products; Making of Decision Tree for Critical Control Point (CCP) determination; Prepration of audit report for ISO 9001 and ISO 22000; Evaluation of common sanitizing agents used in dairy plants by (a) suspension, (b) capacity test; Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods; Determination of BOD in dairy waste water.

Suggested Readings

1. Motel A and Whitfield FB. 2012. *Monitoring and Control of Food Safety and Quality*. Springer, New York.
2. Kleter G A and Marvin H J P. 2009. *Food Safety Management: Monitoring and Surveillance Techniques*. Woodhead Publishing, Oxford.
3. Toldrá F. 2017. *Advances in Food Quality and Safety: Analytical and Testing Techniques*. Academic Press, Oxford.
4. Mills E N C, Goodwin B J, Shewry P R. and Jones H D. 2008. *Food and Health: Monitoring Risks and Assessing Benefits*. Cambridge: Royal Society of Chemistry.
5. Mortimore S and Wallace C. 2013. HACCP: *A Practical Approach. (3rd Edn.)*. New York: Springer
6. Wallace C A, Sperber W H and Mortimore S E. 2018. *Food Safety for the 21st Century: Managing HACCP and Food Safety throughout the Global Supply Chain.* (2nd Edn.). Wiley-Blackwell, Chichester.
7. Fung D Y C, Sperber W H and Toma R B. 2018. *'Emerging Food Safety Challenges and Solutions',* Food Microbiology. (76):122-129.
8. Scallan E, Hoekstra R M, Angulo F J, Tauxe R V and Widdowson M A 2011. '*Foodborne Illness Acquired in the United States—Major Pathogens'*. Emerging Infectious Diseases, 17(1):7-15
9. Bouwknegt M, Dam-Deisz W D C, Havelaar A H and Zwartkruis-Nahuis J T M. 2013. *'Quantitative Risk Assessment for Monitoring of Food Safety'*. Risk Analysis, 33(2): 235-248.
10. Forsythe SJ 2020. *The Microbiology of Safe Food*. (3rd Edn.). Wiley-Blackwell, Oxford.

Chemical Quality Assurance 2 (1+1)

Objectives

i. To understand regulatory framework, standards and test methods for ensuring chemical quality assurance of dairy products

ii. To study national and global regulatory systems in place for ensuring chemical quality of milk and milk products

iii. To learn about requirements for setting up of analytical laboratories and its accreditation

iv. To develop skills for standardization of reagents and test procedures and calibration of glasswares for determination of quality parameters

v. To learn about possible chemical contaminants in milk and the test procedures to determine their presence in milk and milk products

Theory

Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc.

Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products.

Sampling procedures; labelling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer.

Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods.

Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf-life behavior of milk and milk products.

Practical

Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Detection of vegetable oils and animal body fat adulteration in ghee. Analysis of market samples of milk and milk products. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

Suggested Readings

1. Christensen J M and Thomsen M. 2020. *Chemical quality assurance of analytical processes*. Springer, Cham.

2. Skoog DA, Holler FJ. and Crouch SR. 2017. *Principles of instrumental analysis*. (7th Edn.). Cengage Learning, Boston.

3. Tamime A Y. 2012. *Milk Processing and Quality management*. Wiley-Blackwell, Oxford.
4. Wong N P, Jenness R, Keeney M and Marth E H. 1988. Fundamentals of dairy chemistry. (3rd Edn.). Springer,New York.
5. Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology: Quality and Safety Assurance*. (2nd Edn.). CRC Press, Boca Raton.

Instrumentation and process control 3 (2+1)

Objective

To study important instruments used in dairy processing operations and learn how to control the processes using these instruments

Theory

Importance of instrumentation and process automation in Dairy process control, Instrumentation scheme and characteristics: Introduction to static characteristics and dynamics characteristics, selection of instruments, loading effects. Dynamic characteristics of measurement systems.

Sensors: Definition, principle of sensing and transduction, classification, selection and applications of Sensors. Types of Sensors, Measurement of parameters Proximity sensors: applications in Dairy processing operations, Digital and analogue signals, handling and processing, Piezo electric sensor: construction- working and applications, Micro, Nano sensors and smart sensors: Construction, characteristics and applications. Switches: Relays, solid state relay, Contactors etc, Micro and Limit switches: Types, construction, working and applications.

Electric Power Monitoring and control: Measurement and control of electric Power, digital AC/DC Volt, current, frequency PF meters. Voltage protection, Earth leakage, current protection, Phase reversal, phases monitoring relays. PF control relays, Smart Energy meters: Role and importance. Solid state alarm: working and application in dairy processing. Valve automation: Different types of automation valves and their application, Variable frequency drives (INVERTER): Importance, types, Construction, working and their application in Dairy process automation.

Speed control of DC motors. Digital Process timers: On-delay, Interval, cyclic, sequential, reverse-forward, star delta, totaliser and counter types of timers, their applications in control of dairy process operation. Micro-processor and Micro-controllers: Introduction and application.

Data acquisition and data loggers: Importance- and applications, Programmable logic controller: Introduction, importance, working- selection and applications, Communication Interfaces: RS-485, Rs-232, modbusetc, their role and applications, Programmable touch screen and HMI: Introduction, importance, working- selection and usage, SCADA: Introduction, importance, working- selection and usage.

Electronic Instruments: Role and importance of general purpose test instruments, Electronic Millimeter, Cathode Ray Oscilloscope, Measurement of amplitude, frequency and phase using CRO Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator. Display devices and recorders like X-Y and X-T recorders. Automation: Introduction to plant automation, automation hierarchy, PLC, SCADA.

Practical

Strain gauge characteristics and weight measurement; Measurement of pressure using bellows and diaphragm; Fabrication and calibration of thermocouples; Study the construction and working of Bourdon pressure gauge; Testing and calibration of pressure gauges using dead weight tester; Study the mechanism of pH meter and calibration; Study of proximity sensor; Study of different parts and working of pressure switch.

Study of RTD and Thermister; Study of different speed measurement sensor/ instruments; Study of LVDT; Measurement of level and flow using controllers; Temperature control using PID and On/Off controllers; Generation of wave signals using CRO, Data acquisition to PC from instruments using RS232/485 and USB interfaces, Fabrication of micro sensors and Study of PLC systems and Demonstration of PLC systems in Dairy Plant.

Suggested Readings

1. Bartelt T L M. 2006. *Instrumentation and Process Control*. Cengage Learning. Massachusetts, United States.
2. Bolton W. 2004. *Instrumentation and Control Systems*. Elsevier. Amsterdam, Netherlands.
3. Boyes W. 2009. *Instrumentation Reference Book*. Butterworth-Heinemann. Oxford, United Kingdom.
4. Douglas O J. 2019. *Instrumentation Fundamentals for Process Control*. Routledge. England, UK.
5. Johnson C D. 1982. *Process Control Instrumentation Technology*. Wiley. New Jersey, United States.
6. Singh K S. 2007. *Industrial Instrumentation and Control*. Tata McGraw Hill Publishing Company Limited. Uttar Pradesh, India.
7. Nakra C. 2016. *Instrumentation Measurement and Analysis*. (4th Edn.). McGraw Hill Education India Private Limited. Uttar Pradesh.

Dairy Process Engineering 3 (2+1)

Objectives

i. To enable students understand working principles and design of equipments involved in concentration and drying of milk, mechanized manufacture of traditional Indian dairy products and packaging of milk
ii. To learn about heat transfer, mass and energy balance and material transport involved in concentration and drying of milk
iii. To understand design and operation of evaporators, dryers and fluidizers used for milk processing plants
iv. To acquire knowledge of various membrane processing systems suitable for processing of milk and whey
v. To understand design and operation of packaging systems for milk, mechanized manufacture of Indigenous dairy products, frozen desserts and cheese

Theory

Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of

condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators.

Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems; Factors affecting bulk density of powder, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers.

Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers.

Processing equipment: Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipment; Packaging equipment: Packaging machines for milk and milk products.

Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

Practical

Constructional details, operation and maintenance of Vacuum pan; Constructional details, operation and maintenance of multiple effect evaporator; Constructional details, operation and maintenance of spray drier; Constructional details, operation and maintenance of butter making equipment; Constructional details, operation and maintenance of equipment related to ghee production; Constructional details, operation and maintenance of ice-cream making equipment; Constructional details, operation and maintenance of cheese making equipment; Constructional details, operation and maintenance of reverse osmosis and ultra filtration system; Design problems on double effect evaporator and vacuum pan; Visit to a milk product plant.

Suggested Readings

1. Berk Z. 2013. *Food Process Engineering and Technology*. Academic Press. Massachusetts, United States.
2. Heldman D R, Lund D B, and Sabliov C. 2018. *Handbook of food engineering*. CRC press. Florida, United States.
3. Kessler H G. 2002. *Food and Bio Process Engineering: Dairy Technology*. Verlag A. Kessler. Michigan, United States.

Operations Research 2 (1+1)

Objective

To make students understand and analyse managerial problems and use optimization techniques to find solutions for using resources more effectively

Theory

Introduction–Elementary concepts, objectives of operations research, Applications of OR in decision-making; Modelling in Operation Research; Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems. Inventory Control – Introduction and general notations, Economic lot size models with known demand; Replacement – Introduction, Replacement of items whose efficiency deteriorates with time.

Queuing – Introduction and general notions, Classification of queues and their problems, Probability distribution of queues; Various models in the queuing system; Sequencing – Statement of the problem, notations and assumptions, Problems with 'n' jobs and two machines; Generalization to 'm' machines. Transportation model – Definition and application of transportation model, Formulation of transportation problems and their solutions; Assignment problems and their solutions. Framework of PERT and CPM, Activities, events and network, PERT and activity time estimates, probability of project completion critical path analysis.

Practical

LP problems; Inventory Control problems; Replacement model problems; Problems on queuing theory, sequencing, transportation, assignment; PERT/CPM.

Suggested Readings

1. Churchman C W, Ackoff R L and Arnoff E L. 1957. *Introduction to Operations Research*. John Wiley and Sons, New York.
2. Goel B S and Mittal S K. 1974. *Operations Research*. Pragati Prakashan, Meerut.
3. Kapoor V K and Kapoor S. 2001. *Operations Research Techniques for Management*. Sultan Chand and Sons, New Delhi.
4. Sasieni M A, Yaspan and Friedman L. 1959. *Operations Research: Methods and Problems.* John Wiley and Sons, New York.
5. Sharma S D. 1999. *Operations Research*. Kedar Nath Ram Nath & Co., Meerut.
6. Swarup K, Gupta P K and Mohan M. 1989. *Operations Research*. Sultan Chand and Sons, New Delhi.
7. Taha H A. 2003. *Operations Research*. (7th Edn.). Pearson Education, New Delhi.
8. Taha H A. 2005. *Operations Research: An Introduction.* Prentice Hall of India Private Limited, New Delhi.
9. Wagner H M. 1982. *Principles of Operations Research, with Applications to Management Decisions*. Prentice Hall of India, New Delhi.

Economic Analysis 2 (2+0)

Objective

To equip students with the knowledge of analytical skills necessary to analyze economic phenomena, make informed decisions and apply economic principles to real-world situations

Theory

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors. Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus.

Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns. Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale. Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition; National income – GDP, GNP, NNP, disposable personal Income, per capita income, inflation.

Suggested Readings

1. Ghai P and Gupta A. 2002. *Microeconomics Theory and Applications*. Sarup and Sons Publ., New Delhi.
2. Henderson J M. and Quandt R E. 2000. *Microeconomic Theory: A Mathematical Approach.* Mc-Graw Hill Kogakusha Ltd., Tokio.
3. Kreps D M. 1990. *A Course in Microeconomic Theory*. Princeton University Press, Princeton.
4. McAfee R P and Johnson J S. 2005. *Introduction to Economic Analysis*. University Press Publ., Florida.
5. Rittenberg L and Tregarthen T. 2009. *Principles of Microeconomics*. Flat World Knowledge, New York.
6. Samuelson P and Nordhaus W. 2010. *Economics*. (17th Edn.). Tata Mc-Graw Hill, New Delhi.

Semester-VI

Dairy Plant Management and Pollution Control 2(1+1)

Objective

The primary objective of the course is to provide students with comprehensive knowledge and skills related to the management of dairy processing operations and the effective control of pollution

Theory

Production Management: Definition, Function and structure of Production Management, Production planning and Control, Work study and measurement motion and time study; Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency.

Plant Operations Product and process control, Control charts, Process Sigma, Efficiency factors losses, Financial and Managerial efficiency; Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act and Regulations.

Human Resource Management: Personnel Management, Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions.

Safety hazards: hazards prevention, security for plant machinery and the employees, Plant Maintenance; Prevention and Break-down maintenance: Spare parts inventory, tools and lubricants, etc; Food hygiene: personnel hygiene, plant hygiene, water quality, etc.

Wastes discharged from dairy plants: An overview; Wastewater discharged from (a) Milk reception dock, (b) Liquid milk processing section, (c) Butter and ghee manufacturing, (d) Ice-cream and condensed milk manufacturing, e) Milk powder manufacturing, (f) Cheese and paneer manufacturing; Packaging wastes; CIP cleaning, Environmental issues in effluent discharge: (a) Effects on waterways, (b) Effects on land, (c) Effects on the atmosphere (d) Solid waste.

Waste treatment process in a dairy processing plant: Wastewater treatment options for A Dairy Processing Plant; Calculation of wastes discharged and the economics thereof.

Practical

Flow process charts of different milk products; Identification of steps of material losses on dairy plants; Identification of hazardous processes and equipment, (HACCPT plan) safety and precautions; Identification and uses of common lubricants; Waste characterization and Waste Utilization processes; Various treatments in waste disposal; Analysis of cleaning agents and sanitizers; Reports and records maintenance of dairy plant; Operational precautions; CIP cleaning.

Suggested Readings

1. David J. 2007. *Contemporary Trends in Dairy Plant Management*. Gyan Books Pvt. Ltd., Delhi
2. Kumar H D. 1998. *Environmental Pollution and Waste Management*. MD Publ. Pvt. Ltd., New Delhi.
3. Maliwal G L. 2007. *Hand book of Environmental Management*. Agrotech Publ. Academy, India.
4. Warner J N. 1976. *Principles of Dairy Processing*. John Wiley Publ., New York.

Strength of Materials and Dairy Machine Design 3 (2+1)

Objective

To enable students to analyze and design dairy machinery and related equipment

Theory

Strength of Materials: Basic concepts in Statics and Dynamics; Force Systems; Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem; Dynamics: Equation of motion.

Translation and rotation of a Rigid body, work and mechanics of materials: Stress-Axial Load Classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio: Shearing Stresses; Torsion, Torsion formula, Angle to Twist of circular members; Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams; Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads.

Dairy Machine Design: Procedures, Specification, strength, design factor, factor of safety selection of factor of safety; Materials and properties; Static strength, ductility, hardness, fatigue, designing for fatigue conditions; Theories of failure, Stresses in elementary machine parts, Design of a drive system; Design of length and thickness of belt.

Bearing: Journal and Anti-friction bearings; Selection of ball, tapered roller and thrust bearing; Springs, helical and leaf springs; Energy stored in springs; Design and selection of springs.

Practical

Design problems on applications of engineering statics and dynamics; Design problems on applications of work and energy; Design problems on applications of linear and angular momentum; Design problems on stress-strain diagram evaluation of elastic constants; Study on shear force and bending moment diagrams and its applications; Design problems on applications of flexural stresses; Design problems on applications of shearing stresses in beams; Study on system of limits, fits and tolerances and their applications; Design stresses in elementary machine parts; Design features and applications of shafts; Design features and applications of axles; Design features and applications of keys; Design features and applications of couplings.

Design problems on various types of power transmission systems; Design features and applications of bearings; Design features and applications of springs; Design problems on agitator/ stirrer; Design features of milk silo.

Suggested Readings

1. Bansal R K. 2010. *A Textbook of Strength of Materials: (In S.I. Units)*. Laxmi Publications. Chennai.
2. Bansal R K. 2011. *Strength of Materials (U.P. Technical University, Lucknow)*. Laxmi Publications Pvt Limited. Chennai.
3. Bedi D S. 2019. *Strength of Materials*. (6th Edn.). Khanna Publishing House. New Delhi.
4. Hartog J P D. 2012. *Strength of Materials*. Courier Corporation. Massachusetts, United States.
5. Jindal U C. 2012. *Strength of Materials.* Pearson Education India. New Delhi.
6. Khurmi R K N. 2019. *A Textbook of Strength of Materials*. S. Chand Publishing. New Delhi.
7. Singh D K. 2020. *Strength of Materials*. Springer Nature. New York.

Financial Management and Cost Accounting 3 (2+1)

Objective

To provide students with a foundational understanding of financial management principles, accounting systems and cost analysis methods

Theory

Introduction: Definition, scope and objectives of financial management; Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting; Doubles entry system of Book-Keeping; Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book; Preparation of Final Accounts and adjustments

at the end of trading period; Preparation of Trial Balance Banking Transactions and Bank reconciliation statements; Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making.

Financial Analysis: Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis; Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis; Capital Structure: C;S Planning, risk return trade off, financial leverage; Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital and retained earnings, overall cost of capital.

Investment decision: Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Pay-back period method, Accounting rate of return method; Capital budgeting: Complex Investment Decisions: Investment timing and duration Investment decisions under inflation, Investment decisions under capital rationing.

Project Report; Feasibility Report Valuation; Working capital management- Concept and determinants of working capital, Estimating working capital needs; Depreciation – Concept and method; Introduction, Definition, Objectives, Common terms.

Costing: Essentials of sound costing system; Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium and Bonus Plans, Materials, Overheads.

Cost classification: Direct and Indirect expenses, fixed and variable costs; Various methods of apportioning indirect expenses; Inventory Management: Planning, control and costing; Stores and storekeeping, scope and importance, purchase procedure, types of purchase, location of stores and materials, procedure for the movement of stores, different methods of pricing materials, store records; Cost Sheets-Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations; Contract or Terminal costing; Process Costing: Process losses and inter-process profits, joint products and by products costing; Ascertainment of cost of milk production; Preparation of Cost Account Information for managerial decisions.

Practical

Preparation of Profit and Loss account; Preparation of Balance Sheet; Preparation of Cash flow statements; Preparation of Funds flow statements; Problems on Ratio analysis; Problems on Break-Even Analysis; Problems on Profit analysis; Problems on Operating Analysis; Problems on Financial leverage; Problems on Cost of Capital; Problems on Investment decisions; Problems on Capital budgeting.

Suggested Readings

1. Bhattacharyya. 2007. *Essential of Financial Accounting.* S. Chand and Co., New Delhi.
2. Gupta S K and Sharma R K. 1996. *Financial Management: Theory and Practice*. Kalyani Publ., Ludhiana.

3. Khan M Y and Jain P K. 2011. *Financial Management: Text, Problems and Cases*. Tata Mc Graw-Hill Publ., New Delhi.
4. Maheswari S N. 2010. *Management Accounting and Financial Control*. Sultan Chand and Sons, New Delhi.
5. Pandey I M. 1989. *Financial Management*. Vikas Publ., New Delhi.
6. Pandey I M. 2006. *A Management Guide for Managing Company Funds and Profits*. Tata Mc Graw-Hill Publ., New Delhi.
7. Reddy P N and Appaniah H R. 1997. *Essential of Management Accounting*. Himalaya House, Bombay.
8. Shukla M C and Grewal T S. 1979. *Advanced Accounts*. S. Chand and Co., New Delhi.

Food and Industrial Microbiology 2 (1+1)

Objective

The first part of the course deals with microbiological aspects of various food products including their spoilage and preservation technologies; The latter part deals with industrial fermentation and product manufacturing.

Theory

Scope of food microbiology: Basic aspects, history and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in different foods; Microbial Spoilage of foods: Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; Sources of contamination; Control of spoilage.

Food preservation: Principles of food preservation: physical methods, viz. low temperature and high temperature preservation (D, Z and F Values); Drying Methods; Chemical preservatives, Natural antimicrobial compounds and bio- preservation; Alternate methods of food preservation; Mode of action of various preservation methods on microbes.

Fermentation processes: Fermentation processes: Historical development, the range, components and types (i.e., submerged, surface and solid-state fermentation); criteria for selection of industrially important microorganisms; preservation and improvement of industrially important micro-organisms using metabolic engineering/genetic engineering; media for industrial process; upstream and downstream processing.

Types of fermenters: Fermenters: types (batch, fed batch and continuous), functions, design and control; sterilization; growth rate analysis, estimation of biomass; difference in chemostat and turbidostat.

Microbial production of industrial products: Immobilization of enzymes/cells; Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine; organic acids (citric and lactic), enzymes (protease, lipase and rennet), vitamin (B_{12}), antibiotics and bacteriocins; and fermented whey beverages.

Practical

Microbiological examination of: (1) fresh and canned fruits, vegetables and juices; (2) flour and bread; and (3) eggs and meat; Isolation of psychrophilic, salt and sugar tolerant

microorganisms from foods; Isolation of industrially important microorganisms from environment; Determination of Z, D and F values; Production and assaying of microbial enzymes (protease/ lipase); Production of lactic acid from whey; Production of nisin and assaying the antimicrobial activity of the culture; Design and control of a table-top and 10 liter lab fermenter (Demonstration); Production of ethyl alcohol from molasses and whey by yeasts; Production of fermented whey beverages; Educational tour to food processing/ fermentation industries.

Suggested Readings

1. Jay J M, Loessner M J and Golden DA. 2005. *Modern Food Microbiology*. (7th Edn.). Springer, New York.
2. Doyle M P and Buchanan RL. 2013. *Food Microbiology: Fundamentals and Frontiers*. (4th Edn.). ASM Press, Washington, D.C.
3. Adams M R and Moss M O. 2008. *Food Microbiology. (*3rd Edn.). Royal Society of Chemistry. CUP, Cambridge.
4. Ray B and Bhunia A K. 2013. *Fundamental Food Microbiology. (*5th Edn.*)*. CRC Press, Boca Raton.
5. Montville T J, Matthews K R and Kniel K E. 2012. *Food Microbiology: An Introduction. (*3rd Edn.*)*. ASM Press Washington, D.C.
6. Batt C A and Tortorello M L. 2014. *Encyclopedia of Food Microbiology.* (2nd Edn.). Academic Press. Oxford
7. Forsythe S J. 2020. *The Microbiology of Safe Food. (*3rd Edn.*)*. Wiley-Blackwell, Oxford.
8. Reed G (Ed.). 1987 *Prescott and Dunn's Industrial Microbiology. (*4th Edn.). CBS Publ., and Distributors, Delhi, India.
9. Waites M J. 2001. *Industrial Microbiology: An Introduction*. Blackwell Science, London.

Packaging of Dairy Products 2 (1+1)

Objective

To learn about the packaging materials and packaging systems available for milk and different types of milk products

Theory

Introduction, Importance of Packaging, History of Package Development, packaging materials, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeats, concentrated and dried milks including baby foods; Packaging of functional dairy/food products.

Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages. Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for

AP, Description of equipment (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems; Hazards from packaging materials in food.

Practical

Identification of packaging materials, Flame Hot wire test, Testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength; Testing of glass bottle – resistance to thermal shock; Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance; Packaging of different dairy products by using prepack and vacuum packaging machines.

Suggested Readings

1. Dharaiya C N, Singh B, Rani R and Modha H. 2023. *Packaging Techniques and Packaging of Dairy and Food Products.* In: Recent Technologies in Dairy Science. Today's and Tomorrow's, New Delhi.
2. Grumezescu A M and Holban A M. (Eds.). 2017. *Food Packaging and Preservation* (Vol. 9). Academic Press, London.
3. Panjagari N and Ganguly S 2024. *Textbook on Packaging of Dairy Products*. Indian Council of Agricultural Research, New Delhi.
4. Ahvenainen R. 2003. *Novel Food Packaging Techniques*. Woodhead Publ. Ltd., Cambridge, England.
5. Coles R, Mc Dowell D and Kirwan M J. 2003. *Food Packaging Technology*. Blackwell Publishing Ltd., Oxford, UK.
6. Engineers India Research Institute. 2005. *Handbook of Packaging Technology*. EIRI, Delhi.
7. Han J. 2005. *Innovations in Food Packaging*. Elsevier Science & Technology Books.
8. Piringer O G and Baner A L. (Eds.). 2008. *Plastic Packaging: Interaction with Food and Pharmaceuticals*. John Wiley and Sons, Weinheim, Germany.
9. Yam K L. 2009. *Encyclopedia of Packaging Technology* (3rd Edn.). John Wiley and Sons, Inc. Publ., USA.

Food Technology-I 3 (2+1)

Objective

To provide students with an in-depth understanding of food processing techniques as applied to fruits, vegetable and other plant based products

Theory

Harvesting, transportation and storage of fruits and vegetables; Post harvest processing of fruits and vegetables: Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables.

Juice processing: General steps in juice processing, role of enzymes in fruit; Juice extraction, equipment and methods of fruit juice extraction, preservation of fruit juices, fruit juice

clarification, concentration of fruit juices, fruit juice powders; Fruit juice processing; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices.

Manufacture of Jam, Jelly and Marmalade: Role played by pectin, sugar and acid in jellied fruit products; Fruits and vegetable preserves, Glazed, Crystallized fruits; Tomato based products: Juice, puree, paste, sauce, ketchup; Pickles: Principle of pickling, technology of pickles.

Beverages: Classification, scope, carbonated non-alcoholic beverages and their manufacture; Fruit beverages and drinks, additives for fruit based beverages; Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee; Tea: Tea leaf processing, green, red, yellow, instant tea.

Technology of confectionery foods: Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products; Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products; Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

Practical

Manufacture of toffees and caramels, Testing the efficacy of blanching process; Drying of fruits and vegetables; Preparation of fruit-based drinks and beverages: Ready-to-serve drink, Nectar, Squash, Whey-fruit based beverages; Manufacture of fruit jam; Manufacture of fruit jelly; Manufacture of chocolate confections; Manufacture of tomato ketchup/tomato sauce; Manufacture of soups; Manufacture of fruit preserve; Manufacture of candied fruits; Manufacture of fruit bar; Manufacture of pickles.

Suggested Readings

1. Beckett S T. 1999. *Industrial Chocolate, Manufacture and Use*. Blackwell Science Ltd., Maldon, USA.
2. Belitz H D, Grosch W, and Schieberle P. 2009. *Food Chemistry*. (4th Edn.). Springer, Berlin.
3. Campbell-Platt G. 2009. *Food Science and Technology*. Wiley-Blackwell, Oxford.
4. Heldman D R and Lund D B. 2006. *Handbook of Food Engineering*. (2nd Edn.). CRC Press, Boca Raton.
5. Edwards W P. 2000. *The Science of Sugar Confectionery.* The Royal Society of Chemistry, Cambridge, UK.
6. Er B Pantastico. 1975. Post *Harvest Physiology, Handling, and Utilization of Tropical and Sub-troipcal Fruits and Vegetables*. AVI Publishing Co. Westport Conne.
7. Fellows P J. 2009. *Food Processing Technology: Principles and Practice*. (3rd Edn.). Woodhead Publishing, Cambridge.
8. Goldberg Israel. 1994. *Functional Foods: Designer Foods, Pharma Foods, Nutraceuticals*. Aspen Publications, Maryland.
9. Hui Y H. 2006. *Handbook of Food Science, Technology and Engineering*. CRC Taylor & Francis Group, Boca Raton, FL, USA.

10. Jackson E B. 1990. *Sugar Confectionery and Manufacture*. Blackie and Son Ltd., Glasgow, NZ.

11. Laura A. de la Rosa, Emilio Alvarez-Passilla, Gustavo A and Gonzalez-Aguilera. 2010. *Fruits and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability.* Willey Balckwell Publisher, Iowa (USA).

12. Potter N N and Hotchkiss J H. 1995. *Food Science*. (5th Edn.). Springer, New York.

13. Ramaswamy H and Marcotte M. 2005. *Food Processing: Principles and Applications*. CRC Press, Boca Raton.

14. Somogyi L P, Ramaswamy H S and Hui Y H. 1996. *Processing Fruits: Science & Technology. Biology, Principles and applications, Vol.1*. Technomic Publ. Co. Inc, Lancaster, USA.

15. Thompson A. 2010. *Controlled Atmosphere Storage of Fruits and Vegetables. (*2nd Edn.). CAB International, Oxfordshire, UK.

16. Vernam A H and Sutherland J P. 1999. *Beverages: Technology, Chemistry and Microbiology, (Vol. II).* Aspen Publ., Maryland.

Food Chemistry 3 (2+1)

Objective

To provide students with a comprehensive understanding of the chemical composition and properties of food systems and constituents

Theory

Water: Water binding and chemical reaction mediated by water; Food proteins: Classification and physico-chemical and structural properties; Lipids: Definition, classification of lipids, Unsaponifiable matter contents in various fats and oils, classification and chemical composition.

Carbohydrates: Classification of carbohydrates, polysaccharides, viz. linear, branched and modified; Properties and utilization of common polysaccharides, viz. cellulose, glycogen, hemicelluloses, pectin; Food Enzymes: Hydrolases and lipases, utilization in food chemistry; Minerals in foods: Main elements, trace elements in eggs, cereals and cereal products, vegetables and fruits; Aroma compounds in foods: Threshold value, off-flavours.

Food additives: Vitamins and Amino acids, Minerals, Aroma Substances/flavour enhancers-Monosodium glutamate, 5-nucleotides sugar substitutes, sorbitol sweeteners- saccharin, and cyclamate, Food colours and food preservatives.

Antinutritional factors and Food contaminants: Toxic trace elements, radio nucleotides; Cereal and cereal products: Individual constituents like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making, influence of additives /minor ingredients on baking properties: physico-chemical changes during baking; Legumes: Classification, general composition and physico-chemical properties.

Vegetables and Fruits: Classification, general composition, chemical changes during ripening and storage; Jams, Jellies and Pickles: Classification, composition and preservation; Preservation of foods, general principles of food preservation.

Practical

Determination of moisture, acidity and gluten content in flour; Determination of total ash and acid insoluble ash in flour; Determination of starch in flour; Determination of total nitrogen in cereal products; Determination of acidity and vitamin C in citrus fruits; Analysis of tomato ketchup for total solids, acidity, ash and salt; Determination of total sugar in tomato ketchup; Determination of total ash and alkalinity of soluble ash in tea; Determination of water extractive in tea leaves. Determination of presence of Chicory in coffee powder; Determination of reducing sugars in Jam; Determination of iron in infant foods.

Suggested Readings

1. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.). Springer, Berlin.
2. Damodaran S, Parkin K L and Fennema O R. 2017. *Fennema's food chemistry*. (5th Edn.). CRC Press, Boca Raton.
3. Coultate T P. 2009. *Food: The Chemistry of its Components*. (5th Edn.). Royal Society of Chemistry, Cambridge.
4. Fennema O R. 1996. *Food Chemistry*. (3th Edn.). Marcel Dekker, New York.
5. Vaclavik V A and Christian E W. 2014. *Essentials of Food Science*. (4th Edn.). Springer, New York.
6. Shahidi F 2006. *Bailey's Industrial Oil and Fat Products*. (6th Edn.). Wiley-Interscience, New York.
7. Zheng G and Xu X. 2022. *Lipid Oxidation in Food and Biological Systems: A Physical Chemistry Perspective*. Elsevier, London.
8. McClements D J. 2019. *Future Foods: How Modern Science is Transforming the way we eat*. Springer, London.
9. Cheung P C K and Mehta B M. 2015. *Handbook of Food Chemistry*. Springer, Berlin.
10. Eskin NAM and Shahidi F. 2012. *Biochemistry of Foods*. (3th Edn.). Academic Press, San Diego.

Energy Conservation and Management 2 (1+1)

Objective

To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries

Theory

Introduction: Potential and Importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act 2003, Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution.

Energy balances and computation of efficiencies of equipment; Role of Energy inspectors and Auditors in energy management; Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques; Quality of power, Power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motor-selection and application, Energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls.

Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings.

Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors; Maintenance and upkeep of Vacuum lines and Compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment.

Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator.

Energy conservation in buildings: Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits.

Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries; Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of Energy Balance in Unit Operations and System boundaries; Solving examples on energy balances; Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve.

Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different

BEE Star Ratings; Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Suggested Readings

1. De B K. 2007. *Energy Management, Audit and Conservation*. Vrinda Publications. Delhi, India.
2. Demirel Y. 2021. *Energy: Production, Conversion, Storage, Conservation, and Coupling*. Springer Nature. New York, United States.
3. Kreith F and Goswami D Y. 2016. *Energy Management and Conservation Handbook*. CRC Press. Florida, United States.
4. Patrick D R, Fardo S W, Richardson RE and Fardo B W. 2020. *Energy Conservation Guidebook. (3rd Edn.)*. CRC Press. Florida, United States.
5. Sharma K V and Venkataseshaiah P. 2013. *Energy Management and Conservation*. I.K. International Publishing House Pvt. Limited. New Delhi, India.
6. Thipse S S. 2014. *Energy Conservation and Management*. Alpha Science International, Limited. England, United Kingdom.

Semester-VII

S. No.	Course Title	Credit Hours
1.	Food Engineering	3 (2+1)
2.	Dairy Plant Design and Layout	2 (1+1)
3.	Food Technology-II	3 (2+1)
4.	Sensory Evaluation of Dairy Products	2 (1+1)
5.	Biochemistry and Human Nutrition	2 (1+1)
6.	Elective Courses	**8*** **
	Total	**20**
Student has to complete 20 credits in 7th Semester (Courses 1 to 5 (12 credits) are compulsory) ***Courses listed under Elective Courses (minimum of 8 credit hours from the elective courses should be opted to complete total 20 credits)		

Food Engineering 3 (2+1)

Objective

To provide a strong foundation in understanding the physical and mechanical properties of food and various unit operations in food processing.

Theory

Rheology: Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Viscoelastic models; Measurement of food texture; Food Freezing: Thermal properties of frozen foods; Predication of freezing rates; Plank's equation, Design of food freezing

equipment, Air blast freezers, Plate freezers, spiral freezers, and immersion freezers, IQF, storage of frozen foods.

Food dehydration: Estimation of drying time for food products, constant rate period and falling rate period dehydration; Diffusion controlled falling rate period; Use of heat and mass balances in analysis of continuous dryers, Principle, construction working of vacuum drier, ring dryer, Flash dryer, fluid bed granulator, tunnel, Rotary dryer, solar dryer; Freeze concentration and dehydration: Heat and mass transfer, Calculation of drying time, Industrial freeze drying.

Other advance food processing operations and equipment: Equipment for fruit washing, pulping, fruit juice extraction, blanching, de-hulling, milling, Juice concentration, aroma recovery and distillation; Handling and storage of fresh produce like fruits and vegetables: Pre-cooling (Field heat removal), cleaning, grading, sorting, packaging and storage; Study of Stability chambers: Principle, construction and working.

Unit operations in Fruit and vegetable: Processing for production of puree and paste : Washing (Hydraulic flume Rotary washer, sorting and grading, size reduction, blanching, hot/ cold break system, De-aerators, Pulpers, turbo extractors, forced circulation evaporators, Tube- in tube type sterilizer- Aseptic filler; Size reduction: Theory and principle, Different size reductions equipment; Unit operations and equipment for production of bakery products: Planetary mixer, sigma mixer, Rotary oven, etc. Unit operations in production of Coffee powder production: Mixer, roaster, size reduction plant, Extraction, concentration and spray drying unit; Rewet method of production of granulated coffee.

Meat and fish processing: Meat mincer, Marinator, sausage maker; Food extruder: Principle construction and working of Single and double screw extruder, Hot and cold extrude for production of ready eat and ready to cook foods.

Practical

To determine physical properties of food product; To determine rheological properties of food product; Determination of rheological parameters of solid and liquid foods by graphical solutions; To study food freezers; To study freeze drier; To determine drying characteristics of food product; To compare various dying methods; To determine juice yield; To compare hot water, steam and vacuum blanching; To study construction and working of aroma /distillation system; To study various size reduction equipment; Study of sifter for size separation; Study of planetary mixer/sigma mixer/whisker etc; Study of grain mill; Study of microniser/colloid mill for homogenisation, emulsification of viscous products like tomato paste, mayonnaise etc; Visit to cold storage; Visit to food processing plant (bakery, coffee processing, meat processing, cereal processing).

Suggested Readings

1. Anandharamakrishnan C and Ishwarya S P. 2019. *Essentials and Applications of Food Engineering*. CRC Press. Florida, United States.
2. Berk Z. 2013. *Food Process Engineering and Technology*. Academic Press. New York, United States.
3. Chakraborty S K. 2014. *Fundamental Food Engineering*. Alpha Science International, Limited. England, United Kingdom.

4. Heldman D R, Lund D B and Sabliov C. 2018. *Handbook of Food Engineering*. CRC press. Florida, United States.
5. Kessler H G. 2002. *Food and Bio Process Engineering: Dairy Technology*. Verlag A. Kessler. Michigan, United States.
6. Kutz M. 2019. *Handbook of Farm, Dairy and Food Machinery Engineering*. Academic Press. Academic Press. New York, United States.
7. Singh R P and Heldman D R. 2008. *Introduction to Food Engineering*. Academic Press. Academic Press. New York, United States.
8. Singh R P, Heldman D R and Erdogdu F. 2023. *Introduction to Food Engineering*. Elsevier. New York, United States.

Dairy Plant Design and Layout 2 (1+1)

Objective

To equip students with the knowledge and skills necessary to design and plan dairy processing plants efficiently and hygienically

Theory

Introduction of Dairy Plant design and layout: Type of dairies, perishable nature of milk, reception flexibility; Classification of dairy plants, Location of plant, location problems, selection of site; Hygienic design considerations for dairy processing plants;

Planning: Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout; Space requirements for dairy plants, estimation of service requirements including peak load consideration.

Dairy plant design aspects: General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design; Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop; Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility; Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout.

Building construction materials: Floors, general requirement of dairy floor finishes, floors for different section of dairy; Foundations, walls doors and windows.

Other design aspects: Drains and drain layout for small and large dairies; Ventilation, fly control, mold prevention, illumination in dairy plants; Computer aided Design: Introduction to CAD software.

Practical

Building symbols and convention; Symbols for equipment; Study of process schedule; To draw layout of collection/chilling centre; Visit to dairy processing plant for understanding of layout of different sections.

To draw layout of small dairy plant; To draw layout of small dairy plant using CAD; To draw layout of medium dairy plant; To draw layout of large dairy plant; To draw layout of cheese plant; To

draw layout of ice-cream plant; To draw layout of butter manufacturing unit; To draw layout of ghee plant; To draw layout of composite dairy plant.

Suggested Readings

1. Agarwal G K. 2007. *Plant Layout & Material Handling*. Jain Brothers. Haryana, India.
2. Ahmad T. 2003. *Dairy Plant Engineering and Management (9th Edn. 2021)*. Kitab Mahal. New Delhi, India.
3. Experts E P. 2024. *Dairy Plant Design and Layout*. EduGorilla Publication. Uttar Pradesh, India.
4. Lopez-Gomez A and Barbosa-Canovas G V. 2005. *Food Plant Design*. CRC Press. Florida, United States.
5. Moran S. 2019. *An Applied Guide to Process and Plant Design*. Elsevier. New York, United States.
6. Pothuvaal S. 2025. *Dairy Plant Management: A Practical Approach*. Educohack Press. Bangalore, India.

Food Technology-II 3 (2+1)

Objective

To provide students with a understanding of the processing and technology involved in the production of various food products, with a focus on cereal grains, legumes, oilseeds, bakery and snack items, as well as meat, fish and egg products

Theory

Cereal grains, legumes and oilseeds: Structure and composition of cereals, legumes and oilseeds, milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour.

Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in manufacture of value added food products including malted milk foods.

Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates/ isolates, Utilization of oil cake in food formulation.

Bakery and Snack technology: Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti, Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips.

Meat, fish and egg technology: Development of meat, poultry, egg and fish industry in India, Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish;, Manufacturing process of dehydrated fish and fish pickles; Cleaning and sanitation, Waste management of food processing plants.

Practical

Manufacture of barley malt; Determination of cooking quality of rice; Manufacture of bread and bun; Manufacture of biscuits; Preparation of noodles; Preparation of cake; Manufacture of potato chips; Preparation of malt based food products; Manufacture of malted milk foods, Manufacture of soy beverage and tofu, Preparation of salami; Preparation of chicken soup; Manufacture of chicken pickle.

Suggested Readings

1. Bamforth C W and Barclay, A H. 1993. *Malting Technology and the uses of malt*. In: Barley: Chemistry and Technology, Alexander W. MacGregor and Rattan S. Bhatty (Eds.) pp. 297-354, American Association of Cereal Chemists, St. Paul, MN, USA.
2. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.). Springer, Berlin.
3. Biscuit and Cracker Manufacturers Association. 1981. *Biscuit and Cracker Handbook*, Washington, DC.
4. Campbell-Platt G. 2009. *Food Science and Technology*. Wiley-Blackwell, Oxford.
5. Chavan J K and Kadam S S. 1989. *Nutritional Improvement of Cereals by Fermentation*. CRC Crit. Rev. Food Sci. Technol., 28: 349-400.
6. Dhillon L S. 2005 *Manufacturing of Malt-Milk Based Food Products*. Indian Dairyman, 57: 59-66.
7. Fast R B and Caldwell E F. 1993. *Breakfast Cereals and How They Are Made*. American Association of Cereal Chemists, Inc., St. Paul, Minnesota, USA.
8. Fellows P J. 2009. *Food Processing Technology: Principles and Practice*. (3rd Edn.). Woodhead Publishing, Cambridge.
9. Heldman D R, and Lund D B. 2006. *Handbook of Food Engineering*. (2nd Edn.) CRC Press, Boca Raton.
10. Hoseney R C, Wade P and Finely J W. 1988. *Soft Wheat Products, In: Wheat Chemistry and Technology, (3rd Edn.)* (Y. Pomeranz, Edn.) American Association of Cereal Chemists, St. Paul, M N.
11. Kulp K and Ponte J G Jr. 2000. *Handbook of Cereal Science and Technology, (2nd Edn.), Marcel Dekker*, Inc., New York, USA.
12. Lorenz K J and Kulp K. 1991. *Handbook of Cereal Science and Technology*, Marcel Dekker, Inc., New York, USA.
13. Matz S A. 1969. *Cereal Science, Samuel A. Matz (Ed.)* pp. 79-96. The AVI Publishing Company Inc., England.
14. Gopalan C, Rama Sastri BV and Balasubramanian S C. 2004. *Nutritive Value of Indian Foods*. Revised & Updated by: Narasinga Rao B S, Deosthale Y G and Pant K C, National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.
15. Pomeranz Y and Bechtel D B 1978. Structure of Cereal Grains as Related to End-use Properties. Postharvest Biology and Biotechnology. H O Hultin and M Milner,. Food and Nutrition Press, Inc., Westport, CN.

16. Potter N N and Hotchkiss, J H. 1995. *Food Science*. (5th Edn.) Springer, New York.

17. Ramaswamy H and Marcotte M. 2005. *Food Processing: Principles and Applications*. CRC Press, Boca Raton.

Sensory Evaluation of Dairy Products 2 (1+1)

Objective

To provide students with a comprehensive understanding of sensory evaluation techniques as applied to dairy products

Theory

Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Terminology related to sensory evaluation; Design and requirements of a sensory evaluation laboratory; Basic principles: senses and sensory perception; Physiology of sensory organs; Classification of tastes and odours, threshold value; Factors affecting senses, visual, auditory, tactile and other responses.

Fundamental rules for scoring and grading of milk and milk products; Procedure and types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, hedonic scale and descriptive tests; Panel selection, screening and training of judges; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements.

Milk: score card and its use; Judging and grading of milk, defects associated with milk; Cream: desirable attributes and defects in cream, Score card for cream, sensory evaluation of different types of cream; Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter; Ghee: grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee.

Fermented milks: desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks; Frozen dairy products: desirable and undesirable characteristics of frozen dairy products; Sensory evaluation of ice cream, kulfi and milk sherbets; Cheese: sensory attributes of some common cheese varieties and their defects, score card for cheese; Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses; Dried dairy products: desirable and undesirable characteristic of dried milks; Sensory evaluation and grading of dry milk products; Concentrated milks: desirable attributes and defects; Sensory evaluation and grading of evaporated and condensed milk; Heat desiccated Indian milk products: desirable and undesirable characteristics.

Sensory evaluation of khoa and khoa based sweets; Acid coagulated Indian milk products: desirable arid undesirable characteristics; Sensory evaluation of paneer, chhana and chhana based sweets; Consumer acceptance studies: Objectives, methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and consumers studies, limitations; Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests.

Practical

Determination of threshold value for basic tastes; Determination of threshold value for various odours; Selection of sensory evaluation panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Sensory evaluation of milk and cream; Sensory evaluation of butter and ghee; Sensory evaluation of condensed and evaporated milk; Sensory evaluation of milk powders; Sensory evaluation of cheese and related products; Sensory evaluation of frozen products; Sensory evaluation of khoa and khoa-based sweets; Sensory evaluation of chhana and chhana based sweets; Sensory evaluation of dahi and fermented dairy products; Preparation of milk and milk products with defects, techniques for simulation; Novel techniques of sensory evaluation.

Suggested Readings

1. Clark S, Costello M, Deake M and Bodyfelt F (Eds). 2009. The *Sensory Evaluation of Dairy Products*, Springer Science + Business Media, New York, USA.
2. Lawless H T and Haymann H. 1998. *Sensory Evaluation of Food: Principals and Practices*. Chapmann & Hall, New York, USA.
3. Khamrui K. 2012. *Sensory Evaluation of Health Foods: Requirement and Techniques*. In: Health Foods: Concept, Technology and Scope. R. K. Gupta, S. Bansal and M. Mangal (Eds). Biotech Tech Books, 4762-63/23 Ansari Road, New Delhi – 110 002. pp 729-745.
4. Khamrui K, Prasad W and Khetra Y. 2018. *Practical Sensory Evaluation of Milk and Milk Procucts*. NDRI Publication, ICAR-NDRI, Karnal.
5. Patel A A and Gupta S K. 1978. *Sensory Evaluation of Milk Powders.* Indian Dairyman. 50 (5): 361-364.
6. Stone H and Sidel J. 2004. *Sensory Evaluation Practices. (3rd Edn.)* Academic Press, Inc. San Diego, California.

Biochemistry and Human Nutrition 2 (1+1)

Objective

To develop understanding of fundamental principles of biochemistry and human nutrition including macro and micro nutrients requirements and the associated molecular and metabolic mechanism

Theory

Bio-Molecules: General structures, classification and functions of Biomolecules-Amino acids, Protein Structure, Carbohydrates, Fats, Lipids, DNA and RNA.

Enzymes: Activation energy /Transition state and Enzyme Classification, Coenzymes/Co-factors and Enzyme kinetics, Mechanism of enzyme action, Factors effecting enzyme activity, Enzyme inhibition, isozymes and Regulatory Enzymes, Immobilization of enzyme, Ribozymes and Zymogens.

Metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Glycogen synthesis and degradation, Pentose phosphate pathway, Fatty acid oxidation, Urea cycle and transaminase reactions, ATP and Electron transport chain.

Fundamentals of human nutrition, concept of balanced diet, nutrient requirements of different age groups; Methods of evaluation of nutritive value of food and nutritional value of cow, buffalo and human milk, biochemical composition and energy value of foods with special reference to milk and dairy products.

Nutrition, digestion and absorption, Vitamins (structure and function), Hormones (structure and function), Milk intolerance and hypersensitivity, Concept of functional foods and Nutraceutical, Milk based functional foods.

Practical

Estimation of alkaline phosphatase by conversion of a non-chromogenic substrate to a chromogenic substrate; Effect of temperature, pH and enzyme inhibitors on the activity of the enzyme; Estimation of catalase by spectrophotometric method; Determination of the Michaelis Menten constant of an enzyme; Estimation of RNA by colorimetric method; Estimation of DNA by colorimetric method; Estimation of Ascorbic acid in plasma; Estimation of serum Protein (Biuret method /Lowry method); Estimation of Blood Glucose (Folin Wu method); Estimation of Serum inorganic phosphorus (Fiske and Subba Row method);Estimation of blood creatinine, triglyceride and cholesterol levels; Estimation of calorific value of food items; Diet and nutrition surveys: (a) Identification of vulnerable and risk groups; (b) Diet survey for breast-feeding and weaning practices of specific groups; (c) Use of anthropometric measurement in children; Preparation of visual aids for nutritional disorders; Field visit to (a) Observe the working of nutrition and health oriented program (survey based result); (b) Hospitals to observe nutritional deficiencies; Identification of Mono, Di and Polysaccharides; Identification of Proteins (albumin, gelatin, peptone).

Suggested Readings

1. Berg J M, Tymoczko J L, Gatto G J and Stryer L. 2019. *Biochemistry*. (9th Edn.) W. H. Freeman, New York.
2. Lehninger A L, Nelson D L and Cox M M. 2021. *Lehninger Principles of Biochemistry*. (8th Edn.). W. H. Freeman, New York.
3. Voet D and Voet J G. 2016. *Biochemistry*. (5th Edn.) Wiley, Hoboken.
4. Gibney M J, Lanham-New, S A, Cassidy A and Vorster, H H. 2019. *Introduction to Human Nutrition.* (3rd Edn.). Wiley-Blackwell, Chichester.
5. Whitney E and Rolfes S R. 2022. *Understanding Nutrition*. (16th Edn.). Cengage Learning, Boston.
6. Sizer F S and Whitney E N. 2021. *Nutrition: Concepts and Controversies.* (15th Edn.). Cengage Learning, Boston.
7. Gropper S S and Smith J L. 2022. *Advanced Nutrition and Human Metabolism*. (8th Edn.) Cengage Learning, Boston.

ELECTIVE COURSES

(Total 8 credits of electives are to be taken out of the following indicative courses)

Course Title	Credit
Industrial Statistics	2 (1+1)
Fundamentals of Dairy Extension	2 (1+1)
Dairy Biotechnology	2 (1+1)
Instrumental Technique in Food Analysis	2 (1+1)
Food Additives and Preservatives	2 (1+1)
Design and Formulation of Foods	3 (2+1)

Industrial Statistics 2 (1+1)

Objective

To equip students with the knowledge and skills required to collect, analyze, and interpret data relevant to dairy and animal husbandry sector

Theory

Definition and scope; sources of animal husbandry and dairy statistics; Measures of central tendency, Measures of dispersion, Moments, skewness and kurtosis; Elementary notions of probability, Laws of addition and multiplication probability.

Theoretical frequency distributions: Binomial, Poisson and Normal distribution and their application; Concepts of sampling methods, Introduction to testing of hypotheses, Tests of Significance-Z, t, F tests, and their application in the field of dairying.

Analysis of variance- One-Way and two-way classification; Simple correlation coefficient and its test of significance, Linear regression, rank correlation.

Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

Practical

Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis Fitting of binomial and Poisson distribution; Application of 'Z' test for one and two sample problems; Application of 't' test for one and two sample problems; Application of Chi-square test and F-test; Correlation and regression; Rank correlation coefficient; Control chart for variables and attributes.

Suggested Readings

1. Agarwal B L. 1991. *Basic Statistics*. Wiley Eastern Ltd., New Delhi.
2. Amble V N. 1975. *Statistical Methods in Animal Sciences*. Indian Society of Agril. Statistics, New Delhi.

3. Goon A M, Gupta, M K and Gupta B D. 1979. Fundamental of Statistics. (Vol. I and II). The World Press Pvt. Ltd., Kolkata.
4. Goulden C H. 1959. *Methods of Statistical Analysis.* John Wiley and Sons, New York.
5. Gupta S C. 1987. Fundamental of Statistics. Himalaya Publishing House, New Delhi.
6. Gupta S C. and Kapoor V K. 1990. *Fundamentals of Applied Statistics*. Chand & Sons, New Delhi.
7. Gupta S P. 2010. *Statistical Methods.* Chand and Sons, New Delhi.
8. *Handbook on Statistical Quality Control.* 1986. Indian Standards Institute, New Delhi.
9. Moroney M J. 1975. *Facts from Figures*. Penguin Books, England.
10. Snedecor G W. and Cochran W G. 1967. *Statistical Methods*. Oxford and IBH Publishing Co., New Delhi.

Fundamentals of Dairy Extension 2 (1+1)

Objective

To provide students with a basic understanding of extension education principles and practices within the context of dairy and animal husbandry

Theory

History, need, definition, philosophy, principles, approaches and objectives of extension education; Present status of dairy and animal husbandry development programme launched in pre and post-independence era; Teaching and learning process, Extension Teaching Methods, classification and selection of teaching methods; Importance of Audio-Visual-Aids; Identification of rural leaders, their characteristics, role and function in rural development, training of rural leaders; Principle of working with group and their mobilisation; Need, principle and step of programme planning; Evaluation of extension program; Diffusion of innovations and categories of farmers; Problems of different stake holders, Conceptual orientation about different terms, like- RRA, PRA, IVLP/TAR, ATMA, ATIC, PTD, etc.

Practical

Acquiring skill in use of audio-visual and other aids: Hands-on training on use of LCD projector, PA system, camera; Skills in preparation of documents including script writing; Preparation and use of audio-visual aids including animation for dairy stakeholders Group discussion technique, Hands on learning of field problems in dairy and animal husbandry.

Suggested Readings

1. Adams M E. 1982. *Agricultural Extension in Developing Countries*. Longman, Singapore Publ.
2. Blackburn D J and Vist DL. 1984. *Historical Roots and Philosophy of Extension*. *In:* D J. Blackburn (Ed.), Extension Handbook, University of Guelph, Guelph, Ont., Canada.
3. Burton E S, Robert P B. and Andrew J S. 1997. *Improving Agricultural Extension – A Reference Manual*. FAO, Rome.
4. Chouhan J. 2006. *Communication and Extension Management*. Anjali Prakashan, Kanpur.
5. Dahama O P and Bhatnagar O P. 1987. *Education and Communication for Development*. Oxford & IBH.

6. Farrington J, Pal S, Sulaiman R V. 1998. *Improving the Effectiveness of Agricultural Research and Extension in India,* Policy Paper 8, NCAP, New Delhi.
7. Hayward J. 1990. *Agricultural Extension: The World Bank's Experience and Approaches. In:* FAO Report of the Global Consultation on Agricultural Extension (p. 115-134). Rome: FAO.
8. Jha D and Kandaswamy A. (Eds). 1994. *Decentralising Agricultural Research and Technology Transfer in India*. ICAR, New Delhi.
9. Kumar B and Hansra B S. 2000. *Extension Education for Human Resource Development. Concept* Publishing Company, New Delhi.
10. Macklin M. 1992. *Agricultural Extension in India. Technical Paper 190, World Bank*, Washington, DC.
11. Mook BT. 1982. *The world of the Indian Field Administrator*. Vikas Publishing House. New Delhi.
12. Moris J. 1991. *Extension Alternatives in Tropical Africa*. Overseas Development Institute, London.
13. Owen E, Kitalyi A, Jayasuriyia N and Smith T. (Eds.). 2005. *Livestock and Wealth Creation – Improving of the Husbandry of Animals kept by Resource Poor People in Developing Countries*. Nottingham Univ. Press, UK.
14. Ray G L. 1991. *Extension Communication and Management*. Naya Prokash, Calcutta
15. Reddy A A. 1993. Extension Education. Shree Laxmi Press, Bapatla, Andhra Pradesh.
16. Rivera W M. and Gustafson D J. (Eds.) 1991. *Agricultural Extension: Worldwide: Institutional Evolution and Forces for Change*, Elsevier.
17. Samanta R K. 1993. *Extension Strategy for Agricultural Development in 21st Century*. Mittal Publications, New Delhi.
18. Swanson B E. (Ed). 1984. Agricultural Extension: A Reference Manual. (2nd Edn.). FAO, Rome.
19. Van den Ban A W and Hawkins H S. 1998. *Agricultural Extension*. Longman Scientific Tech., UK.

Dairy Biotechnology 2 (1+1)

Objective

To provide students with understanding of biotechnological applications in dairy industry.

Theory

Definition, scope and historical development of biotechnology, achievement and future application. Structure of DNA and RNA; DNA replication, protein synthesis, genetic code, mutations. Vectors, cloning strategies in bacteria and animals, rDNA technology and Protoplast fusion; Application of biotechnology in food and dairy industry, dairy effluents; Genetic manipulation of dairy starters for improved attributes of commercial value; Dairy enzymes and whole cell immobilization; Ethical issues related to use of genetically modified foods; Ethical issues related to use of genetically modified foods.

Practical

Isolation of plasmid and genomic DNA from bacteria (E; coli, lactic acid bacteria); Agarose gel electrophoresis of DNA fragments); Restriction analysis of DNA; Curing of plasmids; Preparation of competent cell; Transformation of *E; coli* by calcium chloride treatment/ electro oration; Conjugal transfer in *E; coli* cells; Preparation of protoplasts and protoplast fusion; PCR technique demonstration; Visit to a biotechnology lab.

Suggested Readings

1. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.). Springer-Verlag, Berlin, Heidelberg.
2. Deshpande S S. 2002. *Handbook of Food Toxicology. Marcel and Dekker AG*, Basel, Switzerland.
3. Mahindru S N. 2008. *Food Additives: Characteristics, Detection and Estimation*. APH Publishing Corporation, New Delhi.

Instrumental Techniques in Food Analysis 2 (1+1)

Objective

To expose students to principles and theory of selected instrumental methods used in food analysis

Theory

Concepts of food analysis; Rules and regulations of food analysis.

Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods. Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry. Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing, chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, rapid microbiological methods: Overview, Conductance/ impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Quality evaluation of raw materials: Fruits products; Quality evaluation of raw materials: vegetables products; Quality evaluation of raw materials: cereals products; Quality evaluation of raw materials: dairy products; Quality evaluation of food products for color and taste of marketed products (sweet); Quality evaluation of food products for color and taste of marketed products (carbonated drinks; Quality evaluation of food products for color and taste of marketed products (Processed food); Quality evaluation of food products for color and taste of marketed products (Chili powder); Estimation

of phytic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Analysis of heavy metals using atomic absorption spectrophotometer (mercury/ lead/arsenic/tin); Identification of organic acids by paper electrophoresis; Estimation of vitamins (A) using HPLC; Estimation of vitamins (thiamine) using HPLC; Estimation of vitamins (riboflavin) using HPLC; Estimation of vitamins (nicotinamide) using HPLC; Estimation of lycopene using HPLC; Estimation of betacarotein using HPLC; Estimation of vitamins A using HPLC; Analysis of foods for drug residues in milk/milk products; Analysis of foods for pesticide residues in fruit; Analysis of foods for pesticide residues in vegetable; Analysis of foods for pesticide residues in spices; Spectrophotometric method of total chlorophyll (A and B); Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE; Fatty acid profiling using gas chromatograph.

Suggested Readings

1. Nielsen S Suzanne. 2003. *Food Analysis. (3rd Edn.*). Kluwer Academic, New York, USA.
2. Nielsen S Suzanne. 2010. *Food Analysis Laboratory Manual.* (2nd Edn.). Springer, NY, USA.
3. Semih Ötles. 2009. *Handbook of Food Analysis Instruments.* CRC Press, Boca Raton, FL, USA.
4. Sun Da-Wen. 2008. *Modern Techniques for Food Authentication.* Elsevier Inc., Burlington, MA, USA.

Food Additives and Preservatives 2 (1+1)

Objectives

i. To introduce the different additives and preservatives used in food industry.
ii. To understand the mode of action of additives and preservatives used in food products. Students will also be familiarized with regulatory requirements of food additives.

Theory

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action; Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic);Identification of food colour by TLC (organic and inorganic);Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in foods; Role of leavening agent in baked food product; Preservation of food samples using humectants.

Suggested Readings

1. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry. (4th Edn.)* Springer-Verlag, Berlin, Heidelberg.
2. Deshpande S S. 2002. *Handbook of Food Toxicology*. Marcel and Dekker A G, Basel, Switzerland.
3. Mahindru S N. 2008. *Food Additives: Characteristics, Detection and Estimation*. APH Publishing Corporation, New Delhi.

Design and Formulation of Foods 3 (2+1)

Objectives

i. Understand about RDA for Indians
ii. Design and formulation of new and innovative target foods
iii. Gain knowledge about various functional foods

Theory

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people; Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition; Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation; Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods; Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Suggested Readings

1. Antia F P. 1974. *Clinical Dietetics and Nutrition*, Oxford Medicine Publications.
2. Davidson S. Passmore R and Eastwood M A. 1986. *Davidson and Passmore Human Nutrition and Dietetics*. Churchill Livingstone.
3. Gopalan C, Ramasastri B V, Balasubramanian S C. 1989. *Nutritive Value of Indian Foods* National Institute of Nutrition, Hyderabad.

4. Pokorny J, Yanishlieva N and Gordon M. 2001. *Antioxidants in Food*, Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter N N and Hotchkiss J H. 1995. *Food Science, (5th Edn.*). Chapman & Hall, NY, USA.
6. Mazza G 1998. *Functional Foods*. Biochemical and Processing Aspects, Technomic Publ. Co.
7. Robinson C. 1975. *Basic Nutrition and Diet Therapy*, Macmillan.
8. Swaminathan M. 1974. *Essentials of Nutrition*, Ganesh Co.
9. Steinkrauss K H. 1995. *Handbook of Indigenous Fermented Foods*, Marcel Dekker..

Semester-VIII

S. No	Course tilte	Total credits
1	Student READY (RAWE/ Experiential Learning / Hands on Training / Industrial Attachment /Project Work / Internship etc.)	20
	Total	**20**

- In eighth semester of the degree program students will be offered Internship (In-plant training) of 20 credits.
- The Training will be carried out at a commercial dairy plant.
- The students will be exposed to processing, production, testing and quality assurance and marketing of dairy products at commercial scale.
- The students would be required to submit a certificate of completion of the training from the concerned authorities of the company.

ONLINE COURSES

The students will have to take a minimum of 08 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Dairy Technology). The online courses can be from any field such as Basic Sciences, Humanities, Commerce, Business Management, Languages including foreign language, Communication skills, Music, etc. and can be taken from SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera, or any other portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The courses will be non-gradial as separate certificates would be issued by the Institute/ University offering the courses. However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student. The courses can be taken during whole span of degree parogramme as per choice of students. The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course). The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

List of Suggestive Online Course

Course Title	Duration	Credit
Digital Media	12 weeks	3
Basics of Photography	12 weeks	3
Design, Technology and Innovation	8 weeks	2
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	2
Consumer Protection Legislation	8 weeks	2
Visual Communication Design for Digital Media	4 weeks	1
Certificate Course in Environmental Sustainability	8 weeks	2
Consumer Protection Legislation	8 weeks	2
Communication and Extension for Sustainable Development	12 weeks	3
Intellectual Property	12 weeks	3
Biopsychology	12 weeks	3
NGO'S and Sustainable Development	12 weeks	3
Counselling Psychology	12 weeks	3
Gender Sensitization: Society Culture and Change	12 weeks	3
Basics of Health Promotion and Education Intervention	8 weeks	2
Psychology of Stress, Health and Well-being	12 weeks	3
Diet Management in Health & Disease	12 weeks	3
Dairy and Food Process and Products Technology	12 weeks	3
Thermal Processing of Foods	12 weeks	3
Nano-technology, Science and Applications	8 weeks	2
Food Science & Processing	12 weeks	3
Diet Management in Health & Disease	8 weeks	2
Human Nutrition and Biochemistry	12 weeks	3
Personality Development and Communication Skills	8 weeks	2
Public Speaking	8 weeks	2
Personality Development	8 weeks	2
Personality Development	8 weeks	2
Yoga Practices 1	12 weeks	3
Yoga Practices 2	12 weeks	3
Ethics: Theories and Applications	12 weeks	3
Information Sources and Library Services	8 weeks	2
Qualitative Research Methods and Research Writing	12 weeks	3
Food Science & Processing	12 weeks	3
Food Safety & Quality Control	8 weeks	2
Communication Skills and Computer Operations	12 weeks	3
Human Resource Management	12 weeks	3
Business Plan and Finance Management	12 weeks	3

SAUs will be free to include more Elective courses with approval from their competent bodies.

* The list of online courses will be uploaded on College/University website. The student will have choice to select courses of his/her choice up to 08 credits.

Minimum Standards for Establishing a College of Dairy Technology

- **Degree Nomenclature:** B. Tech. (Dairy Technology)

1. **Minimum intake (per year):** 60

2. **Faculty:**

A. **Core faculty**: 16

Dairy Technology (0+1+3), Dairy Engineering (0+1+3), Dairy Chemistry (0+1+2), Dairy Microbiology (0+1+2), Dairy Business Management (0+1+1)

B. **Allied faculty**:

Faculty for Mathematics, computer science, Sociology, Psychology, English, Food Science and Technology, Microbiology, Agrometerology and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. **Land requirement (ha):** 5

4. **Essential Instructional units:**

- Dairy Pilot Plant (1000 L Capacity).
- Business Process Development Centre.
- Laboratories and instructional facilitiesas per V Deans' Committee report.
- ELP units to be established under skilldevelopment or Entrepreneurial mode- 0.5 ha.

5. **Divisons/Departments/Sections:**

- Dairy Technology
- Dairy Engineering
- Dairy Chemistry
- Dairy Microbiology
- Dairy Trade and Dairy Business Management
- Pilot Dairy Unit cum Business Process Development Centre.

6. **Faculty Expertise**

Division/Section	Faculty	Associated
Dairy Technology	Dairy Processing Food Technology	Cheese and Fermented Dairy Products Traditional Dairy Products PackagingSensory Science Rheology
Dairy Engineering	Dairy Engineering	Food Process Engineering
Dairy Chemistry	Dairy Chemistry	ThermodynamicsCivil Engineering Mechanical Engineering Analytical Techniques
Dairy Microbiology	Dairy Microbiology	Microbial Techniques
Dairy Business Management	Dairy Economics	Business Management
	Dairy Extension	

7. Non- Teaching Staff:

Sl. No	Division/Section	Steno/PA/ Computer Operator (9300-34800+ GP 4200)	Assistant (5200-20200+ GP 2800)	Attendant/ Messenger (5200-20200+ GP 4200)	Clerk (9300-34800+ GP 4200)	Laboratory Assistant/ Attendant (5200-20200 +GP 2800)
1	Dairy Technology	2	1	2	1	2
2	Dairy Engineering	2	1	2	1	2
3	Dairy Chemistry	2	1	2	1	2
4	Dairy Microbiology	2	1	2	1	2
5	Dairy Business Management	2	1	2	1	2
	Total	**10**	**5**	**10**	**5**	**10**

8. Manpower Requirements of Dean s Office:

Designation	No. of Position
Dean	1
A. Establishment	
PA to Dean	1
Administrative Officer	1
Administrative Comptroller/Assistant Accounts Officer	1
Superintendent	1
Steno/Computer operator	4
Assistant	1
Operator (Audio Visual)	1
Attendants/Messengers	4
Clerk (LDC)	4
Electrician	1
Store Keeper	1
Driver	4
B. Dairy Plant and Business Incubation Centre, Laboratories,	
Manager, Pilot plant/Business Incubation Centre	01
Laboratory Technician for the college	06
Plant Supervisors/ Technical Assistants (Dairy Processing-10, Refrigeration-2, Electrical-2)	14
Plant Operators (Processing-6, Boiler-2 Refrigeration-2)	10
Mechanical Draftsman	01
Jr. Mechanic/wireman	01
Fitter	01
Steno/PA	01

Assistant	01
Computer operator	02
LDC	01
Attendants	02
C. Library	
Assistant Librarian	01
Library Assistants	01
Clerks	01
Shelf Assistants	01
D. Students Welfare	To be provided by the University as Central Facility
E. Hostel Staff for Two Hostels	
Warden	1+1
Hostel Superintendents	2
Clerks	2
Attendants	8
Security, Sanitation and Landscaping	To be outsourced

9. Central/Division/Section Laboratories (as per requirements of the teaching and research work of the college)

Division/Section	Laboratory
Dairy Technology	Product Development Laboratory Product Characterization and RheologyPackaging Laboratory
	Sensory Evaluation Laboratory Central Instruments LaboratoryFood Technology Laboratory
Dairy Engineering	Bioprocess Engineering Laboratory Fluid Mechanics Laboratory
	Heat Transfer Laboratory
	Refrigeration and Air ConditioningFood Engineering Laboratory Thermodynamics Laboratory
	Electrical Laboratory Instrumentation and Control LaboratoryDairy Engineering Workshop
Dairy Chemistry	Dairy Food Analysis Laboratory
Dairy Microbiology	Dairy Food Quality and Safety Laboratory
Dairy Business Management Laboratory	Computer Laboratory Audio-Visual Laboratory Language

10. Floor Space Requirements:

A) Central Facilities

Sl. No.	Details	Number of Rooms	Dimensions (ft)
1.	Dean office	1	20 × 24
2.	PA room	1	20 × 12
3.	Committee room will video conferencing facility	1	20 × 48
4.	Administrative officer room	1	20 × 12
5.	Admin. Staff rooms	3	20 × 36 each
6.	Examination hall	1	20 × 12
7.	Evaluation room	1	20 × 36
8.	Faculty room	1	20 × 12 each
9.	Placement cell	1	20 × 48
10.	Smart Lecture rooms	5	Seating capacity - 50
11.	Auditorium (Optional)	1	Seating capacity-300
12.	Library/Book bank	1	30 × 72
13.	Examination hall (optional)	1	Seating capacity - 300
14.	Multipurpose room	1	20 × 36
15.	Laboratories	4	30 × 48 each
16.	Hostels	2	Boys and Girls
17.	Generator Shed	1	20 × 36
18.	Toxic chemical storage and waste unit	1	20 × 24
19.	Canteen	1	20 × 12 (kitchen)
			& 20 × 36 (Seating)
20.	Toilets	-	2 sets for each floor
21.	Parking Space	As per requirement	Office and Hostels
22.	Vehicles:		
	Officer car	1	
	Staff car/Jeep	3	
	Bus	1	
	Pick-up van	1	

B) Division/ Section

Sl. No.	Details	No. of Rooms	Dimensions (ft)
1.	Office of the Head of Division (05)	05 (One for each division)	20 × 24 each
2.	Administrative staff	05 (One for each division)	20 × 36 each
3.	Faculty room	26	20 × 24 (05 rooms)
			20 × 12 (21 rooms)

Sl. No.	Details	No. of Rooms	Dimensions (ft)
4.	Room for research scholar	04 (one for every Division)	20 × 24 each
5.	Committee room cum library	05 (One for each division)	20 × 36 each
6.	Smart lecture cum seminar room	05 (One for each division)	Seating capacity - 50 Each

C) Laboratories (UG & PG teaching)

Sl. No.	Details	No. of Laboratories	Dimensions (ft)
1.	Dairy Technology	05	20 × 60 (one) 20 × 36 (four)
2.	Dairy Engineering	09	20 × 60 (two) 20 × 36 (seven)
3.	Dairy Chemistry	04	20 × 60 (one) 20 × 36 (three)
4.	Dairy Microbiology	03	20 × 60 (one) 20 × 36 (two)
5.	Dairy Business Management	04	20 × 60 (two) 20 × 36 (two)

D) Dairy Plant and Business Incubation Centre

Details	Dimensions (ft)
Raw Milk receiving Dock, Milk storage tank room, Milk Processing Hall, Cheese Room, Condensing & Drying Plant room, Cheese Drying & Curing room, Milk Cold Store, Ice Cream Hardening Room, Dispatch Dock, Milk Bottling / Pouch Filling Room, Food processing section (Vegetable/cereal/meat processing) Boiler House, Refrigeration & Ice Bank, System room, Store room – Products, Store room, chemicals & accessories, Sales Counter, Office of the Head of the Department, Offices for the Teaching	200 × 72Milk
Staff - Assistant professor, Associate Professor, Offices for the Technical Staff – Boiler Attendant, Refrigeration Attendant, Fitter, Office for the Ministerial Staff & Driver, Wash rooms– Staff & Students (both for Male & Female)	

11. Equipment required:

A) Central Instrument Facility:

Sl. No.	Name	Number
1.	High pressure Liquid Chromatography	01
2.	Atomic absorption spectrophotometer	01
3.	Hunter LAB Colorimeter	01

Sl. No.	Name	Number
4.	Instron Texture Analyzer	01
5.	IR Moisture analyser	01
6.	Water activity meter	01
7.	Flame photometer	01
8.	Rheomat	01
9.	Viscoamylograph	01
10.	Bench-top Microfluidizer	01
11.	Rotary evaporator	01
12.	Differential Scanning Calorimeter	01
13.	Refrigerator	01
14.	Deep freezer	01
15.	Kjeltec	01
16.	Fibretec unit	01
17.	Rancimat	01
18.	Millipore water purifier	01
19.	Low temperature bath	01

B) Pilot Plant cum Business Incubation Centre for Dairy and Food Processing

Sl. No.	Name	Number
1.	Milk reception section	01
2.	Liquid milk processing unit	01
3.	Cream processing , butter and ghee Section	01
4.	Powder reconstitution & milk poly pack section	01
5.	Paneer section	01
6.	Curd/Lassi/Chhach Section	01
7.	Ice cream section	01

C) Dairy Trade and Business Management Division:

Sl. No.	Name	Number
1.	Desktop computer with LAN facility and Internet connection	20
2.	Photocopier	03
3.	Laser Printer	06
4.	Colour Laser Printer	01
5.	Softwares: SPSS/Metlab/Design expert	01 each with multiuse license
6.	Indian patent database	01

D) UG/PG Laboratories

Sl. No.	Name	Number
1.	UV-Vis Spectrophotometer	02
2.	Analytical balances	04
3.	Electronic balances	04
4.	Muffle furnace	02
5.	Automatic titrator	01
6.	Soxhlet instrument	01
7.	Gerber centrifuge	02
8.	pH meter	04
9.	Autoclave	02
10.	Laminar flow/Biosafety cabinet	02
11.	BOD Incubator	02
12.	Simple microscope	01
13.	Simple oil immersion microscope	01
14.	Hot air oven	04
15.	Hot water batch	04
16.	Serological bath	02
17.	Centrifuge	01
18.	Low temperature centrifuge	01
19.	Pipette washer	02
20.	Rotary shaker	01
21.	Gas supply and burners	01
22.	Standard assembly for titrimetric analysis with indicator solutions & buffer tablets; Magnetic stirrer; Cyclomix (vortex mixer)	All items: 02each

E) Packaging Laboratory:

Sl. No.	Name	Number
1.	Weighing balance (Accuracy 0.001 g)	02
2.	Micrometre	04
3.	Mullen Bursting strength tester	01
4.	Mechanical drop tester	01
5.	Compression strength tester	01
6.	Smoothness or porosity tester	01
7.	Cobb tester	01
8.	Elmendorf tear tester	01
9.	Water absorption tester	01
10.	Head space analyser	01
11.	Universal testing machine	01
Barrier testing instruments		
12.	Oxygen	01
13.	Carbon dioxide	01
14.	water vapour transmission tester	01

F) Pilot Plant cum Business Incubation Centre for Dairy and Food Processing

Sl. No.	Name	Number
1.	Milk reception section	01
2.	Liquid milk processing unit	01
3.	Cream processing, butter and ghee Section	01
4.	Powder reconstitution & milk poly pack section	01
5.	Paneer section	01
6.	Curd/Lassi/Chhach Section	01
7.	Ice cream section	01

The total production line to be developed for the Dairy Unit (10,000 LPD) is illustrated in the tablebelow:

Sl. No.	Product to be manufactured	Quantity of Milk
1.	Liquid milk (Different qualities) of milk such as full cream, Standardized milk, Toned milk, doubletoned, milk as per the requirement by PDP	2,500 litres
2.	Paneer/Cheese/Shrikhand/Chhana (Production and Chhaina based sweets packaging)	1000 litres
3.	Curd/Lassi/Chhach/Yoghurt	1000 litres
4.	Ice-cream (1000 litres mix)	1000 litres mix
5.	By-Products: casein, caseinates, whey products, etc. (only for practical purpose)	500 litters
6.	Heat desiccated products (Khoa, Khoa based sweets like (for practical purpose &Gulabjamun, Peda, Phirni, Rabri, Kurchan, Kheer, etc.) also for marketing as per demand)	500 litres
7.	Fat rich products Butter, Ghee, etc	Regular production from cream obtained from market milk industry

G) Major Common Pilot Plant Equipment:

Sl. No.	Item	Numbers	Capacity
1.	Milk Weighing Scale	1	0-100 kg
2.	Bulk Cooling Tank	1	1000 L
3.	Can Washer	1	5 cans/hr
4.	HTST Plate Heat Exchanger	1	500 L/hr
5.	Batch Pasteurizer	1	500 L
6.	Homogenizer	1	500 L/hr
7.	Milk Storage Tank	2	1000 each
8.	Milk Bottling Plant	1	10 bottle/ min

Sl. No.	Item	Numbers	Capacity
9.	Butter Churn	1	1kg
10.	Ghee Boiling Vat	1	100 kg
11	Ice cream Freezer - Batch	1	20 kg/batch
12	Cheese Vat	3	200 L each
13	Cheese Cutting Frame	3	1×3ft size
14	Cheese Press	1	6 block
15	Milk Condensing Unit	1	40 kg water evaporation/hr
16	Spray Drying Unit	1	5-10 kg water evaporation/hr
17	Refrigeration Plant	1	10 ton
18	Portable Weighing Scale	2	5 kg
19	Curd Mill	1	-
20	Cheese Hoop	6	20 kg size
21	Milk Cans	50	40 kg each
22	Autoclave	1	-
23	Ice Water Plant	1	5 ton
24	Cheese Block Cutter	1	-
25	Sieve for Shrikhand	2	-
26	Planetary Mixer	1	10 kg
27	Hand Bottle Filler	1	-
28	Can Scrubber Tank	1	-
29	Pouch Filling Machine	1	100 pouch/hr
30	Cream Separator	1	500 L/hr
31	Butter Trolley	1	50 kg
32	Wet Casein Grinder	1	5 kg
33	Casein Shredder	1	5 kg
34	Casein Dryer	1	5kg /batch
35	Bottle Sterilizer	1	40 bottles/batch
36	Khoa Kettle	1	10 kg/batch
37	Colloidal Mill	1	1 kg/min
38	Crown Capping Machine	1	Manual
39	Sugar Grinder	1	5 kg
40	Tin Seamer	1	Manual
41	UF Cum RO Unit	1	50 kg/hr
42	Crates For Milk Bottles	100	10 kg each
43	Deep Freezer	4	-
44	Gerber Centrifuge	2	24 tubes
45	BOD Incubator	2	-
46	Hot Air Oven	2	-
47	Hot Plate	1	-
48	Magnetic Stirrer	1	-
49	Colony Counter	1	-

Sl. No.	Item	Numbers	Capacity
50	Weight Box	1 set	100 gm
51	Paraffin Bath	1	50kg
52	Vacuum Packaging Machine	1	5kg/batch
53	Milk Analyser	1	-
54	Ice Cream Freezer - Continuous Type	1	50 L/hr
55	Cooling Unit For Cheese Curing Room	1	2 tonnes
56	Candy Making Machine	1	50 candy/batch
57	Candy Moulds	10	24×100 ml
58	Vacuum Tray Dryer	1	-
59	Extruder	1	-
60	Ice Cream Cup Filling Machine	1	100 cups/hr
61	UHT Milk Sterilization Unit with Aseptic Packaging	1	100 L/hr
62	Tray sealing machine	1	-
63	Colloid Mill	1	-
64	Hammer mill	1	-
65	Planetary mixer	1	-
66	Pin mill	1	-
67	Homogenizer	1	-
68	Steam Jacketed Kettle	3	-
69	Refrigeration System For Ice CreamHardening Room	1	2 tonnes
70	Processed Cheese Kettle	1	5kg
71	Steam Boiler	2	500-1000 kg steam/hr
72	Diesel power generator	1	125 KWA
73	Effluent Treatment Plant	1	-

H) Equipment for Fruit and Vegetable Processing

	Name	Number
1.	Fruit pulper	01
2.	Screw juice extractor	01
3.	Bottle filling machine	01
4.	Mechanical peeler	01
5.	Peeling knives	Complete set
6.	Slicing knives	Complete set
7.	Mechanical slicer	01
8.	Basket press	01
9.	Plunger press	01
10.	Autoclave	01
11.	Can sealer	01

I) Equipment for Processing of Cereals, Pulses and Oilseeds:

Sl. No.	Name	Number
1.	Dehuller	01
2.	Screw expeller	01
3.	Paddy sheller	01
4.	Corn degermer	01
5.	Popping unit	01
6.	Flaking roller	01
7.	Mini flour mill	01
8.	Pasta making machine	01
9.	Deep fat fryer	01

J) Equipment for Bakery and Confectionary Products:

Sl. No.	Name	Number
1.	Moulding unit	01
2.	Baking oven	01
3.	Sugar grinder	01
4.	Biscuit baking unit	01
5.	Proofing unit	01
6.	Slicing unit	01
7.	Chocolate moulder	01

K) Equipment for Meat and Fish processing (Optional):

Sl. No.	Name	Number
1.	Bowl chopper	01
2.	Meat mincer	01
3.	Sausage filler	01
4.	Ice flaking machine	01
5.	Chopping table	01
6.	Combo microwave	01
7.	Tumblers	01
8.	Molds for hams	01
9.	Heating kettle	01

L) Equipment for Dairy Engineering Division:

Sl. No.	Name	Number
1.	Orifice and Mouthpiece apparatus	02
2.	Pipe friction apparatus	01
3.	Minor head loss apparatus	01
4.	Flow through channel apparatus	01
5.	Computerized centrifugal pump test rig	01

Sl. No.	Name	Number
6.	Rotameter	02
7.	Water flow meters	02
8.	Reynolds apparatus	01
9.	Bernoulli's apparatus	01
10.	Various types of pipe fittings and valves	02 set
11.	Self priming pump	02
12.	Monoblock pump set	02
13.	Submersible pump	01
14.	Powder conductivity meter	01
15.	Computerized counter and parallel flow apparatus	01
16.	Plate Heat Exchanger	01
17.	Steam Jacketed kettle	01
18.	Stefan Boltzmann Apparatus	01
19.	Jacketed vats	02
20.	Heat Transfer through composite wall	01
21.	Heat Transfer through Natural Convention	01
22.	Critical Heat Flux Apparatus	01
23.	Heat Transfer through lagged pipe	01
24.	Digital temperature indicators with probes	05 set
25.	Multi-channel temperature indicator	02
26.	Solar water heating system	01
27.	Computerized refrigeration tutor	01
28.	Computerized air conditioning tutor	01
29.	Water cooler	01
30.	Window AC	02
31.	Split AC	02
32.	Refrigerator	01
33.	Models of sealed and open type compressor	01 set
34.	Refrigeration plant controls such as thermostat, pressure switches, solenoid valves, expansion valves	01 set
35.	Dessert cooler	02
36.	Dehumidifier	01
37.	Food Processor	01
38.	Texture Analyzer	01
39.	Laboratory scale freeze dryer	01
40.	Try dryer	01
41.	Texturometer	01
42.	Juice extractors	01
43.	Extruders	01
44.	Sulfuring chamber	01
45.	Blanching equipment	01

Sl. No.	Name	Number
46.	Clinching equipments	01
47.	Jacketed kettle	01
48.	Bomb calorimeter	01
49.	Flue gas analyzer	01
50.	Bucket calorimeter	01
51.	Baby boiler	01
52.	Models of boiler mountings and accessories.	01 set
53.	IC Engine test rig	01
54.	Steam flow meter	02
55.	Water flow meter	02
56.	Models of two stroke and four stroke engine	01 each
57.	Different types of steam traps	02 set
58.	Pipes and pipe fittings	As per the requirements
59.	Oil and gas burners	01 each
60.	Water softening plant	01
61.	Boiler feed water pump	01
62.	Digital clip-on-meters	02
63.	Digital Energy analyzer	01
64.	Power measuring instruments such as volt meter, ampere meter, energy meter, meger	05 set
65.	Inverter	01
66.	Induction Motors with starters	02
67.	Variable Frequency Drive	02
68.	Single phase Transformer, 2 kVA	02
69.	Digital three phase Energy meter	02
70.	Different types of starters such as direct on line starter, Star delta starter, Auto- transformer starter ect.	02 set
71.	Experimental set up for experiment in parallel & series connection, setstair case wiring, tube light wiring, motor connection, speed measurement, demonstration of winding etc with necessary power, voltage, and current measuring devices.	02
72.	Hand tachometer	02
73.	Non contact type tachometer	02
74.	Soft starter	02
75.	Air anemometer	01
76.	Magnetic flow meter	02
77.	Digital pocket type thermometers with different types of probes	05

Sl. No.	Name	Number
78.	Multi channel data logger	01
79.	Various tutors/transducers such as Strain gauge, pressure, LVDT, Inductive, Photo cell, piezometer, etc.	01 set
80.	Water Level controller	01
81.	Pneumatic controller	01
82.	PID controller temperature controller system	01
83.	Digital Tachometer	01
84.	Lux meter	01
85.	Solar lighting system	02
86.	Lathe Machine	01
87.	CNC lathe	01
88.	Grinding machine	01
89.	Power saw	01
90.	Drilling machine	01
91.	Pipe bending machine	01
92.	Electric welding machine	01
93.	Portable welding machine	01
94.	Gas welding set	01
95.	Shear cutting machine	01
96.	Threading machine	01
97.	Universal wood working machine	01
98.	Bench vice	20
99.	Portable grinding machine	02
100.	Shaping machine	01

M) Dairy Trade and Business Management Division:

Name	Number
Desk top computers with LAN facility and Internet connection	20
Photocopier	03
Laser Printer	06
Colour Laser Printer	01
Softwares: SPSS/Metlab/Design expert	01 each with multiuse license
Indian patent database	01

FISHERIES SCIENCE

Course Curricula for Undergraduate Program in Fisheries Science: UG-Certificate (Fisheries Science); UG- Diploma (Fisheries Science); B. F. Sc. (Hons.)

INTRODUCTION

The fisheries sector is a critical and fastest-growing allied agricultural sector in India, contributing to the national income, exports, food and nutritional security, and employment generation. In FY 2022-23, the total fish production in India was estimated at **17.54 million metric tons**, with **13.11 million metric tons** from the inland sector and **4.43 million metric tons** from the marine sector. The annual average growth rate in the fisheries sector has been **7%** over the last five years. The fisheries sector is an important source of food, nutrition, income, and livelihood for millions of people. It has shown an impressive growth rate of **9.03%** (Constant Price: 2011-12) during the years 2015-16 to 2020-21. The fisheries sector's share in the total Gross Value Added (GVA), at Constant prices, in 2022-2023 is estimated at **₹137,716 crore** that constitutes about **1.09%** of the total national GVA and **6.72%** of agricultural GVA. India is the third-largest fish-producing country and the fourth-largest exporter of fish and fisheries products in the world, contributing **7.96%** of the global production and taking Brand India from Local to Global. The fisheries sector is also a principal source of livelihood for a large section of the economically underprivileged population of the country, with about **28 million people** (16 million male and 12 million female) directly and indirectly involved in the fisheries sector for their livelihood.

The development of the sector depends on strong, skilled, and educated human resources. The education on the subject again depends on the modern, more competitive, marketability, and employability course curricula, which is the backbone of the sector. Fisheries colleges are rapidly coming up all over the country, almost in all the states. Hence, a common academic course curriculum and regulations are paramount to achieving necessary quality and need-based agricultural education. In this background, a restructured undergraduate course curriculum has been developed in the light of the National Education Policy (NEP-2020).

The restructured course curriculum in India aims to strengthen critical thinking, creativity, communication, and collaboration among students. The course begins with a three-week immersion-cum-foundation program that instils life and social skills, social awareness, ethics and values, team work, leadership, creativity, and more. The restructured course curriculum in India emphasizes skill enhancement courses, rural fisheries work experience, research works, in-plant training, industry attachments, flexibility in the choice of courses via electives, and online courses of MOOCs/ SWAYAM, etc. The curriculum also provides for advanced skill enhancement through project work or experiential learning/incubation. Through such activities, the curriculum emphasizes conceptual learning over rote learning and inculcates integrity and critical thinking. As per NEP–2020, the curriculum also includes multiple exit and entry options.

The semester-wise course structure for undergraduate courses in Fisheries viz. UG-Certificate, UG-Diploma and B. F. Sc. (Hons.) have been prepared after multi-stage in-depth deliberations and discussions through virtual meetings and personal communications with committee members, Deans' and faculty members of the Fisheries Colleges of different SAUs and CAUs, stakeholders from related industries, Govt. Institutions, and alumni. The curriculum is expected to strengthen the knowledge and skill base of students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The undergraduate program of B. F. Sc. (Hons.) is of **182 credit hours** comprising **172 credit hours** of coursework and **10 credit hours** of online courses (MOOCs/SWAYAM etc.). The minimum eligibility requirement for admission in the undergraduate program in Fisheries Science will be the same as the existing system followed by SAUs (State Agricultural University)/ CAUs (Central Agricultural University).
- After the admission of students in the university, the students will register for the *Deeksharambh* of two weeks' duration in the 1st semester. The course will include, discussions on the operational framework of the academic process in the university, interactions with alumni, business leaders, scientists and perspective employers, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated to knowledge and skill enhancement, including applied aspects of Fisheries. After satisfactory completion of two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of internship/ industry/ institute/ farm attachment, the student will become eligible for the award of UG-Certificate in Fisheries Science on exit. Students continuing their studies further would not have to attend the internship after the 1st year.
- The second year has been designed with practical exposure on Fisheries as well as skill enhancement courses and some part of fundamental courses related to fisheries with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of fisheries. After satisfactory completion of four semesters and subsequent satisfactory completion of 10 credits (10 weeks) of internship/ industry/ institute/ farm attachment, the student will become eligible for the award of UG-Diploma in Fisheries Science on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- The undergraduate program in India offers a Skill Enhancement program during the first and second years. Students have the flexibility to choose skill enhancement areas from a basket of Skill Enhancement Courses offered by the parent institute. After a one-week common orientation on different skill enhancement courses, students can take up one or more courses (maximum 4 credits in each semester) as per local needs and gain complete hands-on experience on these subjects. In addition to the proposed courses in this report, the SAUs/CAUs can formulate other courses relevant to their respective regions or modify the proposed courses as applicable. An institution is at liberty to work in partnership with capable organizations/ companies/ NGOs/progressive entrepreneurs for running various skill enhancement programs. In such cases, the parent institution will control the admission process, develop the content and delivery of the program, and monitor the learning and skill enhancement by students. The evaluation can be done jointly by the collaborating partners.

- The third and fourth years of the course are designed to impart in-depth details, including specialized knowledge to students in the major disciplines. During the 5th semester, the students will have a study tour of 10-14 days' duration, which will be counted as 2 credits (non-gradial).
- In the final year (7th Semester), students will have adequate choice of electives/specialized courses (with minimum 20 credits). The SAUs/CAUs will have the flexibility to include more courses as electives depending on specific needs. The objective is to enable the student to acquire a deeper understanding of any field. The SAUs/CAUs may modify the contents of individual courses to the extent of 30 percent whenever necessary as per the regional demands and needs.
- In the 8th Semester, students opting for the 4-year B. F. Sc. (Hons.) degree will undergo 20 credits of Student READY (Rural Entrepreneurship Awareness Development Yojana) program. This program includes the Rural Fisheries Work Experience (RFWE), Experiential Learning (EL), In Plant Training/Industrial Attachment, and Student Project to provide practical experience in real-life situations, create awareness about practical agriculture and allied sciences, and develop entrepreneurial skills among the graduates. The program also helps in building confidence, skills, and acquiring Indigenous Technical Knowledge (ITK) of the locality, thereby preparing the pass-out for self-employment.
- In addition to the prescribed courses, students will have the freedom to opt for 10 credits of non-credit courses from MOOCs/SWAYAM or any other online portal to groom their passion and add to their knowledge components based on their choice. These non-credit courses can be from any field such as Agriculture, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including Foreign Languages, Communication Skills/Music, etc. The objective is to allow students to groom their passion or strengthen their knowledge and competency in any field beyond the prescribed courses. Students will have the flexibility to complete these courses of 10 credits throughout the span of the degree program. These online courses will be non-gradial, and separate certificates will be issued by institutes offering the courses. However, the SAUs/CAUs will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in the final transcript issued to the student.

Entry and Exit Options

The entry and exit options for the UG program in Fisheries science are shown in Figure 1 below:

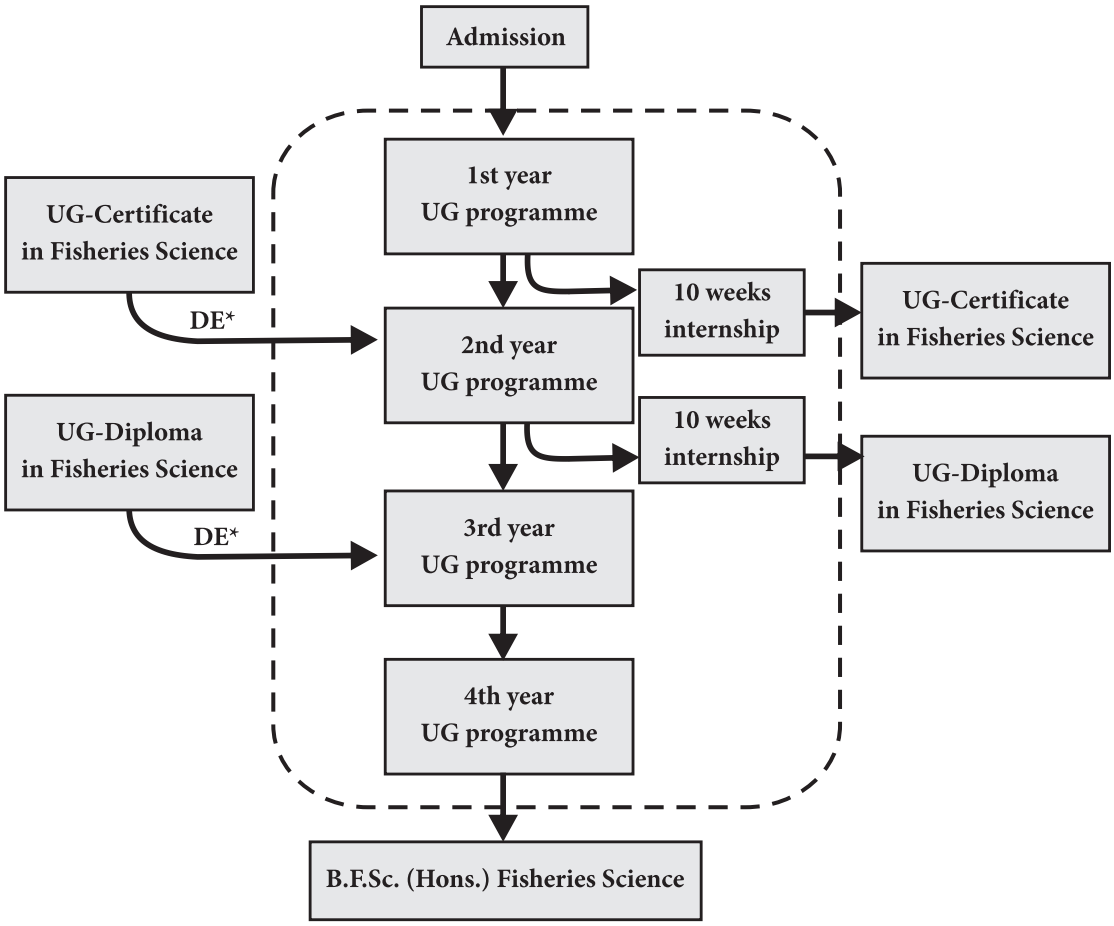


Fig. 1. Entry and Exit options for the UG program in Fisheries Science
DE* Direct Entry In the Respective year

Exit options

- **UG-Certificate in Fisheries Science** (Exit after the first year and completion of 10 weeks' Internship)
- **UG-Diploma in Fisheries Science** (Exit after second year and completion of 10 weeks' Internship)
- **B. F. Sc. (Hons.)** (On successful completion of four-year degree requirements)

Admission Eligibility for Entry into 1st year UG Programme: 10+2 or intermediate with Physics, Chemistry, Mathematics, Biology from a recognized Board/University or as per the criteria decided by the ICAR/SAU/HAEI.

ACADEMIC PROGRAM

Semester-Wise Course Distribution

Sl. No.	Course Title	Credit Hours	Total Credit hours
	First Year		
	I semester		
1.	Deeksharambh (Induction-cum-Foundation course of 2 weeks)	2 (0+2) Non-gradial	**23 (10+13)**
2.	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)	
3.	Soil and Water Chemistry	3 (2+1)	
4.	Freshwater Aquaculture	3 (2+1)	
5.	Fundamental Microbiology	2 (1+1)	
6.	Meteorology and Geography	2 (1+1)	
7.	Farming Based Livelihood Systems	3 (2+1)	
8.	Communication Skills	2 (1+1)	
9.	NCC-I/NSS-I	1 (0+1)	
10.	Skill Enhancement Courses* (SEC-I)	2 (0+2)	
11.	Skill Enhancement Courses* (SEC-II)	2 (0+2)	
	II semester		
1.	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)	**24 (12+12)**
2.	Anatomy and Biology of Finfish and Shellfish	3 (2+1)	
3.	Physiology of Finfish and Shellfish	3 (2+1)	
4.	Limnology	2 (1+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	Personality Development	2 (1+1)	
8.	NCC-II/NSS-II	1 (0+1)	
9.	Skill Enhancement Courses* (SEC-III)	2 (0+2)	
10.	Skill Enhancement Courses* (SEC-IV)	2 (0+2)	
	Post Semester-II (only for exit option for award of UG- Certificate)		
1.	Internship (for 10 weeks)	10** (0+10)	**10** (0+10)**
	III Semester		
1.	Coastal Aquaculture and Mariculture	3 (2+1)	**21 (10+11)**
2.	Fish Nutrition and Feed Technology	3 (2+1)	
3.	Inland Fisheries	2 (1+1)	
4.	Fishing Craft Technology	2 (1+1)	
5.	Fundamentals of Biochemistry and Food Chemistry	2 (1+1)	
6.	Post-Harvest Handling and Preservation	3 (2+1)	
7.	Fisheries Extension	2 (1+1)	
8.	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)	
9.	Skill Enhancement Courses* (SEC-V)	2 (0+2)	

Sl. No.	Course Title	Credit Hours	Total Credit hours
IV Semester			
1.	Breeding and Culture of Ornamental Fish	2 (1+1)	**23 (13+10)**
2.	Live Food Organisms for Fish and Shellfish	2 (1+1)	
3.	Fish and Shellfish Diseases and Treatment	3 (2+1)	
4.	Marine Fisheries	2 (1+1)	
5.	Fishing and Gear Technology	3 (2+1)	
6.	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)	
7.	Agriculture Marketing and Trade	3 (2+1)	
8.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9.	Skill Enhancement Courses* (SEC-VI)	2 (0+2)	
Post Semester IV (Only for exit option for award of UG -Diploma)			
1.	Internship (for 10 weeks)	10*** (0+10)	**10*** (0+10)**
V Semester			
1.	Fish Genetics and Breeding-	2 (1+1)	**21 (12+9)**
2.	Marine Biology	2 (1+1)	
3.	Fish Population Dynamics and Stock Assessment	2 (1+1)	
4.	Aquatic Ecology and Biodiversity	2 (1+1)	
5.	Pharmacology and Technology	3 (2+1)	
6.	Fish Freezingg Toxicology	2 (1+1)	
7.	Fish Canning Technology and Packaging	2 (1+1)	
8.	Aquaculture Engineering	3 (2+1)	
9.	Fisheries Economics	3 (2+1)	
10.	Education Tour (2 Weeks)	NG	
VI Semester			
1.	Fish Biotechnology and Bioinformatics	2 (1+1)	**20 (11+9)**
2.	Fish Immunology	2 (1+1)	
3.	Therapeutics in Aquaculture	2 (1+1)	
4.	Coastal Zone Management	2 (1+1)	
5.	Microbiology of Fish and Fisheries Products	2 (1+1)	
6.	Refrigeration and Equipment Engineering	2 (1+1)	
7.	Navigation and Seamanship	2 (1+1)	
8.	Statistical Methods	3 (2+1)	
9.	Fisheries Policy and Laws	1 (1+0)	
10.	Fisheries Co-operative and Marketing	2 (1+1)	
VII Semester			
1.	Elective Courses (Major)#	12	**20**
2.	Elective Courses (Minor)##	8	

Sl. No.	Course Title	Credit Hours	Total Credit hours
	VIII Semester		
Student opting for 4-year B. F. Sc. (Hons.) a Student READY (Students Entrepreneurship Awareness Development Yojana) Program on In-plant/Industry Attachment / Rural Fisheries Work Experience (RFWE) Program/ Experiential Learning Program (ELP) / Project Work/Seminar will be undertaken as follows.			
1.	In-plant/ Industry Attachment (for 8 weeks)	5 (0+5)	**20 (0+20)**
2.	Rural Fisheries Work Experience (RFWE) Program (for 8 weeks)	6 (0+6)	
3.	Experiential Learning Program (ELP)	6 (0+6)	
4.	Project Work	2 (0+2)	
5.	Seminar	1 (0+1)	

* From the basket of courses of Skill Enhancement Courses
** Mandatory requirement for UG-Certificate.
*** Mandatory requirement for UG-Diploma.
Students have option to choose any Four Major Courses (12 credits) from the list of courses
Students have option to choose any Four Minor Courses (08 credits) from the list of courses

Department/ section wise course breakup

1. Department of Aquaculture

Sl. No.	Course Title	Credit Hours
1.	Freshwater Aquaculture	3 (2+1)
2.	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)
3.	Coastal Aquaculture and Mariculture	2 (1+1)
4.	Breeding and Culture of Ornamental Fish	2 (1+1)
5.	Fish Nutrition and Feed Technology	3 (2+1)
6.	Fish Genetics and Breeding	2 (1+1)
7.	Biotechnology and Bioinformatics	2 (1+1)
8.	Live Food Organisms for Fish and Shellfish	2 (1+1)
9.	Open-water Aquaculture	3 (2+1)
10.	Smart Aquaculture Production Systems	3 (2+1)
11.	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)

2. Department of Fisheries Resource Management

Sl. No.	Course Title	Credit Hours
1.	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)
2.	Anatomy and Biology of Fish and Shellfish	3 (2+1)
3.	Physiology of Fish and Shellfish	3 (2+1)
4.	Inland Fisheries	2 (1+1)
5.	Marine Fisheries	2 (1+1)
6.	Fish Population Dynamics and Stock Assessment	2 (1+1)
7.	Sustainable Fisheries Management and Conservation	3 (2+1)

3. Department of Aquatic Environmental Management

Sl. No.	Course Title	Credit Hours
1.	Soil and Water Chemistry	3 (2+1)
2.	Meteorology and Geography	2 (1+1)
3.	Limnology	2 (1+1)
4.	Aquatic Ecology and Biodiversity	2 (1+1)
5.	Coastal Zone Management	2 (1+1)
6.	Marine Biology	2 (1+1)
7.	Aquatic Pollution	3 (2+1)
8.	Fishery Oceanography	3 (2+1)
9.	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)
10.	Climate Change and its Impact on Fisheries	2 (0+2)
11.	Aquatic Microbiology	2 (1+1)

4. Department of Aquatic Animal Health Management

Sl. No.	Course Title	Credit Hours
1.	Fundamental Microbiology	2 (1+1)
2.	Fish and Shellfish Diseases and Treatment	3 (2+1)
3.	Pharmacology and Toxicology	3 (2+1)
4.	Fish Immunology	2 (1+1)
5.	Therapeutics in Aquaculture	2 (1+1)
6.	Fish and Shellfish Pathology	3 (2+1)
7.	Disease Diagnostics Techniques	3 (2+1)

5. Department of Fish Processing Technology

Sl. No.	Course Title	Credit Hours
1.	Fundamentals of Biochemistry and Food Chemistry	3 (2+1)
2.	Post-Harvest Handling and Preservation	2 (1+1)
3.	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)
4.	Fish Freezing Technology	2 (1+1)
5.	Microbiology of Fish and Fisheries Products	2 (1+1)
6.	Fish Canning Technology and Packaging	2 (1+1)
7.	Quality Assurance of Fish and Fishery Products	3 (2+1)
8.	Principles and Techniques of Seafood Analysis	2 (1+1)
9.	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)

6. Department of Fisheries Technology and Engineering

Sl. No.	Course Title	Credit Hours
1.	Fishing Craft Technology	2 (1+1)
2.	Fishing and Gear Technology	3 (2+1)
3.	Aquaculture Engineering	3 (2+1)
4.	Refrigeration and Equipment Engineering	2 (1+1)
5.	Navigation and Seamanship	2 (1+1)
6.	GIS and Remote Sensing in Fisheries	2 (1+1)
7.	Responsible and Sustainable Fishing Methods	2 (1+1)

7. Department of Fisheries Extension, Economics and Statistics

Sl. No.	Course Title	Credit Hours
1.	Fisheries Extension	2 (1+1)
2.	Fisheries Economics	3 (2+1)
3.	Statistical Methods	3 (2+1)
4.	Fisheries Policy and Laws	1 (1+0)
5.	Fisheries Co-operative and Marketing	2 (1+1)
6.	Marketing Intelligence and Business Analysis	2 (1+1)
7.	ICT in Fisheries	2 (1+1)

Basic Supporting Courses

Sl. No.	Course Category	Course Title	Credit Hours
1.	FC	*Deeksharambha* Induction-cum-Foundation course) 2 weeks duration	2 (0+2) Non-Gradial
2.	MDC	Farming-Based Livelihood Systems	3 (2+1)
3.	MDC	Entrepreneurship Development and Business Management	3 (2+1)
4.	MDC	Agriculture Marketing and Trade	3 (2+1)
5.	VAC	Environmental Studies and Disaster Management	3 (2+1)
6.	VAC	Agricultural Informatics and Artificail Intellegnece	3 (2+1)
7.	AEC	Communication Skills	2 (1+1)
8.	AEC	Personality Development	2 (1+1)
9.	AEC	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)
10.	AEC	NSS/ NCC	2 (0+2)
11.		Educational Tour (2 Weeks Duration)	Non-Gradial

Table 1: Credits Allocation Scheme of UG Fisheries Science Programs (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	13	3[2]	-	1[3] + 2[4]	4	-	23	2[1]		
II	11	3[5]	3[6]	1[3] + 2[7]	4	-	24	-	10[12]	
III	17	-	-	2[8]	2	-	21	-		
IV	15	3[9]	3 [10]	-	2	-	23	-	10[13]	**10**
V	21	-	-	-	-	-	21	2[11]		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**117**	9	**6**	**8**	**12**	**20**	**172**	**4**	**20**	**10**

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems
(3) NCC/NSS

(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Meditation
(9) Agriculture Marketing and Trade
(10) Agricultural Informatics and Artificial Intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

Summary of Credit Distributions

Type of courses	Credits
Core courses (Major and Minor/s)	117
Common courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Student READY (RAWE/Industrial Attachment /Experiential Learning/Hands-on Training/ Skill Development/Project Work/Internship etc.)	20
**MOOCS/SWAYAM	10 non-gradial
Total	**172+10****

Detailed Syllabi

Semester-I

Deeksharambh (Induction-cum-Foundation Program)-Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Taxonomy of Commercially Important Fish and Shellfish 3 (1+2)

Objectives

i. To identify the commercially-important fish and shell-fish species inhabited in the aquatic environment

ii. To acquire knowledge on the fish and shell-fish species in the aquatic environment

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyo-taxonomy, DNA barcoding, protein analysis and DNA polymorphism.

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

Practical

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition.

Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, and cephalopods from natural habitats. Field visits for collection and study of commercially important shellfish.

Suggested Readings

1. Bal D V and Rao K V. 1990. *Marine Fishes of India*. (1st Revised Edn.). Tata McGraw Hill.
2. Day F S. 1878. *The Fishes of India*. William and Sons Ltd.
3. Fischer W. 1984. FAO Species Identification Sheets for Fishery Purposes. *Western Indian Ocean (Fishing Area 51)*, pp I-IV.
4. Hamilton F. 1822. *An Account of the Fishes found in the River Ganges and its Branches.* Vol. I. Archibald Constable.
5. Jayaram K C. 2010. *The Freshwater Fishes of the Indian Region*, (2nd Edn.) Narendra Publishing house New Delhi
6. Kocher T D and Stepien C A (Eds). 1997. *Molecular Systematics of Fishes*. Elsevier.
7. Kurian C V and Sebastian V O. 1986. *Prawns and Prawn Fisheries of India*. Hindustan Publishing. Corporation.

8. Jayaram K C. 2002. *Fundamentals of Fish Taxonomy*. Narendra publishing house.
9. Nelson J S. 2006. *Fishes of the World*, John Wiley and Sons.
10. Ponniah A G and George John. 1998. *Fish Chromosome Atlas*. National Bureau of Fish Genetic Resources (NBFGR), Lucknow publication.
11. Talwar P K and Jhingran A G. 1991. *Inland Fishes of India and Adjacent Countries* (Vol. II). CRC press.
12. Talwar P K and Kacker R K. 1984. *Commercial Sea Fishes of India*. 997p. ZSI, Kolkata.
13. Walker P and Subasinghe R P (Eds). 2000. *DNA-Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases* (No. 395). Food & Agriculture Organisation.

Soil and Water Chemistry 3 (2+1)

Objectives

i. To analyse the water and soil quality parameters in relation to aquaculture for assessing the health of the water bodies
ii. To study the impact of water and soil quality parameters on fish and shellfish production

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve, nomograph. Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Dissolved gasses: Factors affecting natural waters. Acid, base, salts, Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Soil Chemistry: Origin and nature of soils. Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation.

Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

Practical

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis. Water analysis: measurement of temperature, turbidity, determination of pH and EC. Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO_2. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus.

Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

Suggested Readings

1. Benjamin M M. 2014. *Water Chemistry*. Waveland Press.
2. Boyd C E, Wood C W and Thunjai T. 2002. *Aquaculture Pond Bottom Soil Quality Management*. Oregon State University, Corvallis, Oregon.
3. Cheremisinoff P N. 2019. *Handbook of Water and Wastewater Treatment Technology*. Routledge.
4. Conklin A R. 2013. *Introduction to Soil Chemistry: Analysis and Instrumentation*. John Wiley & Sons.
5. Essington M E. 2015. *Soil and Water Chemistry: An Integrative Approach*. CRC press.
6. Ham B M and MaHam A. 2015. *Analytical Chemistry: Chemist and Laboratory Technician's Toolkit*. John Wiley & Sons.
7. Hesse P R and Hesse P R. 1971. *A Textbook of Soil Chemical Analysis*. Cambridge University Press
8. Jeffery G H. 2022. *Vogel's Textbook of Quantitative Chemical Analysis. (*5th Edn.). A John Wiley & Sons, INC.
9. Rice E, Baird R and Eaton A. 2017. *Standard Methods for the Examination of Water and Wastewater, (*23rd Edn.) Washington DC: American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF) [online]
10. Sparks D L (Ed). 1998. *Soil Physical Chemistry*. CRC press.
11. Strawn D G, Bohn H L and O'Connor G A. 2019. *Soil Chemistry*. John Wiley & Sons.

Freshwater Aquaculture 3 (2+1)

Objectives

i. To gain knowledge and understand the recent advances in freshwater aquaculture under different culture systems

ii. To impart the knowledge of the different types of aquaculture methods and commercially importable freshwater fish and shell-fish species

Theory

Major species cultured, production trends and prospects in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs, etc. Nursery, rearing and grow out ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed

fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods - Indian major carps, exotic carps, air-breathing fishes, cold water fishes, freshwater prawns, freshwater mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfishes and murrels. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/ horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

Practical

Preparation and management of nursery, rearing and grow-out ponds. Study on the effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of the economics of different culture practices. Estimation of livestock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

Suggested Readings

1. Agarwal S C. 2008. *A Handbook of Fish Farming*. (2nd Edn.) Narendra Publ. House.
2. Ayyappan S, Jena J K, Gopalakrishnan A and Pandey A K. 2006. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi
3. Bandyopadhyay B K. 2022. *Freshwater Aquaculture: A Functional Approach*. CRC Press.
4. Bardach J E, Ryther J H and McLarney W O. 1974. *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.
5. De Silva S S. 2001. *Reservoir and Culture-Based Fisheries: Biology and Management*. FAO of the Uinited Nation
6. Midlen and Redding TA. 1998. Environmental Management for Aquaculture. Kluwer.
7. New M B. 2000. *Freshwater Prawn Farming*. CRC Publ.
8. Pillay T V R and Kutty M N. 2005. *Aquaculture-Principles and Practices*. Blackwell.
9. Pillay T V R. 1990. *Aquaculture: Principles and Practices*. Fishing News Books, Cambridge University Press, Cambridge.
10. Rath R K. 2000. *Freshwater Aquaculture*. Scientific Publication.
11. Venugopal S. 2005. *Aquaculture*. Pointer Publication.
12. Welcomme R L. 2001. *Inland Fisheries: Ecology and Management*. Fishing News Book
13. ICAR. 2006. Handbook of Fisheries and Aquaculture.
14. Jhingran V G. 1991. *Fish and Fisheries of India*, (3rd Edn.). Hindustan Publication.
15. Stickney R R and Gatlin III D M. 2022. *Aquaculture: An Introductory Text*. CABI Publication.

Fundamental Microbiology 2 (1+1)

Objectives

i. To create a basic understanding on microbiology and its importance in the aquatic environment

ii. To develop skills in the identification of microbes, culture of microbes, and diagnosis of microbial pathogens in aquatic organisms

Theory

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM. Microbial taxonomy–Bergy's and molecular taxonomy. Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods. Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation –types and significance. Microbial ecology: Introduction and types of interaction, extremophiles and their significance.

Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses. Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self-purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

Practical

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry. Determination of size of microorganisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, dry heat, moist heat, chemical agents. Cultivation technique: Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems. Study of bacteria involved in nutrient cycles. Biofilms, water testing for

potability, enumeration of coliform. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.

Suggested Readings

1. Aneja K R. 2008. *Textbook of Basic and Applied Microbiology*, New Age International (P) Limited, Publishers (New Delhi).
2. Baveja C P. 2022. *Text Book Microbiology*. Arya Publishing Comp.
3. Chakraborthy P. 1995. *A Text Book of Microbiology*. New Central Book Agency.
4. Criusted J. 1986. *Methods in Microbiology*. Academic Press.
5. Harry WSJR, Paul J V and John J L 2000. Microbes in Action. Freeman and Co.
6. Jay J M, Loessner M J and Golden D A. 2008. *Modern Food Microbiology*. Springer Science & Business Media.
7. Khuntia B K. 2021. Basic Microbiology- A Illustrated Laboratory Manual. Daya Publ.
8. Maheshwaii D K. 1999. *A Text Book of Microbiology*. S. Chand Publishing.
9. Michael J, Pelizar J R and Chan E C S. 1998. *Microbiology*. McGraw Hill.

Meteorology and Geography 2 (1+1)

Objective

To teach the meteorological phenomena and geographical distribution

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: the relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements.

Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms.

Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.

Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion.

Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.

Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector.

Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Practical

Graphic representation of the structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Isotherms: world mean Temperatures-January to July. India means temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: Fortin's mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

Suggested Readings

1. Ackerman S A and Knox J. 2011. *Meteorology*. Jones & Bartlett Publishers.
2. Ahrens C D. 2011. *Essentials of Meteorology: An Invitation to the Atmosphere*, International Edition, Brooks/Cole Publ.
3. Barry Roger G. 2009. Atmosphere, Weather and Climate, Taylor and Francis Ltd.
4. Gersmehl P. 2014. *Teaching Geography*. Guilford Publications.
5. Maury M. 2023. *The Physical Geography of the Sea*. BoD–Books on Demand.
6. McAdie A. 1921. *A Textbook of Meteorological Physics*. Tyilor & Francis
7. Mölders N and Kramm G. 2014. *Lectures in Meteorology*, Cham: Springer.
8. Naik M G. 2013. *Meteorology and Geography*, Narendra Publishing House.
9. Roger G. 1982. *Atmosphere, weather, and climate*. Routledge.
10. Spiridonov V. 2021. *Fundamentals of Meteorology*, Springer.
11. The Indian Meteorological Department (IMD), Weather Instruments, Maps and Charts, In Practical Geography. 2022-23.

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming-based livelihood systems in agriculture
ii. To disseminate the knowledge and skill, and how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting the integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculturally based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop-based, livestock-based, processing-based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about the concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. *Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development,* Center for Science and Environment, New Delhi, India
2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience,* Vol. 7. Department for International Development: London, UK.
3. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa,* Consultation Document, FAO, Rome, Italy
4. Dixon J, Gulliver A, Gibbon D and Hall M. 2010. *Farming systems and Poverty: Improving Farmers' Livelihoods in a Changing World.* FAO, Rome, World Bank, Washington D C
5. Evenson R E. 2000. Agricultural Productivity and Production in Developing Countries'. *(In) FAO, The State of Food and Agriculture,* FAO, Rome, Italy
6. Maharjan K L. 2014. *Communities and Livelihood Strategies in Developing Countries*. Springer Japan.

7. Panwar A S, Ravisankar N, Singh R A, Prusty A K, Shamim M, Ansari M A and Noopur K O. 2020. *Integrated Farming System Models for Agricultural Diversification, Enhanced Income and Employment,* Indian Council of Agricultural Research, New Delhi.
8. Reddy S R. 2016. *Farming System and Sustainable Agriculture*, Kalyani Publishers, New Delhi.
9. Singh J P., et al. 2015. *Region Specific Integrated Farming System Models*, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*, Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport G W. 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.

4. Francis Peter S J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Konar N. 2021. *Communication Skills for Professionals*. PHI Learning Pvt. Ltd.
6. Kumar S and Lata P. 2011. *Communication Skills*. Oxford University Press.
7. Neuliep James W. 2003. *Intercultural Communication- A Contextual Approach*. Houghton Mifflin Co Boston.
8. Pease Allan. 1998. Body Language. Sudha Publications, Delhi.
9. Raman M and Singh P. 2000. *Business Communication*. Oxford University Press.
10. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press.
11. Sen L. 2007. *Communication Skills*. PHI Learning Pvt. Ltd.
12. Thomson A J and Martinet A V. 1977. *A Practical English Grammar*. Oxford University

National Cadet Corps (NCC-I) 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defence organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, the contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) 1 (0+1)

Objective

Evoking social consciousness among students through various activities, viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace- building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

Semester-II

Fish and Shellfish Breeding and Hatchery Management 3 (2+1)

Objectives

i. To acquire knowledge and hands-on-training on the processes and practices of fish and shellfish breeding, hatchery management and quality seed production of different cultivable fish and shellfish species

ii. To develop the professional skill on the production of fish and shellfish seeds and hatchery management

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity

indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages, and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation, and preparation of extract for injection, dosages, and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carp, mahseer, trout, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea horse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps. Natural seed resources, site selection and collection methods.

Life cycle of important shellfish (*Penaeus monodon, P. indicus, Macrobrachium rosenbergii, P. vannamei, Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe carb, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and Penaeus monodon and *P. vannamei*. Induced maturation in *Penaeus monodon, P. vannamei* and *P. indicus* by eye stalk ablation. Reproductive physiology. Reproductive hormones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *P. monodon* and *M. rosenbergii*. Breeding and hatchery management of crabs, lobster, mussels, edible and pearl oysters. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practical

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anaesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

Identification of brood stock and maturity stages of important crustaceans and molluscs. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii, Penaeus monodon,* and *P. vannamei*. Identification of larval stages of important crustaceans and molluscs. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and brood stock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

Suggested Readings

1. Ayyappan S, Jena J K, Gopalakrishnan A and Pandey A K. 2006. *Handbook of Fisheries and Aquaculture.* ICAR, New Delhi
2. Bondad-Reantaso M G (Ed). 2007. *Assessment of Freshwater Fish Seed Resources for Sustainable Aquaculture* (No. 501). Food & Agriculture Organisation
3. Chakraborty C. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Books.
4. CMFRI. 2009. *Training Manual on Breeding and Larval Rearing of Marine Finfishes and Shellfishes,* CMFRI, Cochin
5. Diwan A D, Joseph S and Ayyappan S. 2008. *Physiology of Reproduction, Breeding and Culture of Tiger Shrimp*. Narendra Publ. House
6. FAO. 1992. *Manual of Seed Production of Carps*. FAO Publication.
7. Gupta S D, Mohapatra P C, Routray P, Sahoo S K, Verma D K and Sarangi N. 2008. *Textbook of Breeding and Management of Carps*. Narendra Publ. House
8. Jhingran V G and Pullin R S. 1985. *A Hatchery Manual for the Common, Chinese and Indian Major Carps.* (No. 252), WorldFish.
9. Kurian CV and Sebastian V O. 1976. *Prawns and Prawn Fisheries of India*, Hindustan Pub. Corp., Delhi.
10. Landau M. 1992. *Introduction to Aquaculture*. John Wiley and Sons.
11. Pillay T V R and Kutty M N. 2005. *Aquaculture- Principles and Practices*. Blackwell.
12. Rath R K. 2000. *Freshwater Aquaculture*. Scientific Publication.
13. Thomas P C, Rath S C and Mohapatra K D. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publishing House.

Anatomy and Biology of Fish and Shellfish 3 (2+1)

Objectives

i. To familiarize with the anatomy and biology of fish and shellfish

ii. To understand the anatomy and developmental biology of fish and shellfish

Theory

Study of the external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practical

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

Study of Internal Organs commercially important crustaceans and molluscs. Study of Digestive, respiratory, circulatory, nervous, and reproductive systems. Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity, and larval stages.

Suggested Readings

1. Barrington E J W. 1979. *Invertebrate Structure and Function.* Thomas Nelson & Sons. 765 pp.
2. Ede D A. 1978. *An Introduction to Developmental Biology*. Glasgow London: Blackie.
3. Jobling M. 1995. *Environmental Biology of Fishes.* Chapman and Hall.
4. Khanna S S and Singh H R. 2014. *Textbook of Fish Biology and Fisheries*. (3rd Edn.) Narendra Publishing House.
5. Hart P J, Reynolds J D and Reynolds J D (Eds). 2002. *Handbook of Fish Biology and Fisheries* (Vol. 1). Oxford, UK: Blackwell.
6. Reece W O and Rowe E W. 2017. *Functional A Anatomy and Physiology of Domestic Animals*. John Wiley & Sons.
7. Samantaray K. 2015. *Physiology of Finfish and Shellfish*. New India Publishing Agency.
8. Silas E G. 1983. *Development of Penaeid Prawns*. CMFRI Bull. No. 28.8.
9. Tembhre M. 1996. *Anatomy and Physiology of Fishes*. Vikas Publishing House.
10. Venkataramanujam K, Ramanathan N, Sastry A. 1994. Manual of Finfish Biology. *Indian Journal of Marine Sciences*, 23(4):.250-250.

Physiology of Finfish and Shellfish — 3 (2+1)

Objectives

i. To understand the physiological function of fish and shellfish
ii. To understand concepts in physiology of fish and shellfish

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on the physiology of fish and shellfish. Stress-related physiological changes. Structure and functions of important endocrine glands.

Practical

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbon dioxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques.

Suggested Readings

1. Diwan A D. 2007. *Physiology of Marine White Shrimp, Fenneropenaeus Indicus*. Narendra Publishing House.
2. Evans D H and Claiborne J B. 2006. *The Physiology of Fishes.* CRC Press.
3. Evans. 2014. *Physiology of Fishes*. Boca Raton CRC Press 2014, (4th Edn).
4. Gosling E. 2021. *Marine Mussels: Ecology, Physiology, Genetics and Culture*. John Wiley & Sons.
5. Hoar W S and Randall D J.1988. *Fish Physiology*. Academic Press.
6. Reinecke M. 2006. *Fish Endocrinology*, Vol. 1. Enfield Science Publishers, Inc.
7. Reinecke M. 2006. *Fish Endocrinology,* Vol. 2. Enfield Science Publishers, Inc.
8. Rocha 2008. *Fish Reproduction*. Enfield Science Publishers, Inc.
9. Samantaray K. 2015. *Physiology of Finfish and Shellfish*. New India Publishing Agency.
10. Shumway S E (Ed). 2011. *Shellfish Aquaculture and the Environment*. John Wiley & Sons.
11. Shumway S E and Parsons G J (Eds). 2016. *Scallops: Biology, Ecology, Aquaculture, and Fisheries*. Elsevier.
12. Smith Lynwood S. 1999. *Introduction to Fish Physiology*. Narendra Publishing House.

Limnology 2 (1+1)

Objectives

i. To study the limnetic environment

ii. To understand the physico-chemical and biological characters of the limnetic environment

Theory

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

Practical

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams, and canals. Collection and identification of nekton/ aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

Suggested Readings

1. APHA. 2017. *Standard Methods for the Examination of Water and Wastewater, American Public Health Association*, Washington DC.
2. Ham B M and MaHam A. 2015. *Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit*. John Wiley & Sons.
3. Boyd C E (Ed). 2012. *Bottom Soils, Sediment, and Pond Aquaculture*. Springer Science & Business Media.
4. Cole G A and Weihe P E. 2015. *Textbook of limnology*. Waveland Press.
5. Datta Munshi J. 2015. *Fundamentals of Limnology*, Daya Publ. House.
6. Dodds W K. 2002. *Freshwater Ecology: Concepts and Environmental Applications*. Academic Press, New York.
7. Edmondson W T. 2003. *Freshwater Biology*. Textbook Publishers.
8. Essington M E. 2003. *Soil and Water Chemistry: An Integrated Approach*, CRC Press.
9. Fasset N G. 1997. *A Manual of Aquatic Plants.* Allied Scientific Publishers, Bikaner.
10. Jónasson P M. 1995. *A treatise on limnology.* Vol. *IV. The Zoobenthos* (G E Hutchinson), Wiley Online Library.
11. Jones I D and Smol J P (Eds). 2023. *Wetzel's Limnology: Lake and River Ecosystems*. Elsevier.
12. Mitsch W J. 2009. *Wetland Ecosystems*. John Wiley and Sons.
13. Ruttner F. 2020. *Fundamentals of limnology*. Walter de Gruyter GmbH & Co KG.
14. Tan K H. 1998. *Principles of Soil Chemistry.* CRC Press Inc., Boca Raton.
15. Wetzel R G. 2010. *Limnology*. Saunders Publication.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide students an insight into the concept and scope of entrepreneurship

ii. To expose the student to various aspects of the establishment and management of a small business unit

iii. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment–identification of product/service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing knowhow, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages/salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposals for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises.* Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management*, Himalaya Publ. House.
3. Gupta C B. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
4. Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
5. Khanka S S. 1999. *Entrepreneurial Development*. S. Chand and Co.
6. Mehra P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
7. Pandey M and Tewari D. 2010. *The Agribusiness Book.* IBDC Publishers, Lucknow.
8. Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
9. Singhal R K. 2013. *Entrepreneurship Development and Management*, Katson Books.
10. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill.
11. Vasant Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment: Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management: Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to windmill/hydropower / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted systems. Visit to local polluted site - Urban/Rural/ Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate

Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disasters.

Suggested Readings

1. Bharucha E. 2023. *Textbook for Environmental Studies*. UGC, New Delhi
2. De A K. 2010. *Environmental chemistry*. New Age International Publishers, New Delhi
3. Dhar Chakrabarti P G. 2011. *Disaster management - India's risk management policy frameworks and key challenges.* Centre for Social Markets (India), Bangalore.
4. O'riordan T. 2014. *Environmental Science for Environmental Management*. Routledge.
5. Prasanthrajan M. 2018. *Objective Environmental Studies and Disaster Management*. Scientific publishers, Jodhpur, India. 146 pp.
6. Sharma P D. 2009. *Ecology and Environment*, Rastogi Publications, Meerut, India
7. Miller Jr G T and Spoolman S E. 2009. *Living in the Environment: Concepts, Connections and Solutions*, Brooks, Cole, Cengage Learning Publication, USA
8. Murthy D B N. 2007. *Disaster Management: Text and Case Studies*. Deep and Deep Publications.
9. Shaw R and Tran P (Eds). 2012. *Environment Disaster Linkages*. Emerald Group Publishing.
10. Smith K, Fearnley C J, Dixon D, Bird D K and Kelman I. 2023. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Carnegie Napolean Hill. 2019. World's Greatest Book for Persoanl Growth & Wealth. Finger Print Publishing.
2. Damon W, Lerner R M and Eisenberg N (Eds). 2006. *Handbook of child psychology, social, emotional, and personality development*. John Wiley & Sons.
3. Frager R. 2007. *Personality and Personal Growth*. Pearson Education India.
4. George Mathew Adams. 2020. You Can. Finger Print Publishing.
5. Hindle T. 2003. *Reducing Stress*. Essential Manager Series.
6. Mile D J. 2004. *Power of Positive Thinking*. Rohan Book Company, New Delhi.
7. Kumar P. 2005. *All about Self- Motivation*. Goodwill Publishing House, New Delhi.
8. Ryckman R M. 2013. *Theories of Personality*. Wadworth Cengage Learning.
9. Smith B. 2004. *Body Language*. Rohan Book Company, New Delhi.
10. Shaffer D R. 2009. *Social and Personality Development*. (6th Edn.). Belmont, CA: Wadsworth.

National Cadet Corps (NCC-II) 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.

Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defences obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS- II) **1 (0+1)**

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs. Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations. Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water-borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-II Semester

Internship (only for exit option for award of UG-Certificate) **10 (0+10)**

Objectives

i. To make students capable of working in commercial establishments with ground-level knowledge

ii. To make students capable of initiating entrepreneurship

Activity

- 10 weeks of intensive training on any aspects of Fisheries.
- The area of training may be in the hatchery, in culture farms or in processing setup to gain basic field-level knowledge to be part of any commercial setup.

Semester-III

Coastal Aquaculture and Mariculture **3 (2+1)**

Objectives

i. To gain knowledge on the culture of coastal and marine fish and shell-fish species

ii. To acquire knowledge of coastal marine farming of fish and shell-fish

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearl spot, tiger shrimp, white

shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster). Seaweed culture. Seed resources. Shore-based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi-intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture: rafts, racks, cages, poles, and ropes. Water and soil quality management. Estimation of growth, survival, and pond productivity. Pearl culture. Sea ranching.

Practical

Identification of important cultivable species. Collection and identification of commercially important seeds of fish and shellfish. Types of fertilizers - Pond preparation. Seed selection, quality, and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

Suggested Readings

1. Appukuttan K K, Asokan P K, Mohamed K S, Subramaniam S and Joseph G K. 2003. *Manual on Mussel Farming*. CMFRI Technical Bulletin 3.
2. Aswathy N, Imelda J, Ignatius B and Joseph S. 2020. *Economic viability of cage fish farming in India* (No. 134). Central Marine Fisheries Research Institute.
3. Ayyappan S, Jena J K, Gopalakrishnan A and Pandey A K. 2006. *Handbook of Fisheries and Aquaculture*. ICAR, New Delhi
4. De Silva S S (Ed). 1998. *Tropical Mariculture*. 487p. Academic Press.
5. Ghosh P K. 2010. *Brackishwater Aquaculture*. Agrobios, India
6. Halwar M, Soto D and Arthur J R (Eds). 2007. *Cage Aquaculture: Regional reviews and Global Overview*. 241p. FAO Fisheries Technical Paper No. 498.
7. IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. 2001. *Planning and Management for Sustainable Coastal Aquaculture Development* (No. 68). Food & Agriculture Organization.
8. James P M. 1983. *Handbook of Mariculture. Vol. I. Crustacean Aquaculture*. CRC Press.
9. Ottolenghi F, Silvestri C, Giordano P, Lovatelli A and New MB. 2004. Capture-based aquaculture: the fattening of eels, groupers, tunas and yellowtails. FAO Publ.
10. Pillay T V R and Kutty M N. 2005. *Aquaculture: Principles and Practices*. (2nd Edn.). Blackwell.
11. Pillay TVR. 1990. *Aquaculture, Principles and Practices*. Fishing News Books.
12. Sekar M, Ranjan R, Xavier B and Ghosh S. 2016. *Training manual on cage culture of marine finfish*. CMFRI Publication
13. Syda Rao G, Imelda-Joseph, Philipose K K and Kumar M S. 2013. *Cage aquaculture in India*. CMFRI Publication
14. Venugopal S. 2005. *Aquaculture*. Pointer Publication.

Fish Nutrition and Feed Technology 3 (2+1)

Objectives

i. To understand the basic principles of fish nutrition and the role of different nutrients

ii. To learn the process of feed formulation and preparation for fish and shell-fish

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.

Practical

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Formulation and preparation of moist feed by using locally available ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality. Estimation of the gross energy content of feed. Estimation of the digestible energy content of the feed. Equipments and machineries used in feed production. Visit to commercial feed plant.

Suggested Readings

1. De Silva S S and Anderson T A. 1995. *Fish Nutrition in Aquaculture*, Chapman and Hall Aquaculture Series, London.
2. Guillame J, Kaushik S, Berqot P and Metallier R. 2001. *Nutrition and Feeding of Fish and Crustaceans*, Springer Praxis Publishing, Chichester, UK.
3. Halver J E and Hardy R W. 2002. *Fish Nutrition*. Academic Press, London.
4. Halver J E and Tiews K T. 1979. *Finfish Nutrition and Fish feed Technology,* Vol. I and II, Heenemann, Berlin.
5. Hardy R W and Kaushik S J (Eds). 2021. *Fish Nutrition*. Academic Press.
6. Hepher B. 1988. *Nutrition of Pond Fishes*. Cambridge University Press, Cambridge.
7. Lovell R T. 1998. *Nutrition and Feeding of Fish*. Kluwer Academic Publishers.
8. New M B. 1987. *Feed and feeding of fish and shrimp. A manual on the preparation and presentation of compound feeds for shrimp and fish in aquaculture*., FAO.
9. Paulraj R. 1993. *Aquaculture Feed*. CMFRI Publication.
10. Reddy D V. 2001. *Principles of animal nutrition and feed technology*. Oxford and IBH Publishing.
11. World Health Organization 2011. *FAO/WHO Guide for Application of Risk Analysis Principles and Procedures during Food Safety Emergencies*. Food and Agriculture Organization of the United Nations.

Inland Fisheries 2 (1+1)

Objectives

i. To understand the present exploitation and future potential of inland fisheries
ii. To learn the methodologies for assessments of inland fisheries resources

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to the respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery- present status of their exploitation and future prospects. Cold water fisheries of India.

Practical

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, floodplain wetlands, coldwater bodies, net making yards.

Suggested Readings

1. Agarwal S C. 2021. *Inland Fisheries: Conservation and Processing*. CRC Press.
2. Ayyappan S, Jena J K, Gopalakrishnan A and Pandey A K. 2006. *Handbook of Fisheries and Aquaculture.* ICAR, New Delhi
3. Blaber J M. 1997. *Fish and Fisheries in Tropical Estuaries*. Chapman and Hall.
4. Chandra P. 2007. *Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India*. Daya Publ. House.
5. Funge-Smith S J. 2018. *Review of the State of the World Fishery Resources: Inland Fisheries*, FAO, Rome
6. Jain V, Sinha R, Singh L P and Tandon S K. 2016. River Systems in India: The Anthropocene Context, *In: Proceeding of Indian National Science Academy No. 82,* 3 July.
7. Jayakumar N, Ahilan B and Felix S. 2019. *Inland Fisheries*, Narendra Publ. House, New Delhi
8. Jhingran V G and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. *In: Workshop on Development of Bheel Fisheries in Assam*, held at Assam Agricultural University, Guwahati from 21 to 22 April, 1987.
9. Jhingran V G and Sehgal K L. 1978. Cold Water Fisheries of India. *J. Inland. Fish. Soc. India*.
10. Jhingran V G. 1991. *Fish and Fisheries of India*. (3rd Edn.). Hindustan Publication.
11. Muthmainnah D, Makmur S, Rais AH, Sawestri S, Supriyadi F and Fatah K. 2019. *The Features of Inland Fisheries in Southeast Asia*. Inland Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center.
12. Sugunan V V. 1997. *Reservoir Fisheries of India*. Daya Publ. House.
13. *Handbook on Fisheries Statistics*. 2022. Dept. of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India, New Delhi.
14. Welcomme R L. 2001. *Inland Fisheries: Ecology and Management*. FAO, Wiley-Blackwell.

Fishing Craft Technology 2 (1+1)

Objectives

i. To teach advanced aspects of fishing craft design

ii. To learn about modification of existing craft layout

Theory

Introduction: History and development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History and development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of the longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance of fishing vessels. Fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

Practical

Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing. Drawing of back bone assembly. U and V bottom hull of wooden boat. General view of boat; Drawing of sheer plan, body plan and half breadth plan. Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

Suggested Readings

1. Fyson J (Ed). 1985. *Design of Small Fishing Vessels*, Fishing News Books, FAO.
2. Gabriel O, Lange K, Dahm E and Wendt T. (Eds). 2008. *Von Brandt's fish Catching Methods of the World*. John Wiley & Sons.
3. Pike D. 1992. *Fishing Boats and Their Equipment*. 184p. Fishing News Books. Oxford.
4. Ponnambalam A. 2003. *Fishing Craft Technology*. 158p. CIFNET. Cochin.
5. Sanisbury J C. 1996. *Commercial Fishing Methods-An Introduction to Vessels and Gear*. 352p. Fishing News Books Ltd., Farnham.
6. Shenoy L.1988. *Course Manual in Fishing Technology*. 95p. CIFE, Mumbai.
7. Sreekrishna Y and Shenoy L. 2001. *Fishing Gear and Craft Technology*. 342p. Indian Council of Agricultural Research, New Delhi.
8. Yadav Y S. 2002. *Traditional Fishing Craft of the Bay of Bengal*. 55p. BOBP. Chennai.

Fundamentals of Biochemistry and Food Chemistry 2 (2+1)

Objectives

i. To create basic understanding on biochemical constituents of food fish and shell-fish
ii. To develop skills on the analysis of chemical constituents in food

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, phosphate/oxygen (P/o) ratio; oxidative phosphorylation. Carbohydrates: Structure, classification and functions of carbohydrate. Isomerism and mutarotation. Metabolism of carbohydrates: Glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic.

Lipids: Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids.

Proteins: Classification, structure, function and properties of proteins. Essential and non-essential amino acids. Biuret reaction and xanthoproteic reaction of protein detection. Metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration-native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing. Texturized proteins.

Enzymes: Nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones: Chemistry and function. Vitamins and Minerals: Classification and functions. Structure and functions of fat and water-soluble vitamins. Minerals: Classification and functions minerals. Nucleic acids: Structure and function. Importance of genetic code.

Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

Practical

Preparation of normal solution of acid and base, buffers and reagents. Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Estimation of carbohydrates in foods. Determination of energy value of fish. Estimation of glucose and salt content in foods.

Colorimetric method of estimation of proteins and carbohydrates. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods. Determination of specific gravity of oil. Determination of saponification value, iodine value and free fatty acid value.

Suggested Readings

1. Baines D and Seal R (Eds.). 2012. *Natural Food Additives, Ingredients and Flavourings*. Elsevier.
2. Belitz H D and Grosch W. 1999. *Food Chemistry*. (2nd Edn.) Springer.
3. Berg J M, Tymoczko J L and Stryer L. 2002. *Biochemistry*. W H Freeman and Company.
4. Hutching J B. 1999. *Food Colour and Appearance*. (2nd Edn.) Aspen Publication.
5. Michael J and Scotter. 2015. *Colour Additives for Foods and Beverage*. Woodhead Publishing Limited. Oxford.
6. Modi H A. 2012. *Food Additives*. Aavishkar Publishers Distributors, Jaipur
7. Murray R K, Granner D K, Mayes P A and Rodwell V W. 2003. *Harper's Illustrated Biochemistry*. McGraw-Hill, New Delhi
8. Otles S (Ed). 2011. *Methods of Analysis of Food Components and Additives*. CRC Press.
9. Teranishi R, Buttery R G and Shahidi F. 1989. *Flavour Chemistry – Trends and Developments*. American Chemical Society, Washington D.C
10. Voet D, Voet J G and Pratt CW. 2006. *Fundamentals of Biochemistry*. John Wiley and Sons
11. Walker J M and Wilson K (Eds.). 2010. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

Post-Harvest Handling and Preservation 3 (2+1)

Objectives

i. To teach scientific techniques of handling, storage and transport of fresh fish

ii. To teach various post-harvest changes during chill storage of fish

Theory

Structure of fish myosystems, Postmortem changes - Structural and chemical. Fish as raw material for processing: Body structure, physical properties, shape, specific weight, bulk weight, angle of slip, weight composition. Factors affecting quality of fresh fish: intrinsic and extrinsic factors. Handling of fish onboard fishing vessels, Unit operations. Unloading fish, Fish pumps. Post-harvest Fishery losses, Methods to reduce losses. Handling of fish in landing centers, defects and modifications needed. Chill storage of fish: Heat load calculation, storage methods. Insulated boxes and insulation thickness, different types of ice, physical, chemical, microbiological and sensory changes during chill storage, iced storage shelf life, cold shock, physical, chemical and sensory methods of analysis. Different types of ice and their advantages. Melanosis and its prevention, discolouration in aquatic products, nonenzymatic browning. Depuration of bivalves. Transportation: Live fish/shell fish, Transportation of raw fish to local markets and processing centres, Improvements needed in transportation, Refrigerated transport systems. Classification of transport vehicles. Cold chain.

Practical

Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. Handling of fish, bivalves, prawns, molluscs, Depuration, treatment with chemicals, evaluation of freshness of fish.

Suggested Readings

1. Aitken A, Mackie I M and Merritt J H. 1982. *Fish Handling and Processing*. SIDALC, Alliance of Agricultural Information Services
2. Balachandran K K. 2001. *Post Harvest Technology of Fish and Fish Products*. Daya Publication
3. Connell J J. 1980. *Advances in Fish Sciences and Technology*. Farnhan Surrey.
4. George M H. 1992. *Fish Processing Technology*. VCH Publication.
5. Gopakumar K. (Eds). 2002. *Text Book of Fish Processing Technology*. ICAR, New Delhi.
6. Mishra R. 2021. *Handbook on Fish Processing and Preservation*. CRC Press.
7. Sen D P. 2005. *Advances in Fish Processing Technology*. Allied Publication.

Fisheries Extension 2 (1+1)

Objectives

i. To help the students to appreciate the process of extension education

ii. To cater the need of equipping the scholars with essential skills

Theory

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education. History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process. Important ToT programs in fisheries; role of NGOs and SHGs in fisheries. Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in the diffusion of fisheries innovations. Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries. Theories of learning, learning experience, learning situation.

Practical

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques. Stakeholders' analysis and needs assessment. Assessment of development needs of community and role of formal and non – governmental organizations through stakeholders' analysis. Case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

Suggested Readings

1. Adhikarya R. 1994. *Strategic Extension Campaign: A Participatory-Oriented Method of Agricultural Extension*. 209p. FAO, Rome..

2. Agarwal B. 1986. *Women, Poverty and Agricultural Growth in India*, JPS, New Delhi.
3. Antholt C and Zijp W. 1994. *Participation in Agricultural Extension*. Washington, DC: The World Bank
4. Berdegue J A and Escobar G. 2001. *Agricultural Knowledge and Information Systems and Poverty Reduction.* AKIS Discussion Paper. Washington D C. The World Bank.
5. Birner R and Anderson J R. 2007. *How to Make Agricultural Extension Demand Driven–The Case of India's Agricultural Extension Policy*. IFPRI Discussion Paper. International Food Policy Research Institute. Washington DC: IFPRI
6. Daivadeenam P. 2002. *Research Methodology in Extension Education*. Agro-Tech Publ. Academy.
7. Kerlinger N Fred. 2002. *Foundations of Behavioural Research*. Surjeet Publication.
8. Menon N. 2009. Sexuality, caste, governmentality: Contests over 'gender' in India. *Feminist Review*, 91(1): 94-112.
9. Ray G L and Mondal S. 1999. *Research Methods in Social Science and Extension Education*. Naya Prokash.
10. Sen R and Menon K. 2020. Mapping Forty Years of Women's/Gender Studies in India. *Doing Feminisms in the Academy: Identity, Institutional Pedagogy and Critical Classrooms in India and the UK*.
11. Uberoi P. 2006. *Freedom and Destiny: Gender, Family, and Popular Culture in India*. Oxford University Press, New Delhi.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices
ii. To disseminate the knowledge and skill how to perform physical training, perform first-aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga: History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan

- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Swimming: History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke). Competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving-styles of diving, rules, regulations, and precautions. Methods of life saving in water; Boating, canoeing, and sailing: types, maintenance, skill development, rules and regulations and practice. Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques. First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with the Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester-IV

Breeding and Culture of Ornamental Fish 2 (1+1)

Objectives

i. To gain knowledge on ornamental fish production technologies and aquarium building

ii. To produce ornamental fish for marketing

Theory

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filtration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental

fish farms. Common diseases and their control. Conditioning, packing, transport, and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

Practical

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

Suggested Readings

1. Ahilan B, Felix N and Santhanam R. 2008. *Textbook of Aquariculture*. Daya Publishing House, Delhi.
2. Axelrod H R and Sweenen M E. 1992. *The Fascination of Breeding Aquarium Fishes*. TFH Publication
3. Axelrod H R and Vorderwinkler W. 1978. *Encyclopaedia of Tropical Fishes*. TFH Publication.
4. Boyd C E. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn
5. Crow R and Keeley D. 1992. *A Practical Guide to Tropical Aquarium Fish*. Tiger Book Int., London.
6. Mills D. 1981. *Aquarium Fishes*. Kingfisher Books.
7. Sanford G and Crow R. 1991. *The Manual of Tank Busters*. Salamander Books.
8. Saxena A. (Ed.). 2003. *Aquarium Management*. Daya Publication.
9. Swain S K, Sarangi N and Ayyappan S. 2010. *Ornamental Fish Farming*. ICAR, New Delhi
10. Thabrow De W V. 1981. *Popular Aquarium Plants*. Thornbill Press.

Live Food Organisms for Fish and Shellfish 2 (1+1)

Objectives

i. To learn the nutritional requirements of fish and shell-fish larvae
ii. Techniques the culture of live food organisms from fish and shell-fish larvae

Theory

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

Practical

Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Proximate composition analysis of live feed organisms. Decapsulation and hatching method of brine shrimp cyst.

Suggested Readings

1. CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. Central Institute of Fisheries Education, Versova, Mumbai.
2. Gopinathan C P. 1995. *Handbook on Aqua Farming - Live Feed*. MPEDA Publication
3. Girijavallabhan K G, Gopinathan C P, Varghese M and Prema D. 2000. Culture of live feed organisms. *In: Marine Fisheries Research and Management*. CMFRI; Kochi, Kochi.
4. Hagiwara A, Snell T W, Lubzens E and Tamaru C S. 1997. Live Food in Aquaculture. *(In) Proceedings of the Live Food and Marine Larviculture Symposium*. Kluwer.
5. Joan Holt G. 2011. *Larval Fish Nutrition*. Wiley Blackwell Publication.
6. Lavens P and Sorgeloos P (Eds). 1996. *Manual on the production and Use of Live Food for Aquaculture*. FAO Fisheries Technical Paper. No. 361. FAO, Rome.
7. Lee C S, O'Bryen P J and Marcus N H. 2005. *Copepods in Aquaculture*. Blackwell Publishing.
8. Muthu M S. 1983. *Culture of Live Feed Organisms*. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.
9. Sorgeloos P and Pandian K S. 1984. *Culture of Live Food Organisms with Special Reference to Artemia Culture*. CMFRI Spl. Publ. No. 15.

Fish and Shellfish Diseases and Treatment 3 (2+1)

Objectives

i. To understand the recent advances in diseases of fish and shell-fish and their remedial measures

ii. Fish and Shellfish disease diagnosis and treatment

Theory

General characteristics, life cycle, diagnosis of pathogens. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Bioremediators, Biocontrol agents, Probiotics, Immunomodulators, Concepts of vaccination. Shrimp toilet. Management measures for the host. Specific pathogen-free (SPF), Specific pathogen-resistant (SPR) and Specific pathogen-tolerant (SPT). Developing management practices and biosecurity principles: Health maintenance, Better management practices (BMP), Good aquaculture practices (GAP), Hazard analysis and Critical control point (HACCP) and Biosecurity principles in aquaculture.

Disease control through environmental management: Importance of Biofilm and Bio-floc. Periphyton in aquatic health management. Zoonotic diseases. Principles of disease diagnosis: Conventional, molecular and antibody-based diagnostic methods. Rapid diagnostic methods.

Practical

General procedure for disease diagnosis. Methods of fish and shell-fish sampling for disease diagnosis. Taxonomy, lifecycle and identification of fish and shell-fish parasites. Sampling, preparation of media and culture of pathogenic bacteria. Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, histopathological,

immunological, molecular techniques and biochemical tests. Agglutination test and Challenge tests; Purification of virus. Stress-related study of fish and shell-fish. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shell-fish.

Suggested Readings

1. Alan C. 2005. *Molecular Virology*. 315p. Academic Press.
2. Austin B and Austin A. 2007. *Bacterial Fish Pathogens*. Springer Publishers, U.K.
3. Bullock L G. 2014. *Diseases of Fishes*. NPH, Delhi
4. Cox F E G. 2005. *Parasitology*. Hodder Arnold. USA
5. Crosa J H. 1983. *Bacterial and Viral Diseases of Fish*. Washington Sea Grant Publication, Seattle.
6. Gupta N. 2014. *Modern Parasitology*. Narendra Publishing House, Delhi
7. Iglewski H B and Clark V L. 1009. *Molecular Basis of Bacterial Pathogenicity*. Academic Press.
8. Inglis V. 1993. *Bacterial Diseases of Fish*. Blackwell Scientific Publications, London.
9. Roberts R J. 2012. *Fish Pathology*. (4th Edn.). WB. Saunders.

Marine Fisheries 2 (1+1)

Objectives

i. To understand the present exploitation and future potential of marine fisheries
ii. To learn the methodologies for assessments of marine fisheries resources

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic, demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of India's EEZ. GIS and Remote sensing in marine capture fishery. Conservation and management of marine fisheries resources in India.

Practical

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

Suggested Readings

1. Bal D V and Rao K V. 1990. *Marine Fishes of India*. (1st Rev. Edn.). Tata McGraw Hill.
2. Blaber J M. 1997. *Fish and Fisheries in Tropical Estuaries*. Chapman and Hall.
3. Chandra P. 2007. *Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India*. Daya Publ. House.
4. FAO. Technical Papers on Marine Fisheries.
5. Grafton R Q (Ed). 2010. *Handbook of marine fisheries conservation and management*. OUP USA.

6. Kurian CV and Sebastian V O. 1986. *Prawns and Prawn Fisheries of India.* Hindustan Publ. Corp.
7. Mohan Joseph M and Pillai N G K. 2007. *Status and Perspectives in Marine Fisheries Research in India*. Central Marine Fisheries Research Institute.
8. Pillai V N and Menon N G (Eds). 2000. *Marine Fisheries Research and Management*. 914p. Central Marine Fisheries Research Institute (CMFRI).
9. Ramadoss K. 2003. Status of Exploited Marine Fishery Resources of India. *In: Joseph, M M and Jayaprakash A A (Eds).* Central Marine Fisheries Research Institute, Kochi, 201-210.
10. Sinclair M Valdimarsson G. 2003. *Responsible Fisheries in the Marine Ecosystem*. 426p. CABI Publishing.
11. Srivastava C B L and Srivastava S. 2006. *Textbook of Fishery Science and Indian Fisheries.* 551p. (Classic Edn.). Kitab Mahal, New Delhi.
12. Upadhyay A K and Joshi B C. 2014. *Textbook of Marine Fisheries: Fisheries of World Oceans and India in Perspective*. 232p. Astral International Private Limited.

Fishing and Gear Technology 3 (2+1)

Objectives

i. To teach advanced fishing gear and fishing technology
ii. To learn design modification and gear selectivity of fishing

Theory

Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear, methods of the world and International Standard Statistical Classification of Fishing gear (ISSCFG). Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order. Construction of ropes and their higher order. Construction of braided netting twines. Yarn numbering system - direct system: Tex system, Denier system and calculation of resultant tex value. Indirect system: British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond, square, hexagonal and their measurement. Properties of netting material: physical properties- Density, twist and amount of twist, breaking strength-tenacity, and tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption and shrinkage, sinking velocity, weather resistance, melting point and visibility. Chemical and Biological properties. Floats and buoys – its materials, types their properties. Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be

considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation. Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear. Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board.

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gear arrangements. Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid-water trawling. Constructional details of single-boat purse seine; two-boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid-water and pelagic gillnetting.

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole and line and trolling line. Operation of long line: set and drift long lining: bottom, mid-water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch-reducing devices. Deck equipment – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practical

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step. Tailoring method: T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination. Joining of net pieces. Net mounting – hanging coefficient, hung depth and their calculation. Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques.

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook and line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Suggested Readings

1. Ben-Yami M. 1994. *Purse Seining Manual*. 416p. FAO Fishing Manual.
2. Biswas K P. 1996. *Harvesting Aquatic Resources*. 207p. Daya Publishing House, Delhi.
3. Bjordal A and Løkkeborg S. 1996. *Longlining Fishing News Books*. Wiley-Blackwell, Oxford.
4. Brandt A V. 1984. *Fish Catching Methods of the World*. 432p. Fishing News Books Ltd.
5. FAO. 1987. *Small Scale Fishing Gear*. pp 19-44. FAO.
6. FAO. 1996. *Fishing Operations*. 26p. FAO Training Guidelines for Responsible Fisheries No.1, FAO, Rome.
7. Fridman A L. 1986. *Calculations for Fishing Gear Designs*. 264p. FAO Fishing Manual, Fishing News Books Ltd, Farnham.

8. Kristionsson H. 1975. *Modern Fishing Gear of the World*. 594p. The White Friars Press Limited. London.
9. Sreekrishna Y and Shenoy L. 2001. *Fishing Gear and Craft Technology*. 342p. Indian Council of Agricultural Research. New Delhi.

Fish Products, By-products, Value Addition and Waste Management 3 (2+1)

Objectives

i. To understand the concepts of fish products and by-products
ii. To teach concepts of value addition of fish products and waste management

Theory

Principle of fish preservation and processing. Processing of fish by traditional methods–salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting–wet salting and dry salting. Drying and dehydration- theory, importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt-cured fish. Quality standard for salted and dry fish. Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. Methods of smoking and equipment used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing. Marinated and fermented fish products–role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibrillar protein and their role in elasticity formation. Extruded products: theory of extrusion, equipment used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. HACCP in safe product production. Fish meal: dry reduction and wet reduction methods, specification, packaging and storage. Fish oil: body oil, liver oil extraction, purification, preservation, storage, and application. Shrimp wastes: chitin, chitosan production, uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish silage, acid silage, fermented silage and their application. Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practical

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn and fish pickles. Preparation of fermented fish sauce and marinade products. Preparation of surimi and surimi-based products. Preparation of diversified and value-added fish products. Quality assessment of market sample of dried and fermented fish products.

Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure. Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

Suggested Readings

1. Balachandran K K. 2001. *Post-Harvest Technology of Fish and Fish Products*. Daya Publication.
2. Borresen T. 2008. *Improving Seafood Products for the Consumer*, Woodhead Publishing Limited, Cambridge
3. Elvevoll (EO.). Fish Waste and Functional foods, Norwegian College of Fishery Science, Department of Marine Biotechnology, Norway. edele@nfh.uit.no
4. Fereidoon Shahidi. 2007. *Maximizing the Value of Marine By-Products*, CRC Press Inc.
5. Gopakumar K. (Ed). 2002. *Text Book of Fish Processing Technology*. ICAR.
6. Hall G M (Ed). 1997. *Fish processing technology*. Springer Science & Business Media.
7. Nambudiri D D. 2006. *Technology of Fishery Products*. Fishing Chimes.
8. Sen D P. 2005. *Advances in Fish Processing Technology*. Allied Publication.
9. Venugopal V. 2005. *Seafood Processing: Adding Value Through Quick Freezing Retort Packaging, and Cook-Chilling*, Taylor and Francis, Boca Raton.
10. Wheaton F W and Lawson T B. 1985. *Processing Aquatic Food Products.* John Wiley and Sons.

Agriculture Marketing and Trade — 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches–cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Government in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of

price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S. 2004. *Agricultural Marketing in India*. Oxford and IBH publishing.
2. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India,* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Barkley A and Barkley P W. 2016. *Principles of Agricultural Economics*. Routledge.
4. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Pub, N Delhi.
5. Kohls Richard L and Uhl Josheph N. 2002. *Marketing of Agricultural Products*, Prentice-Hall of India Private Ltd., New Delhi.
6. Kotler P and Armstrong G. 2010. *Principles of Marketing*, Pearson Prentice Hall. *New Jersey*.
7. Lekhi R K and Singh J. 2006. *Agricultural Economics*. Kalyani Publishers, Delhi.
8. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India,* Kitab Mahal, New Delhi.
9. Norton G W, Alwang J and Masters W A. 2009. *Economics of Agricultural Development*. Routledge.
10. Pandey M and Tewari D. 2004. *Rural and Agricultural Marketing*, International Book Distributing Co. Ltd, New Delhi.
11. Vercammen J. 2012. *Agricultural Marketing: Structural Models for Price Analysis*. Routledge.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.

ii. To provide basic knowledge of computer with applications in agriculture

iii. To make the students familiar with agricultural-informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc.

Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands. Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS-EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands-on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Abdel-Basset M, Hawash H, Abdel-Fatah L. 2024. *Artificial Intelligence and Internet of Things in Smart Farming*, CRC Press
2. Date C. 2007. *Date on Database: Writings 2000-2006*. Apress.
3. ESL I. 2012. *Introduction to Information Technology*. Pearson Education India.
4. Misra N N, Dixit Y, Al-Mallahi A, Bhullar M S, Upadhyay R, Martynenko A. 2020. IoT, Big Data, and Artificial Intelligence in Agriculture and Food Industry. *IEEE Internet of things Journal*, 9(9): 6305-6324.
5. Mishra R and Pandey D K. 2021. Agri/Bioinformatics: Shaping Next-Generation Agriculture. *Bioinformatics for Agriculture: High-through put approaches*.
6. Ozguven M. 2023. *The digital age in agriculture*. CRC Press.
7. Prasath V B, Mondal M H, Podder P and Bharati S. Artificial Intelligence and Smart Agriculture Technology.
8. Rajaraman V and Adabala N. 2014. *Fundamentals of computers*. PHI Learning Pvt. Ltd.
9. Satapathy S, Mishra D and Vargas A R. 2022. *Innovation in Agriculture with IoT and AI*. Springer.

Post-IV Semester

Internship (only for exit option for award of UG-Diploma) **10 (0+10)**

General Objectives

i. To make students capable of working in the commercial establishments as a supervising or management staff

ii. To make students capable of being an entrepreneur

Activity

- 10 weeks of intensive training on any aspects of Fisheries will help in broadening career aspects
- The area of training may be in the hatchery, in culture farms or in processing industries

Semester-V

Fish Genetics and Breeding **2 (1+1)**

Objectives

i. To understand the basic principles of genetics and breeding and their application to fisheries

ii. To improve the quality and quantity of fish and shell-fish species

Theory

Principles of genetics and breeding. Gene and chromosome as basis of inheritance. Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex-influenced and sex-limited traits. Linkage and crossing over. Introduction to population genetics. Hardy - Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy

and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross-breeding, heterosis and design of cross-breeding programs, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practical

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Estimation of inbreeding coefficient. Preparation of Selection index for the selective breeding program. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt. Study of risk factors in cryopreservation technique.

Suggested Readings

1. Ayyappan S. 2004. *Fisheries Biotechnology*. Narendra Publ. House.
2. Gjedrem T (Ed). 2005. *Selection and Breeding Programs in Aquaculture* (Vol. 2005). 360p. Dordrecht, The Netherlands: Springer
3. Kirpichnikov V S. 1981. *Genetic Basis of Fish Selection*. Springer-Verlag.
4. Lakra W S, Abidi S A H, Mukherjee S C and Lutz C G. 2003. *Practical Genetics for Aquaculture*. Wiley-Blackwell.
5. Lutz C G. 2003. *Practical Genetics for Aquaculture*. Wiley-Blackwell.
6. Lynch M and Walsh B. 1997. *Genetics and Analysis of Quantitative Traits*. Sinauer, Sunderland.
7. Nair P R. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publication.
8. Purdom C E. 1993. *Genetics and Fish Breeding*. Chapman and Hall.
9. Snustad D P and Simmons M J. 1999. *Principles of Genetics*. (2nd Edn.). John Wiley and Sons.
10. Stansfield W D. 1991. *Theory and Problems of Genetics*. McGraw-Hill.
11. Tave D. 1993. *Genetics for Fish Hatchery Managers*. (2nd Edn.). Chapman and Hall.

Marine Biology 2 (1+1)

Objectives

i. To understand the Marine life and its biology
ii. To study the diversity of marine organism

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, zooplankton and seaweeds. Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in

plankton production, plankton and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonation, communities, and the adaptation. Mud banks: formation and characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species. Blooms, Red tides: cause and effects.

Practical

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, seaweeds and inter tidal organisms.

Suggested Readings

1. Barnes R S K and Hughes R N. 1999. *An Introduction to Marine Ecology*. John Wiley & Sons.
2. Cass-Dudley V L, Dudley G and Sumich J L. 2016. *Laboratory and Field Investigations in Marine Life*. (11th Edn). Jones and Bartlett Learning.
3. Castro P and Huber M E. 2018. *Marine Biology*, McGraw Hill.
4. Kennish M J. 1989. *Practical Handbook of Marine Science*. CRC Press, New York.
5. Laevastu T and Hayes M L. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
6. Lalli C M and Parsons T R. 1993. *Biological Oceanography: An Introduction*. Elsevier Science Ltd., Oxford.
7. Miller C B. 2004. *Biological Oceanography*. Blackwell Publications, Oxford.
8. Pan J. and Pratolongo P (Eds). 2022. *Marine Biology: A Functional Approach to the Oceans and Their Organisms*. CRC Press.
9. Pond S and Pickard G L. 2013. *Introductory Dynamical Oceanography*. Elsevier
10. Reddy M P M. 2007. Ocean Environment and Fisheries, Science Publishers, USA.

Fish Population Dynamics and Stock Assessment 2 (1+1)

Objectives

i. To understand the stock concept and principles of fisheries management
ii. To understand the application of various models and their applications in fisheries management

Theory

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

Practical

Study of length – weight relationship, segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. Estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

Suggested Readings

1. Callucci V G, Saila S B, Gustafson D J and Rothschild B J. 1996. *Stock Assessment. Quantitative Methods and Applications for Small Scale Fisheries*. 527p. Lewis's Publishers.
2. Devaraj M. 1983. *Fish Population Dynamics: A Course Manual*. CIFE Bulletin 3(10):98
3. Gulland J A. 1977. *Fish Population Dynamics*. 422p. John-wiley and Sons. Chichester.
4. Gulland J A. 1992. *A Review of Length-based Approaches to Assessing Fish Stocks*. 100p. FAO Technical Paper-323.
5. Hilborn R and Walters C J. 1992. *Quantitative Fisheries Stock Assessment – Choice, Dynamics and Uncertainty*. 570p. Chapman and Hall.
6. Pauly D. 1980. *Selection of Simple Methods for the Assessment of Tropical Fish Stocks*. 54p. FAO Fish. Circ. (729).
7. Quinn T J and Deriso R B. 2003. *Quantitative Fish Dynamics*. Academic Press.
8. Ricker W E. 1971. *Methods for the Assessment of Fish Production in Freshwaters*. Blackwell, Oxford and IBH.
9. Sparre P and Venema S C. 1998. *Introduction to Tropical Fish Stock Assessment. Part 1 Manual.* FAO. Fisheries Tech. Paper No. 301, Rome
10. Vivekanandan E. 2005. *Stock Assessment of Tropical Marine Fishes*. Indian Council of Agricultural Research, New Delhi.

Aquatic Ecology and Biodiversity 2 (1+1)

Objectives

i. To enrich the knowledge on the ecology and biodiversity of aquatic environment

ii. To assess the threats on the ecosystem and biodiversity of aquatic environment

Theory

Aquatic environment, Flora and fauna: Components of aquatic systems. Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destruction, introduction of exotic species. Conservation of habitats: marine parks and sanctuaries. Conservation programs for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Practical

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Collection, identification, and preservation of mangrove plants. Working out biodiversity indices.

Suggested Readings

1. Barnes R S K and Mann K H (Eds). 2009. *Fundamentals of Aquatic Ecology*. John Wiley and Sons.
2. Carter R W G. 1998. *Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines*. Academic Press, London.
3. Dodds W and Whiles M. 2010. *Freshwater Ecology*, (2nd Edn). Concepts and Environmental Application of Limnology. Academic Press, London.
4. Dodds W K. 2002. *Freshwater Ecology: Concepts and Environmental Applications*. Academic Press, New York.
5. Elliott A. Norse (Ed). 1993. *Global Marine Biological Diversity*. 383p. Inland Press, Washington, D.C.
6. Jones P. 2014. *Governing Marine Protected Areas: Resilience through Diversity*. Routledge.
7. Khanna D R, Chopra A K and Prasad G. 2005. *Aquatic Biodiversity in India*. Daya Publ. House.
8. Kormondy E J. 1986. *Concepts of Ecology*, Prentice-Hall, New Delhi.
9. Kumar U and Asija M J. 2000. *Biodiversity Principles and Conservation*. Agrobios.
10. Magurran A E. 1988. *Ecological Diversity and its Measurement*. Taylor and Francis.
11. Menon A G K. 2004. *Threatened Fishes of India and their Conservation*. Fisheries Survey of India.
12. Mitsch W J. 2009. *Wetland Ecosystems*. 295p. John Wiley and Sons.
13. Okuda N, Watanabe K, Fukumori K, Nakano S I and Nakazawa T. 2014. *Biodiversity in Aquatic Systems and Environments:* Lake Biwa. Springer Japan.
14. Thorpe J E, Talbot C and Miles M S. (Eds). 1995. *Conservation of Fish and Shell Fish Resource; Managing Diversity.* Academic Press.

Pharmacology and Toxicology 3 (2+1)

Objectives

i. To understand the application and impact of aquaculture drugs and chemicals in fisheries

ii. To impart knowledge on the toxicity of drugs and chemicals on aquaculture and fisheries

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs. Pharmacotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation, and excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non-receptor

mediated action. Dose Response Relationship, half-life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transportation. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry.

General Toxicology: Definitions, Branches of Toxicology, Historical developments, Classification and types of poison. Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetic, Toxicodynamic, General approaches to diagnosis and treatment of poisoning.

Systemic Toxicology: Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases. Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish. Metabolism of toxic substances by aquatic organisms.

Practical

Metrology, Prescription Writing, Preparation of drug solution, Source and chemical nature of drugs. Incompatibility, Pharmaceutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish.

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe^{3+}), Copper (Cu), Ammonia, Ammonium (NH_4^+), Chloride (Cl^-), Phosphate (PO_4^{2-}) Sulphate (SO_4^{2-}), Fluoride (Fl^-). Qualitative detection of Nitrite and Nitrate. Detection of hydrocyanic acid. Detection and Estimation of Mycotoxins. Test for detection of alkaloids. Estimation of LD_{50} and ED_{50}. Demonstration of drug toxicity.

Suggested Readings

1. Brown K M. 2000. *Applied Fish Pharmacology*. Kluwer Academic Press, London.
2. Derelanko M J. 1995. *CRC Handbook of Toxicology*. CRC Press, Boca Raton.
3. Hayes A W. 2008. *Principles and Methods of Toxicology*. CRC Press, USA.
4. Herwig N. 1979. *Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases*. Charles C Thomas, Springfield.
5. Hoboken N J. 2010. *A Textbook of Modern Toxicology*. John Wiley and Sons.
6. Stahr H M (Ed). 1977. *Analytical Toxicology Methods Manual*. IOWA State University Press, Ames.
7. Kram D J. 2001. *Toxicology Testing Handbook*. Marcel Dekker, Inc., New York.
8. Malins D C. 1994. *Aquatic Toxicology*. Lewis Publishers, Boca Raton.
9. Metelev V V. 1983. *Water Toxicology*. Amerind Publishing Co Pvt Ltd, New Delhi.
10. Niesink R J M. 1996. *Toxicology Principles and Applications*. CRC Press, New York.
11. Pandey B N. 2011. Fisheries and Fish Toxicology. A P H Publishing Corporation, New Delhi

12. Pandey G. 2017. *Fish Pharmacology and Toxicology*. DPH, New Delhi.
13. Rand G M. 1985. *Fundamentals of Aquatic Toxicology*. Hemisphere Publishing Corporation, Washington.
14. Singh I S B. 2003. *Aquaculture Medicine*. Cochin University 2003.
15. Stockopf M K. 1993. *Fish Medicine*. W.B. Saunders Company, London.

Fish Freezing Technology 2 (1+1)

Objectives

i. To gain knowledge on the mechanism of action of chilling and freezing methods for preservation of fish and shell-fish
ii. To understand the mechanism of the freezing technology for preservation

Theory

Introduction to freezing technology; characteristics of fish and shellfish. Changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. Principles of low temperature preservations. Chilling of fish: methods and equipment for chilling; icing: quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish: fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico–chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish and shellfish for freezing. Changes that occur during frozen storage: microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments: polyphosphate, glazing, antioxidants, packaging; thawing of frozen fish and shellfish: methods of thawing. Transportation of frozen fish and shellfish, cold chain, quality control, HACCP in freezing industry.

Practical

Sanitation and plant housekeeping. Chilling and freezing equipment, instruments. Packages and product styles. Methods of icing fish; cooling rate. Preservation by chilled sea water; freezing and thawing curves. Freezing of different varieties of fish and shellfish; estimation of drip. Determination of quality changes during frozen storage. Inspection of frozen fishery products. Visits to ice plants, cold storages, and freezing plants.

Suggested Readings

1. AOAC Manual
2. Balachandran K K. 2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ. House.
3. Clucas I J. 1981. *Fish Handling, Preservation and Processing in the Tropics*. Parts I, II. FAO
4. Desrosier N W. 2012. *Fundamentals of Food Freezing*. Springer Science & Business Media.
5. Gokoglu N and Yerlikaya P. 2015. *Seafood Chilling, Refrigeration and Freezing: Science and Technology*. John Wiley & Sons.
6. Gopakumar K (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.
7. Hall G M (Ed). 1997. *Fish Processing Technology*. Springer Science & Business Media.

8. Mallett C P (Ed). 1993. *Frozen Food Technology*. Springer Science & Business Media.
9. Mishra R. 2021. *Handbook on Fish Processing and Preservation*. CRC Press.
10. SEAFDEC Manual
11. Sen D P. 2005. *Advances in Fish Processing Technology*. Allied Publishers.
12. Venugopal V. 2006. *Seafood Processing*. Taylor and Francis

Fish Canning Technology and Packaging 2 (1+1)

Objectives

i. To provide information on various aspects of thermal/heat processing, fish packaging materials, their appropriate use and benefits
ii. To impart knowledge on canning technology, packaging and labeling

Theory

Fish Canning Technology: Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, absolute sterility, pasteurization and sterilization. Canning process: Process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of microorganisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Process calculation by general/ graphical methods. Estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept. Canning of commercially important fin fishes, shellfishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal.

Packaging: Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use; Protective packaging with special reference to food. Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. Principles of packaging: fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging, Modified Atmosphere Packaging (MAP). Polymeric Packaging. Packaging requirements of fresh fish, frozen fish, canned fish. Transport worthiness of packaging materials, accelerated shelf testing. Safety and legislation aspects of packaging. Labelling and bar coding.

Practical

Types of cans, canning equipment and layout of cannery. Canning of different varieties of fish and shellfish. Cutout test of canned products. Examination of can double seam. Heat resistance of

bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

Suggested Readings

1. D'Souza J. and Pradhan J. 2010. *Handbook of Food Processing Packaging and Labeling*, SBS Publishers and Distributors Pvt. Ltd. New Delhi
2. Gopakumar K. 1993. *Fish Packaging Technology - Materials and Methods*. Concept Publication.
3. Gopal T S Srinivasa. 2012. *Contribution of CIFT to Indian fisheries*. ICAR-Central Institute of Fisheries Technology, Cochin.
4. Gordon L Robertson. 2005. *Food Packaging: Principles and Practices*, Marcel Dekker, Inc. New York
5. Hall GM (Ed). 1992. Fish Processing Technology. Blackie.
6. Hersom A C and Hulland E D. 1980. *Canned Foods*. Chemical Publ. Co.
7. Holdsworth S D. 1997. *Thermal Processing of Packaged Foods*, Blackie Academic and Professional.
8. Larousse J and Brown B E. 1997. *Food Canning Technology*. Wiley VCH.
9. Mathur A. 2012. *Food Processing, Packaging, Labelling and Marketing*. Anmol Publications Pvt. Ltd. (New Delhi)
10. Ponnuswami V. 2012. *Nano Food Packaging: A New Post-Harvest Venture*, Narendra Publishing House, Delhi
11. Subasinghe S 1999. *Retail Packaging of Fish and Fishery Products*, Info Fish.
12. Sun D W. 2005. *Thermal Food Processing: New Technologies and Quality Issues*. CRC Press.
13. Venugopal V. 2006. *Seafood Processing*. Taylor and Francis.
14. Warne D. 1988. *Manual on Fish Canning*. FAO Fisheries Tech. Paper 285.
15. Zeathen P. 1984. *Thermal Processing and Quality of Foods*. Elsevier.

Aquaculture Engineering 3 (2+1)

Objectives

i. To acquire the knowledge of land survey, excavation of ponds, design and lay-out of fish/prawn farms.

ii. To understand the basic knowledge for the construction of Finfish and Shellfish farms and hatcheries.

Theory

Fish Farm: Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm: site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics. Land Surveying: definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due to the incorrect chain length. Chain surveying: definition, instruments used for setting out right angles, basic problems in chaining, cross-staff survey. Compass surveying: definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Levelling: definitions, methods of levelling, levelling instruments, terms and abbreviations, types of spirit levelling. Plane table surveying: instruments required, working operation, methods. Contour surveying: definition, contour interval, characteristics of contour, contouring methods and uses of contour. Soil and its properties: classification of soil; soil sampling methods; three-phase system of soil, definitions of soil properties and permeability of soil. Ponds: classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish pond: layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds. Types of ponds: nursery ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond etc., construction ponds, marking, excavation. Dykes: types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes. Water distribution system: canal, types of canals; feeder canal, diversion canal etc., Pipe line system. Water control structures: types of inlets and outlets and their construction. Water budget equation. Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms: tide-fed, pump-fed farms. Hatcheries: Site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries: brood stock ponds, artemia hatching tanks, sheds etc. Raceway culture system: site selection, layout plan, types of raceway culture system viz., parallel system, series system etc., Aerators: principles, classification of aerators and placement of aerators. Pumps: purpose of pumping, types, selection of pump, total head, horse power calculation. Filters: types and constructions.

Practical

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculations. Visit to different types of farms.

Suggested Readings

1. Balasubramanian B, Liu W C and Sattanathan, G (Eds). 2022. *Aquaculture Science and Engineering*. Springer.
2. Bose A N, Ghosh S N, Yang C T and Mitra A. 1991. *Coastal aquaculture engineering*. CUP Archive.
3. Jadhav U. 2009. *Aquaculture Technology and Environment*. PHI Learning Pvt. Ltd.

4. Lawson T B (Ed). 1994. *Fundamentals of Aquacultural Engineering*. Springer Science & Business Media.
5. Lekang O I. 2013. *Aquaculture Engineering*. John Wiley & Sons, Ltd.
6. Mishra R and Dora K C. 2015. *A Text Book on Aquaculture Engineering*, Narendra Publishing House.
7. Odd-Ivar Lekang. 2020. *Aquaculture Engineering*. (3rd Edn.). Wiley-Blackwell.
8. Wheaton F W. 1993. *Aquaculture Engineering*, Krieger Publ. Co.

Fisheries Economics 3 (2+1)

Objective

To teach economics theories for taking decisions by individual consumers, producers, and also farms.

Theory

Introduction to fisheries economics, basic economic terminologies–micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production contribution of fisheries sector to the economic development of the country.

Micro-Economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost.

Macro-Economics: Introduction to national income, accounting, measurement and determinants of national income, the contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalization and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practical

Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products. Calculation of price, income and cross elasticities. Production function – production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm/shrimp farm/seed production unit /fish processing plant/export unit.

Suggested Readings

1. Anderson L G and Seijo J C. 2010. *Bioeconomics of Fisheries Management*. John Wiley & Sons.
2. Bell F W. 2019. *Food from the Sea: The Economics and Politics of Ocean Fisheries*. Routledge.
3. Dewitt K K. 2002. *Modern Economic Theory*. Sultan Chand and Co.
4. Geetika G P and Choudhury P R. 2011. *Managerial Economics* (2nd Edn). New Delhi: Tata McGraw Hill Education Private Limited.
5. Flaaten O. 2011. *Fisheries Economics and Management*. University of Tromsø.
6. Jhingran M L 2004. *Micro Economic Theory*. Vikash Publishing House Pvt. Ltd. New Delhi.
7. Kreps D M. 2020. *A course in Microeconomic Theory*. Princeton University Press.
8. Shrivastava O S. 2013. *Modern Managerial Economics: Including Micro and Macroeconomics*. Anmol Publications Pvt. Ltd., New Delhi
9. Silberberg E and Suen W C. 2000. *The Structure of Economics: A Mathematical Analysis (*3rd Edn.). McGraw-Hill.

Semester-VI

Fish Biotechnology and Bioinformatics 2 (1+1)

Objective

To understand the basic principles of fish biotechnology and bioinformatics and its applications to fisheries

Theory

Introduction to Biotechnology –scope and importance in fisheries/ aquaculture. Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post-transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes. DNA sequencing, Operons. Genetic engineering: Restriction enzymes, Gene isolation, Cloning vectors, Probes. Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism. Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting. Bioinformatics: Introduction to Bioinformatics. Biological Databases and tools: Introduction, Types of biological databases: Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

Practical

Study of structure of prokaryote and Eukaryote Cells. Isolation of DNA and RNA. PCR amplification. Gel Electrophoresis. Study on Model of protein Synthesis. Study of models of DNA Technology. Cell Culture. Isolation of Nucleic Acids. Restriction enzymes. ELISA. DNA sequence analysis and comparison. Study of data search engines. Study of different databases.

Suggested Readings

1. Diwan A D. 2018. *Biotechnology of Penaeid Shrimps*. Narendra Publication.
2. Felix S and Ninawe A S. 2014. *Aquaculture Biotechnology*. Daya Publishing House.
3. Fletcher G L Rise M L. 2012. *Aquaculture Biotechnology*. Wiley Blackwell.
4. Gautam N C. 2007. *Comprehensive Biotechnology - Vol. 4 Aquaculture Biotechnology*. Shree Publishers and Distributors
5. Greglutz C. 2001. *Practical Genetics for Aquaculture*. Wiley Blackwell Publ.
6. Klug W S, Cummings M R, Spencer C A and Palladino M A. 2012. *Concepts of Genetics*. (10th Edn.). Pearson Publication.
7. Kim S K (Ed). 2015. *Springer Handbook of Marine Biotechnology*, Berlin/Heidelberg, Germany: Springer.
8. Montet D and Ray R C. 2009. Aquaculture Microbiology and Biotechnology. (Vol. I). Science Publishers.
9. Nair P R. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publication.
10. Pandey P K and Parhi J (Ed). 2021. *Advances in Fisheries Biotechnology*. 521p. Springer.
11. Pandian T J, Strüssmann C A and Marian M P. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publication.
12. Primrose S B. 1989. *Modern Biotechnology*. Blackwell.
13. Reddy P V G K, Ayyappan S, Thampy D M and Krishna G. 2005. *Fish Genetics and Biotechnology*. ICAR, New Delhi
14. Sunita R. 2015. *Fish Biotechnology*. Random Publications.

Fish Immunology 2 (1+1)

Objectives

i. To impart knowledge on basic principles of fish and shellfish immunology

ii. To understand the immune responses to infection by various fish pathogens and to offer scope for the development of disease protective/prevention measures against bacteria, fungi, viruses and parasites of fish

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell-mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types, epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells. Antigen-antibody reaction - Precipitation and agglutination reactions. Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non-specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease-producing organisms, portals of infection. Immunity to bacteria, fungi and parasites. Role of stress and host defence mechanism in disease development. Vaccines - types of vaccines – whole-cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines,

modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants –types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practical

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination testimonies, diffusion, double immune-diffusion, radial immune-diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

Suggested Readings

1. Abbas A K. 1991. *Cellular and Molecular Immunology*. Saunders Publisher, Philadelphia
2. Anderson D P. 2003. *Textbook of Fish Immunology*. Narendra Publishing House, Delhi.
3. Cooper E L. 1982. *Immunology and Immunization of Fish*. Pergamon Press, New York.
4. Cooper E L. 1982. *General Immunology*. Pergamon Press, Oxford.
5. Dahl E and Støttrup J. 2012. *Global Challenges in Integrated Coastal Zone Management*. John Wiley & Sons.
6. Elgert K D. 2009. *Immunology*. John Wiley and Sons, New York.
7. Fikrig S M. 1982. *Handbook of Immunology for Students and House Staff.* Verlag Chemic International, Florida.
8. Paul W E. 2008. *Fundamental Immunology*. Wolters Kluwer, USA.
9. Richard C. 2015. *Immunology A Short Course*. Wiley Blackwell, UK.
10. Sharma D K. 2015. *Immunology*. New India Publishing Agency, New Delhi.

Therapeutics in Aquaculture 2 (1+1)

Objectives

i. To learn the principles and protocols of drugs in aquaculture
ii. To impart knowledge of antibiotic used in aquaculture

Theory

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoans. Antibiotics used in aquaculture. Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders, and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anesthetics, flesh color enhancers, Chemicals of therapeutic value. Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices. List of the drugs used in aquaculture with therapeutics.

Practical

Regulations of drug use. Introduction to antimicrobials. Preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration (MIC). Five plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

Suggested Readings

1. Bryan L E. 1989. *Handbook of Experimental Pharmacology*. Vol 91. Springer-Verlag, Berlin.
2. Brown K M. 2000. *Applied Fish Pharmacology*. Kluwer Academic Press, London.
3. Herwig N. 1981. *Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases*. 272p. Charles C. TMhomas Publication.
4. Khory R N. 1999. *Material Medica of India and their Therapeutics*. Komal Prakashan, Delhi.
5. Lancaster R. 1980. *Pharmacology in Clinical Practice*. William Helnemann Medical Books Ltd., London
6. Moini J. 2009. *Fundamental Pharmacology*. Cengage Learning, New Delhi
7. Pandey G. 2017. *Fish Pharmacology and Toxicology*. DPH, New Delhi.

Coastal Zone Management 2 (1+1)

Objectives

i. To impart knowledge on the importance of coastal zones for human society
ii. To teach the students on the different management strategies for the conservation of coastal zones
iii. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Estuaries, Wet lands and Lagoons, Living resources – Non-living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application, and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities.

Practical

Field visit to different coastal environments to study erosion of beaches. Identification of ecologically sensitive areas and protection. Study of CRZ, ICZM along the coastal belt. Study on implementation and violation of CRZ. Study of application of remote sensing and GIS. Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation to combat disaster. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices. Project preparation of EIA.

Suggested Readings

1. Cairns J Jr. 1994. *Implementing Integrated Environmental Management,* Virginia Tech University.
2. Clark J R Ed). 2018. *Coastal Zone Management Handbook*. CRC Press.
3. Clark J R. 1992. *Integrated Management of Coastal Zones*. FAO Fisheries Technical Paper No. 327, Rome.
4. Coastal Area Management and Development 1982. U.N. Department of International Economic and Social Affairs, New York.
5. Krishnamurthy R R (Ed). 2008. *Integrated Coastal Zone Management*. Research Publishing Services.
6. Post J C and Lundin C G. 1996. *Guidelines for Integrated Coastal Zone Management* (Vol. 9). Washington, DC: World Bank.
7. Ramkumar M, James A, Menier D and Kumarswamy K. 2018. *Coastal Zone Management: Global Perspective, Regional Processes, Local Issue*. Elsevier
8. Sharma P. 2009. *Coastal Zone Management*. Global India Publications.
9. Vallega A. 2013. *Fundamentals of Integrated Coastal Management* (Vol. 49). Springer Science & Business Media.

Microbiology of Fish and Fisheries Products 2 (1+1)

Objectives

i. To teach nature and activity of microbes in fish and fishery products, microbiological spoilage and preservation.
ii. To teach in detail about food-borne microorganisms of human health significance, food-borne diseases and their prevention.

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food. Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi-processed, and processed fish and fishery products. Indicators of microbiological quality of fish and fishery

products. Food-borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter* and *Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practical

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

Suggested Readings

1. Aneja K R. 2008. *Textbook of Basic and Applied Microbiology*, New Age International (P) Limited, Publishers (New Delhi).
2. Baveja C P. 2022. *Text Book Microbiology*. Arya Publishing Comp.
3. Chakraborthy P. 1995. *A Text Book of Microbiology*. New Central Book Agency.
4. Criusted J. 1986. *Methods in Microbiology*. Academic Press.
5. Doyle M P, Beuchat L R and Montville T J. 1997. *Food Microbiology - Fundamentals and Frontiers*. American Society for Microbiology.
6. Fernandes R (Ed). 2009. *Microbiology Handbook: Fish and Seafood* (2nd Edn.). London (UK): Royal Society of Chemistry.
7. Maheshwaii D K. 1999. *A Text Book of Microbiology*. S. Chand Publishing.
8. Michael J, Pelizar J R and Chan E C S. 1998. Microbiology. McGraw Hill.
9. Narayanan R. 2013. *Food Microbiology: Basic and Applied with Laboratory Exercises*, New India Publishing Agency, New Delhi.
10. Roberts D, Hooper W and Greenwood M. 1995. *Practical Food Microbiology: Methods for the Examination of Food for Micro-organisms of Public Health Significance*, Public Health Laboratory Service (London).
11. William C F and Dennis C W. 2000. *Food Microbiology*. McGraw Hill

Refrigeration and Equipment Engineering 2 (1+1)

Objectives

i. To teach engineering aspects about refrigerators, freezers
ii. To learn about heat load calculation and COP. To teach electrical aspects of fishing vessel

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work - A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. Refrigeration plant: Layout of refrigeration plant, Construction and insulating materials used for the cold storage construction, Frozen product storage, capacity of cold storage, usage of Anteroom. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. Compressors: Definition, Types of compressors, construction, working principle, advantages and disadvantages. Evaporator: Definition, Types of Evaporators, construction, working principle, advantages and disadvantages. Condenser: Definition, Types of Condensers, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice-plant: Ice plant planning, Brine tank construction, preparation of brine. Types of ice, storing of ice, Equipment used in ice plants. Freezers: Definition, Design, and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated Sea water (RSW), Chilled Sea water (CSW). Refrigerated transport. Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study, and use of Psychrometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipment. Theory of machines: Transmission of power, friction wheels, shaft, gears, belt, and Chain drive. Study of equipment used in fish processing with reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practical

Drawing of Refrigeration and Fish processing machineries, plant layout. Graphically represented symbols used in refrigeration. Handling and operation of compressors, condensers, evaporators expansion valves, low- and high-pressure switches. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant, refrigeration plant, ice plant. Visit to fishing harbor or landing center to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

Suggested Readings

1. Ayyappan V P. 2002. *Elements of Electrical Technology*. CIFNET. Cochin.
2. Dincer I. 2017. *Refrigeration Systems and Applications*. John Wiley & Sons.
3. Joshy C D and Devadhason M. 2001. *Basic Electronics and Fish Finding Equipment*. CIFNET. Cochin.

4. Prasad M. 2011. *Refrigeration and Air Conditioning*. New Age International.
5. Shawyer M and Pizzali A M. 2003. *The Use of Ice on Small Fishing Vessels* (No. 436). Food & Agriculture Organization.

Navigation and Seamanship 2 (1+1)

Objectives

i. To learn engineering aspects of fish acoustic equipment
ii. To learn navigation and seamanship for fishing vessel safety

Theory

Principles of navigation –terms and definitions, finding positions and method of position fixing, magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay points, pelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and nonadjustable errors and principles and use. Hand lead line – construction and markings and method of taking soundings. Types of speed logs –patent log, impeller log. Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions. The IALA-buoy age systems, cardinal, and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations Indian coasts, Fog signals, types and methods. Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS. Principles of seamanship- Causes of fire at sea, fire prevention on board the vessel and method of firefighting at sea and recommended firefighting appliances. Lifesaving appliances – life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessels to face heavy weather. Temporary repairs for leaks constructions of the steering system and rigging emergency jury rudder. Types of anchors and their applications: selection of suitable anchorage, procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust, transverse thrust mooring and securing the vessel to the jetty, rigging fenders and gangways, and method of leaving vessels from the berth.

Practical

Anchoring, coming alongside the berth and leaving. Practicing the different types of knots and wire splices. Use of magnetic compass, GPS, Echo-sounder. CHART WORK - Finding positions by latitudes and longitudes by position lines, by cross-bearing, horizontal sextant, angles, vertical sextant angle and by running fix. Finding position by speed, distance and time. Finding set and drift of current and finding course. Steering course and finding position by counter acting the current observation of RADAR.

Suggested Readings

1. Ainslie M A. 2010. *Principles of Sonar Performance Modelling* (Vol. 707). Berlin: Springer.
2. Bennett J A. 2017. *Navigation: A Very Short Introduction* (Vol. 514). Oxford University Press.
3. CIFNET. 2004. Fishery Engineering.
4. FAO. 1998. *Fishing Operations. – Vessel Monitoring Systems*, *FAO Technical Guidelines for Responsible Fisheries No. 1, Suppl. 1,* FAO, Rome.
5. House D J. 2013. *Seamanship Techniques: Shipboard and Marine Operations*. Routledge.
6. Joshy C D and Devadhason M. 2001. Basic Electronics and Fish Finding Equipment. CIFNET. Cochin.
7. Larkin F J. 1998. *Basic Coastal Navigation: An Introduction to Piloting for Sail and Power*. Sheridan House, Inc.
8. Lawson T B (Ed). 1994. *Fundamentals of Aquacultural Engineering*. Springer Science & Business Media.
9. MacLennan D N and Simmonds E J. 2013. *Fisheries Acoustics* (Vol. 5). Springer Science & Business Media.
10. Mitson R B. 1998. *Fisheries Acoustics. Ocean Pulse: A Critical Diagnosis*. 137p.

Statistical Methods 3 (2+1)

Objectives

i. To learn basic statistical methods for research data analysis

ii. To teach statistical problems for analysis

Theory

Definition of statistics, Concepts of population, sample, Census and sample surveys. Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives. Important measures of central tendency - arithmetic mean, median and mode. Relative merits and demerits of these measures. Important measures of dispersion - Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis. Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression. Length-weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practical

Construction of questionnaires and schedules. Diagrams and frequency graphs. Calculation of arithmetic mean, median, mode, range, mean deviation, variance, standard deviation. Exercises on probability, Binomial and Poisson distributions, Area of normal curve, confidence interval for population mean, Test of hypothesis based on normal, t, and chi-square. Computation of Simple correlation and regression. Fitting of length-weight relationship in fishes.

Suggested Readings

1. Bruce P, Bruce A and Gedeck P. 2020. *Practical Statistics for Data Scientists: 50+ essential Concepts using R and Python*. O'Reilly Media.
2. Das N G. 2017. *Statistical Methods (vol. 1 and 2),* Tata McGraw Hill Education.
3. Das M N and Giri N C. 1979. *Design and Analysis of Experiments*. New Age International.
4. Gupta CB. 2009. *An Introduction to Statistical Methods, (23rd Edn.).* Vikas Publishing House.
5. Gupta S P. 2025. *Fundamentals of Business Statistics*. Sultan Chand & Sons.
6. Gupta C B. 2009. *An Introduction to Statistical Methods*. Vikas Publishing House.
7. Rangaswamy R. 1995. *A Text Book of Agricultural Statistics*. New Age International.
8. Wasserman L. 2013. *All of Statistics: A Concise Course in Statistical Inference*. Springer Science & Business Media.

Fisheries Policy and Laws 1(1+0)

Objectives

i. To familiarize various fisheries policy and laws of our country
ii. To gain in-depth knowledge on the fisheries and aquaculture policies for sustainable development

Theory

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of the department of fisheries, corporations and cooperatives. Different central and state-level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community-based resource management plans. Historical review of fisheries development and management in India and world. International agencies/organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries.

Suggested Readings

1. Burke W T. 1982. *Fisheries Regulations under Extended Jurisdiction and International law* (Vol. 223). Food & Agriculture Organization.

2. Churchill R R and Lowe A V. 1988. *Law of the Sea*. Manchester University Press.
3. Day J, Dudley N, Hockings M, Holmes G, Laffoley D D, Stolton S and Wells S M. 2012. *Guidelines for Applying the IUCN Protected Area Management Categories to Marine Protected Areas*. IUCN.
4. Henkin L. 1980. *International Law: Cases and Materials* (Vol. 10). West Publishing Company.
5. Holden M and Garrod D. 1996. *The Common Fisheries Policy: Origin, Evaluation and Future***.** *(*2nd Edn.). Fishing News Books Ltd.
6. Johnston D M. 2023. *The International Law of Fisheries: A framework for Policy-oriented Inquiries* (Vol. 3). Martinus Nijhoff Publishers**.**
7. Nakamura J. 2024. *Implementation of the Small-Scale Fisheries Guidelines: A Legal and Policy Scan*. Springer Nature.
8. Rawat U and Agarwal N K. 2015. Biodiversity: Concept, Threats and Conservation. *Environment Conservation Journal*, *16*(3): 19-28.
9. Mohamed K S, Vijayakumaran K, Zacharia P U, Sathianandan T V, Maheswarudu G, Kripa V, Narayanakumar R, Rohit P, Joshi K K, Sankar T V and Edwin L. 2017. CMFRI Marine Fisheries Policy Series No. 4; Indian Marine Fisheries Code: Guidance on a Marine Fisheries Management Model for India. *CMFRI Marine Fisheries Policy Series*. (4). 102p.
10. Raval N B. 2013. *Combating Marine Pollution: International Laws and Regulations*. 264p. Cyber Tech Publications.
11. Rothwell D R and Stephens T. 2023. *The International Law of the Sea.* 656p. Bloomsbury Publishing.

Fisheries Co-operatives and Marketing **2 (1+1)**

Objective

To familiarize students with basic concepts and principles of co-operative and marketing with reference to fisheries.

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account. Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization in fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification-

export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Practical

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

Suggested Readings

1. Briscoe R and Ward M. 2000. *The Competitive Advantages of Co-operatives*. Centre for Co-operative Studies, National University of Ireland, Cork.
2. Goel B B. 2001. *Re-inventing Co-operatives: A 21st Century Vision*. Deep and Deep Publications.
3. ICAR. 2003.*Text Book of Agricultural Marketing and Cooperation*, ICAR. New Delhi.
4. Krugman P R and Obstfeld M. 1991. *International Economics: Theory and Policy*. Harper Collins Publication.
5. Mahajan K A. 2003, *Cooperative Marketing*, Anmol Publications Pvt. Limited,
6. Ministry of Agriculture. Handbook of Fisheries Statistics. New Delhi.
7. Pinkerton E (Ed). 1989. *Co-operative Management of Local Fisheries: New Directions for Improved Management and Community Development*. UBC Press.
8. Porter G. 1998. *Fisheries Subsidies – Over Fishing and Trade*. Geneva.

Semester-VII

ELECTIVE COURSES

Elective (major/minor) Courses for VII Semester

S. No.	Course Title	Credit Hours
Major Courses (Students have the option to choose any Four Major Courses - 12 credits)		
1.	Open-water Aquaculture	3 (2+1)
2.	Smart Aquaculture Production Systems	3 (2+1)
3.	Fish and Shellfish Pathology	3 (2+1)
4.	Disease Diagnostic Techniques	3 (2+1)
5.	Sustainable Fisheries Management and Conservation	3 (2+1)
6.	Aquatic Pollution	3 (2+1)
7.	Fishery Oceanography	3 (2+1)
8.	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)
9.	Quality Assurance of Fish and Fishery Products	3 (2+1)

Minor Courses (Students have the option to choose any Four Minor Courses - 8 credits)		
1.	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)
2.	Aquatic Microbiology	2 (1+1)
3.	Climate Change and its Impact on Fisheries	2 (2+0)
4.	GIS and Remote Sensing in Fisheries	2 (1+1)
5.	Responsible and Sustainable Fishing Methods	2 (1+1)
6.	Principles and Techniques of Seafood Analysis	2 (1+1)
7.	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)
8.	Marketing Intelligence and Business Analysis	2 (1+1)
9.	ICT in Fisheries	2 (1+1)

A. Elective (Major) Courses

Open-Water Aquaculture 3 (2+1)

Objective

To learn about the open water resources and their enhancement of aquaculture production.

Theory

Overview of global scenario of aquaculture in open waters, open water resources in India, Present status, Utilization, Prospects of production augmentation, Utilization of open water bodies for aquaculture to enhance production. Salient features of open water limnology and their significance to fisheries development; management of small, medium and large water bodies; present status and future prospects in open water fish production. Recent advances in open water fisheries management; conservation measures in open water fisheries. Fish stocking in open water. Cage Culture: Role of cage in enhancement of fish production in reservoirs, estuaries, open sea and open water bodies; History of cage culture, advantages of cage culture; Cages for sea, estuaries, reservoirs, lakes and canals; Selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system; Different designs of open sea farming structures-construction of cages-bioengineering problems and solutions, Species selection for open water aquaculture, Rearing of fingerlings, advanced fingerlings and table size fish in open water bodies; Constraints in cage culture; Economics of cage culture; Integration of cage culture with other farming systems. Pen Culture: History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens; Suitable species for culture in pens; constraints in pen culture; economics of pen culture. Practices: Ranching in open waters, species quality and quantity, Natural feed enhancement, Supplementary feeding in cages and pens, Stock assessment, Harvesting and conflicts with irrigation, Drinking water and hydroelectric projects on open water farming. Environmental impact of Open water Aquaculture: Salinity intrusion, Effluent discharge, Eutrophication, Chemical residues including antibiotics and hormones, Destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.

Practical

Preparation of charts on the present situation of open water fisheries productivity. Different types of cage materials, fabrication of cages and pens and their installation. Determination of stocking density in cages and pens. Feeding in cages and pens. Stock assessment in cages and pens. Environmental impact of cages and pens. Case studies on cage and pen culture. Field visit to cage and pen culture site to acquaint with construction details and operation.

Suggested Readings

1. Aswathy N and Imelda J. 2020. Adoption of Small-scale Coastal Cage Fish Farming in the Southwest Coast of India: Opportunities and Challenges. *Israeli Journal of Aquaculture-Bamidgeh*, 72: 1-9.
2. Beveridge M C. 2008. *Cage Aquaculture*. John Wiley & Sons.
3. Burnell G and Allan G. 2009. *New Technologies in Aquaculture*. (1st Edn.). Woodhead Publishing House.
4. Chiu Liao I and Kwei Lin C. 2000. Cage Aquaculture in Asia, *In: Proceedings of the First International Symposium on Cage Aquaculture in Asia*, AFS and WAS Publ.
5. Lawson T B and Lawson T B. 1995. Aquaculture in Open Systems. *Fundamentals of Aquacultural Engineering*, pp.58-83.
6. Philipose K K, Loka J, Sharma S R and Divu D. 2012. *Handbook on Opensea Cage Culture*. Central Marine Fisheries Research Institute, Karwar.
7. Syda Rao G, Imelda-Joseph, Philipose K K and Suresh Kumar M. 2013. *Cage Aquaculture in India*. CMFRI Publ.

Smart Aquaculture Production Systems 3 (2+1)

Objective

To learn the advanced aquaculture production system research for different species globally

Theory

Introduction: An overview of global aquaculture production, demand- consumption scenario and emerging trends, Present status, Constraints and future prospects in India and the world, Aquaculture practices indifferent parts of the world, Enhancing carrying capacity in culture systems.

Biofloc technology: Principles of biofloc, Different carbon sources, Design of aeration system and biofloc reactor. Carrying capacity, C: N ratio, harvesting of biofloc, Biofloc quality and quantity, Biofloc as feed ingredient, Stocking of fish and shellfish species. Bioremediation in wastewater aquaculture. Minimal water exchange aquaculture systems: Principles of closed system farming, RAS, Components, design of mechanical and biological filters for the water reuse system, Sludge removal, disposal of wastes and control of pollution to the environment, Design of RAS, biofiltration and nitrifiers, Suitable cultivable species for indoor culture systems, polyhouses. Aquaponics: Principles, Components and design of different aquaponics systems, Components in aquaponics, ratio of fish and plants, Water quality and system maintenance, Resource utilization, Nutrient recycling and zero discharge of nutrients. Running water systems: Flow-through system, Raceways (IPR), IMTA, Partitioned Aquaculture Systems (PAS), Aquamimicry systems. Other

farming methods: Cluster farming, Organic farming, Satellite farming, co-operative farming and conservation aquaculture, Network of production and marketing aspects, Economics of super intensive farming systems, Advantages and disadvantages.

Practical

Design, fabrication and performance evaluation of biofloc systems; Different equipment in closed grow-out system; Aerators, Biofilters, RAS, Raceways, IMTA, PAS and aquaponics systems; Plankton and microbial analysis of biofloc. Studies on different C: N ratio; Nutrient analysis in aquaponics; Visit to hatcheries with super-intensive models. Identification and understanding the network of the systems; Market analysis for the produces; Analysis of economic advantages, case studies.

Suggested Readings

1. Avnimelech Y. 2015. *Biofloc Technology- a Practical Guidebook*. (3rd Edn.) World Aquaculture Society
2. Chakrabarti N M. 2014. Biology, Culture and Production of Indian Major Carps.
3. Felix S. 2008. *Biosecured Aquaculture- Principle and Prototype.* Agrobios (India)
4. Hu Z, Li R, Xia X, Yu C, Fan X and Zhao Y. 2020. A Method Overview in Smart Aquaculture. *Environmental Monitoring and Assessment*, 192: 1-25.
5. Kassem T, Shahrour I, El Khattabi J and Raslan A, 2021. Smart and Sustainable Aquaculture Farms. *Sustainability*. 13(19): 10685
6. Parra L, Sendra S, Garcia L and Lloret J., 2024. Smart Low-Cost Control System for Fish Farm Facilities. *Applied Sciences*, 14(14): 6244
7. Soderberg R W. 1995. *Flowing Water Fish Culture*. Lewis Publishers.
8. Tidwell J H. (Ed.). 2012. *Aquaculture Production Systems*. Wiley-Blackwell.
9. Wang C, Li Z, Wang T, Xu X, Zhang X and Li D. 2021. *Intelligent Fish Farm—the Future of Aquaculture*. *Aquaculture International*, pp.1-31.

Fish and Shellfish Pathology 3 (2+1)

Objective

To understand the structural and functional changes in cells, tissues and organs in relation to the development of various finfish and shellfish diseases.

Theory

General pathology: Brief introduction to finfish and shellfish anatomy and histology; General pathology of finfish and shellfish Pathophysiology of fish: Pathophysiology of finfish and shellfish; Stress and stressors; General adaptation syndrome; Types of cellular adaptations; Hypertrophy, hyperplasia, Atrophy and metaplasia, Neoplasia. Inflammation and cellular pathology: Reversible cellular changes and accumulations; Fatty changes and pigments; Inflammation; Causes of inflammation; Cellular responses to inflammation; Mediators; various patterns of inflammation; The difference between acute and chronic inflammation; Tissue repair; Cell death; Necrosis, Apoptosis, Autophagy; Necroptosis; Their mechanisms and different morphological patterns.

Clinical pathology: Normal constituents of blood; Alterations in the haematological parameters and enzymes with reference to different pathological conditions in finfish; Haematology of shrimp and molluscans; Clotting mechanisms; other host defence mechanisms.

Systemic pathology of finfish: Systemic pathology of finfish integumentary system, Respiratory system, Vascular system, Digestive system, Excretory system, Nervous system, Musculoskeletal and Endocrine system due to bacteria, Parasites and viruses. Systemic pathology of shellfish: Major pathological changes due to infectious diseases in the integumentary system, Lymphoid organ, Gill, Hepatopancreas, Gut and other organs of crustaceans; Major pathological changes due to diseases in molluscans.

Practical

Necropsy techniques. Collection and fixation of tissues. Complete histology and different staining techniques. Examination and interpretation of the pathological changes in fish tissues. Complete blood profile of finfish. Routes of blood collection from fish. Different staining techniques for blood cell visualization. Morphology of blood cells. Total leucocyte count. Differential leucocyte count.

Suggested Readings

1. Chong R S M. 2022. General introduction to pathophysiology of finfish, crustacea, and mollusks. *In: Aquaculture Pathophysiology*, pp. 49-71. Academic Press.
2. Coleman W B and Tsongalis G J. 2009. *Molecular Pathology*. Elsevier Publisher, Boston.
3. Couch J A and Fournie J W (Eds). 2021. *Pathobiology of marine and estuarine organisms*. CRC Press.
4. Ellis A E. 1985. *Fish and Shellfish Pathology*. Academic Press, London.
5. Ferguson H W. 2006. *Systematic Pathology of Fish*. Scotain Press, London.
6. Fernandes R (Ed). 2009. *Microbiology Handbook: Fish and Seafood*, (2nd Edn.). London (UK): Royal Society of Chemistry.
7. Killeen A A (Ed). 2001. *Molecular Pathology Protocols* (Vol. 49). Humana Press
8. Roberts R J. 2012. *Fish pathology*. John Wiley & Sons.
9. Salle A J. 1961. *Fundamental Principles of Pathology*. MacGraw-Hill Co., New York.
10. Sindermann C J. 1990. *Principal Diseases of Marine and Shellfish* (Vol. 1). Gulf Professional Publishing.

Disease Diagnostic Techniques 3 (2+1)

Objective

To comprehend theoretical and practical aspects of different disease diagnostic techniques used in aquaculture and to take appropriate decisions on fish health management and appropriate choice of treatment

Theory

Introduction to fish disease diagnosis: Introduction to disease diagnosis; different roles and levels of diagnosis in aquaculture; The evolution of diagnostic techniques in aquaculture; A brief

introduction to diagnostic features of important diseases of finfish and shellfish. Microbiological techniques: Safety in microbiology laboratory; Bio-safety levels and risk groups; Techniques in sterilization; Preparation of microbiological media. Culture Microscopic techniques: Bright field, Darkfield, Phase contrast, Fluorescence and electron microscopy. Cell culture-based diagnostic methods: Introduction to cell culture techniques; Different cells used for virus isolation; CPE. Protein-based diagnostic methods: Antibody-based diagnostic methods (immunohistochemistry, ELISA, western blotting, lateral flow assay etc.), Hybridoma technology and monoclonal-antibody-based diagnosis Nucleic-acid based diagnostic methods: Nucleic acid amplification methods; Types of PCR: Reverse transcriptase-PCR, Real-time PCR and Other variants of PCR; In situ hybridization; Dot blot assay; LAMP etc.

Practical

Sample collection and preparation for microscopic, microbiological, virological and histopathological analysis. Culture of microorganisms using conventional methods. Antibiotic sensitivity testing. Serological techniques in disease diagnosis: SDS-PAGE, Western blotting, ELISA, etc. Cell culture techniques; Molecular techniques in disease diagnosis, Nucleic acid extraction, estimation and different PCR-based diagnosis. Familiarization of some of the commercially available diagnostic kits used in aquatic animal disease diagnosis.

Suggested Readings

1. Austin B and Newaj-Fyzul A (Eds). 2017. *Diagnosis and Control of Diseases of Fish and Shellfish*. Chichester, UK. Wiley.
2. Austin B (Ed). 2012. *Infectious Disease in Aquaculture: Prevention and Control*. Elsevier.
3. Lucky Z. 1977. *Methods for the Diagnosis of Fish Diseases*. Amerind Publishing Co Pvt Ltd, New Delhi.
4. Noga E J. 2010. *Fish Disease: Diagnosis and Treatment*. John Wiley & Sons.
5. Roberts R J. 2012. *Fish Pathology*. John Wiley & Sons.
6. Shotts Jr E B. 1990. Diagnostic approaches for fish diseases. *In: Diagnostic Procedure in Veterinary Bacteriology and Mycology*. pp 507-517. Academic Press.
7. Sindermann C J. 1977. *Disease Diagnosis and Control in North American Marine Aquaculture*. Elsevier Scientific Publishing Company, Amsterdam.
8. Soto E, Boylan S M, Stevens B, Smith S A, Yanong R P, Subramaniam K and Waltzek T. 2019. Diagnosis of Fish Diseases. *In: Fish Diseases and Medicine*. pp 46-88. CRC Press.
9. Sugama K. 1998. *Manual of Fish Diseases Diagnosis*. Nippon Veterinary and Animal Science University, Japan.

Sustainable Fisheries Management and Conservation 3 (2+1)

Objectives

1. To understand the major sustainability issues of inland and marine fisheries resources of the world and India
2. To understand the ways and means of conservation of fisheries resource

Theory

Inland fisheries: Major inland fisheries resource of the World-India-Overview. State of the fisheries- Fishing gears-and crafts-Catch composition. Marine fisheries: Major marine

fisheries resources of the world and India. Overview- State of the fisheries -Fishing gears - Catch composition-pelagic, Demersal, Oceanic, Deep-sea. Sustainability issues in fisheries: Ghost fishing-Overexploitation, Overcapacity, pollution, Habitat degradation/ biodiversity loss. Damming of rivers. Interlinking of rivers, Environmental flows; Fishing Conflicts-Exotics; Trans-boundary issues, IUU fishing, inter-linking of rivers-Climate change, By-catch and discards. Sustainable fishing: Components of sustainability, Indicators and goals of sustainability, Eco-friendly fishing, Ecosystem Based Fisheries Management-resilient fishery system. Principle of fisheries Management-Management approaches-By catch reduction- Rebuilding fishery, Rebuilding stock, Co-management - right based fishing input control (fishing efforts, mesh regulations, fishing ban, licensing, capital investments, etc.) - output control (catch quotas, minimum legal size, etc.). Fishery reserve-technical measures. Spawning aggregates; trade agreement- Market-based instruments; Access right - Catch sharing-balanced Fishing-Subsidy-certification and Traceability-Sustainable management approach in lake, Reservoir and beels. Functions and importance of Aquatic habitats: Mangrove, Corals, Seagrass beds, and dunes, Turtle nesting grounds, horseshoe crab habitat; Role and functions of aquatic habitat; Human activities and pollution sources; Effects of Conservation Practices on Aquatic Habitats and Fauna. Aquatic habitat conservation: Freshwater habitat and Marine water habitat; Erosion and sediment control-transplantation-stocking-population stabilization. Fish refugee- *ex-situ* conservation. Responsible fishing practices Precautionary management -Fisheries co-management: Right-based fishing - Catch sharing access right - Balanced fishing. Technical Guidelines of CCRF for responsible fishing; National and International treaties (National policy on marine fisheries-2017; National policy on inland fisheries 2019; MFRA's; UNCLOS; UNFSA; IOTC).

Practical

Capture fisheries observation at lakes, reservoirs, river stretches, and marine landing centers. Species landings analysis. Interaction with manager's Co-operative societies and stakeholders. Fleet capacity assessment. Visit to fishery reserves to understand management. Field survey and observation of fisheries issues. Development of management plan. Suggest management plan for aquatic habitat protection- permit application form. Valuation of ecosystems – awareness on fisheries resource conservation. Visit to reservoir and assess the threats and developing plan for stock rebuilding.

Suggested Readings

1. Blaber J M. 1997. *Fish and Fisheries in Tropical Estuaries*. Chapman and Hall.
2. Chandra P. 2007. *Fishery Conservation, Management and Development*. SBS Publ. Dholakia AD.
3. Charles A. 2023. *Sustainable Fishery Systems*. John Wiley & Sons.
4. FAO. Technical Papers on Freshwater Fisheries.
5. Hilborn R C and Walters C J. 1992. *Quantitative Fisheries Stock Assessment*. Chapman and Hall. New York, New York.
6. Jhingran V G and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. *In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University*, Guwahati during 21-22 April 1987
7. Sugunan V V. 1997. *Reservoir Fisheries of India*. Daya Publ. House

8. McClanahan. 2000. *Coral Reefs of the Indian Ocean: Their Ecology and Conservation*. Oxford University Press.
9. Nath S. (Ed). 2008. *Recent Advances in Fish Ecology Limnology and Eco Conservation. Vol. VII*. Narendra Publ. House.
10. Phillipson J and Symes D. 2013. Science for Sustainable Fisheries Management: An Interdisciplinary Approach. *Fisheries Research*, 139: 61-64.
11. Ramachandra T V, Ahalya N and Murthy R. 2005. Aquatic Ecosystems: Conservation, Restoration and Management. *Aquatic Ecosystems-Conservation, Restoration and Management*, pp.26-50.
12. Rossiter J S and López-Carr D. 2011. Marine Conservation and Fisheries Management. *Marine Policy*, 35: 351-362.
13. Young T P. 2000. Restoration Ecology and Conservation Biology. *Biological Conservation*, 92(1): 73-83..

Aquatic Pollution **3 (2+1)**

Objectives

i. To impart knowledge on different aspects of aquatic pollution
ii. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment. Classification of pollution; Physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes; composition and pollution effects, sewage treatment and its reuse. Agricultural wastes; organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand (BOD, COD), Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution - Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Solid waste management.

Practical

Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphone,

phosphates, ammonia, nitrates, nitrites, heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Bacteriological tests of waste water: Coliform tests, IMVIC test, standard plate count. Methods of enumerating bacterial biomass in waters and waste waters. Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. (23rd Edn.). American Public Health Association, Washington D.C.
2. Baird D J, Beveridge M C M, Kelly L A and Muir J F. 1996. *Aquaculture and Water Resources Management*. Blackwell Science Ltd., Oxford.
3. Clark R B. 2001. *Marine Pollution*. Oxford University Press.
4. Czernuszenko W and Rowinski P. 2005. *Water Quality Hazards and Dispersion of Pollutants*. Springer Science and Business Media.
5. Gray N F. 2004. *Biology of Wastewater Treatment*. Oxford University Press, London.
6. Laws E A. 2000. *Aquatic Pollution: An Introductory Text*. John Wiley & Sons.
7. Mason C. 2002. *Biology of Freshwater Pollution*. (4th Edn.) Benjamin Cummings.
8. Peirce J J, Vesilind P A and Weiner R. 1998. *Environmental Pollution and Control*. Butterworth-Heinemann.
9. Qayoom I, Abubakr A, Gopinath A, Dar S A and Khurshid K. 2024. *Aquatic Pollution: Concerns and Abatement*. Taylor & Francis Group.

Fishery Oceanography 3 (2+1)

Objectives

i. To educate the students on the oceanographic concepts related to fisheries and impart skill to operate oceanographic equipment

ii. To understand the role of different oceanographic parameters on fisheries production

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification. Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El Nino and Southern Oscillation. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of

constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO_2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution. Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal.

Practical

Field visits and operation of oceanographic instruments - Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water. Use of tide tables. Fisheries forecasting systems. Oceanographic equipment and fish-finding devices.

Suggested Readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. Verlag Chemie, Weinheim.
2. Govoni J J. 2005. Fisheries Oceanography and the Ecology of Early Life Histories of Fishes: A Perspective over Fifty Years. *Scientia Marina*, *69*(S1): 125-137.
3. Kennish M J. 1989. *Practical Handbook of Marine Science*. CRC Press, New York.
4. Laevastu T and Hayes M L. 1981. *Fisheries Oceanography and Ecology*. Fishing News Books, Farnham, U.K.
5. Lalli C M and Parsons T R. 1993. *Biological Oceanography: An Introduction*. Elsevier Science Ltd., Oxford.
6. Miller C B. 2004. *Biological Oceanography*. Blackwell Publications, Oxford.
7. Pond S and Pickard G L. 2013. *Introductory Dynamical Oceanography*. Elsevier.
8. Reddy M P M. 2007. *Ocean Environment and Fisheries*, Science Publishers, USA.

Analytical Techniques in Aquatic Environmental Studies 3 (2+1)

Objective

To teach the student advance analytical techniques in aquatic environment studies

Theory

Qualitative and quantitative analytical techniques including Gravimetric and volumetric analyses used in environmental science, Sampling techniques and procedures, Factors affecting the choice of analytical techniques, Interferences and their minimization, Laboratory safety measures. Photometric techniques: Theory, instrumentation and application of spectrophotometry and spectroscopy, AAS, ICP-MS, Biosensor, Microscopic Techniques etc. Theory and applications of electrophoresis, Principles and uses of ultra-centrifugation, Tracer

Techniques, Isotopes in environmental analysis. Separation techniques: Chromatography – theory, instrumentation and applications of thin layer, paper, ion-exchange, size exclusion, high performance liquid and gas chromatography. Methods of preparing biological samples for chromatographic analysis GC-MS Unit. Bioanalysis techniques: Immunoassay – Principle, methods and applications and Biosensors – components, characteristics, applications, impacts and challenges. Nanotechnology: Preparation of nanoparticles, characterization and applications.

Practical

Eutrophication studies in natural waters - tanks and ponds Estimation of bio-indicator organisms in polluted waters. Bioremediation experiments using different bio-agents. Use of UV-visible Spectrophotometer for phosphate, nitrate other ions. AAS for analysis of heavy metals. Use of HPLC and GC-MS for analysis of pesticide and other volatile and semi volatile organic substances.

Suggested Readings

1. APHA (American Public Health Association). 2017. *Standard Methods for the Examination of Water and Wastewater*. (23rd Edn.). American Public Health Association, Washington D.C.
2. Cheremisinoff N P. 2002. *Handbook of Water and Waste Water Treatment Technologies*. Butterworth – Heinemann, Woburn.
3. Cairns J E. 2017. *Biological Monitoring in Water Pollution*. Elsevier.
4. Hussain C M and Kecili R. 2019. *Modern Environmental Analysis Techniques for Pollutants*. Elsevier.
5. Mitra S, Patnaik P and Kebbekus B B. 2018. *Environmental Chemical Analysis*. CRC Press.
6. Radojevic M and Bashkin V N. 1999. *Practical Environmental Analysis*. Royal Society of Chemistry.
7. Sakhare V B. (Ed.). 2007. *Advances in Aquatic Ecology. Vol. 1*. Daya Publishing House, New Delhi.
8. Zhang C. 2024. *Fundamentals of Environmental Sampling and Analysis*. John Wiley & Sons.

Quality Assurance of Fish and Fishery Products 3 (2+1)

Objective

To familiarize students with different aspects of quality management systems and evaluation techniques for seafood

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post-harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance program for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze-dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non-mandatory standards. Role of export

inspection council and export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India. Certification system for fish and fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish and fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality. Prerequisites to HACCP. Labelling for product traceability and Labelling requirements - National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products. Assessment of food safety program, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods. FSSAI, FDA, ISO. Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practical

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

Suggested Readings

1. Alasalvar C, Miyashita K, Shahidi F, and Wanasundara U. 2011. *Handbook of Seafood Quality, Safety and Health Applications*. Wiley-Blackwell, Oxford.
2. Bonnell A D. 2012. *Quality Assurance in Seafood Processing: A Practical Guide*. Springer Science & Business Media.
3. Bremner H A (Ed). 2002. *Safety and Quality Issues in Fish Processing*. Elsevier.
4. Huss H H. 2007. *Assessment and Management of Seafood Safety and Quality* (No. 444), Daya Publishing House, Delhi
5. Kanduri L and Eckhartt R A. 2002. *Food Safety in Shrimp Processing*. Fishing News Books.
6. Kreuzer R. 1971. *Fish Inspection and Quality Control*. Fishing News Books.
7. Shukla R K. 2006. *Total Quality Management Practicing Manager*. New Royal Book.

B. Elective (Minor) Courses

Coldwater Aquaculture and Recreational Fisheries 2 (1+1)

Objectives

i. To learn about the breeding and culture of different cold-water fishes and their importance as sport fisheries or recreation fisheries
ii. Eco-tourism and recreational aquaculture

Theory

Introduction: Status of coldwater fisheries in World with special reference to India, Biology, breeding and culture of trouts (*Oncorhynchus mykiss, Salmo trutta fario, Schizothoraichthys esocinus, S. longipinnis, S. niger, Schizothorax richadsonii*), mahseer *(Tor putitora, Tor tor, Tor khudree)*, common carp *(Cypinus carpio cummuinis, Cyprinus carpio specularis)*. Specific environmental parameters pertaining to cold water fish culture and metabolic interaction, Feeds suitable for cold water aquaculture. Culture of cold-water fishes: Construction and management of cold-water fish farms, Effect of exotic fish introduction on indigenous fish fauna, Polyculture of exotic carp in mid hill region based on three Chinese carps, post-harvest and harvest issues in trout with regards to cold water species, Special factors for consideration in cold water fish seed production and nursery rearing. Introduction to sport fisheries: Sports fishes and their life history, Equipment for sports fishing, fishing methods, area suitable for sports fishing, etc. Management and conservation of sports fisheries through aquaculture, Sport fisheries and tourism, recreational aquaculture. Issues and Desired Interventions: Potential and Innovative Strategies for the Development of coldwater Aquaculture in India- problems encountered in fisheries development of rivers supporting cold water fisheries.

Practical

Identification of coldwater fish species. Primary and secondary sexual characters in cold water fishes. Different breeding methods for cold water fishes. Identification of larval stages of trout and mahseer. Preparation of hatchery layout for coldwater fishes. Studies on different types of sports fishing equipment. Visit to coldwater fish hatcheries and farms.

Suggested Readings

1. Ayyappan S, Jena J K, Gopalakrishnan A and Pandey A K. 2006. *Handbook of Fisheries and Aquaculture.* ICAR, New Delhi
2. Boghen A D. 1989. Cold-Water Aquaculture in Atlantic Canada. Institut Canadien de Recherche Sur Le Development Regional, Atlantic Coast, Canada
3. Jhingran V G and Sehgal K L. 1978. Cold Water Fisheries of India. *J. Inland. Fish. Soc. India. Sp. Publ.*
4. Mahanta P C and Sarma, D. 2010. *Coldwater Fisheries Management*. ICAR, New Delhi
5. Royce W F. 1996. *Introduction to the Practice of Fishery Science, (*Revised Edition). Elsevier.
6. Singh H R and Lakra W S. 2008. *Coldwater Aquaculture and Fisheries*. Narendra Publishing House.
7. Singh A K, Sarma D, Akhtar M S and Baruah D. 2017. *Souvenir – National seminar on strategies, innovations and sustainable management for enhancing cold water fisheries and aquaculture*. ICAR-DCFR, Bhimtal.
8. Stickney R R and Gatlin III D M. 2022. *Aquaculture: An Introductory Text*. CABI Publication.

Aquatic Microbiology 2 (1+1)

Objective

To impart knowledge on aquatic microorganisms with reference to their role in the aquatic environment and bioprospecting.

Theory

Distribution and classification: Microbial community in freshwater; Estuarine and marine environment (types and abundance); Factors affecting microbial growth and abundance. Microbial interaction: Microbial degradation of persistent organic pollutants (POPs); Microorganisms and public health: Water-borne pathogens of public health importance - Protozoans, bacteria, enteroviruses; Microbial toxins; Algal toxins; Disinfection methods; Microbial standards for different water uses. Principles and applications of bioprocesses: Bioremediation, Biofertilization, Biofilms, Biofloc, Probiotics, Bio-leaching, Bio-corrosion, Bio-fouling; Microorganisms as Bioindicators and Biosensors. Methods of assessing microbial biomass production; Bioprospecting: Current practices in bioprospecting and biopiracy; Microbial metabolites and its industrial application.

Practical

Isolation, identification and enumeration of algae and bacteria from polluted aquatic habitats. Maintenance of algal and bacterial cultures. Microbial sensitivity testing. Bio-activity testing. Disinfection methods.

Suggested Readings

1. Bertrand J C, Caumette P, Lebaron P, Matheron R, Normand P and Ngando T S (Eds.). 2015. *Environmental Microbiology: Fundamentals and Applications*, pp. 659-753. Dordrecht, The Netherlands. Springer.
2. Dhevendaran K. 2008. *Aquatic Microbiology*. Daya Publishing House, New Delhi.
3. Droop M R and Jannasch H W. 2012. *Advances in Aquatic Microbiology.* (Vol.1). 388p. Academic Press.
4. Frobisher M, Hinsdill R D, Crabtree K T and Goodheart C R. 1974. *Fundamentals of Microbiology*. WB Saunders Company, Philadelphia.
5. Maier R M, Pepper I L and Gerba C P. 2009. *Environmental Microbiology*. (2nd Edn.). 624p. Academic Press.
6. Rheinheimer G. 1992. *Aquatic Microbiology*. John Wiley and Sons.
7. Sigee D C. 2005. *Freshwater Microbiology*. 517p. Wiley Publisher.
8. Vernam A H and Evans M. 2000. *Environmental Microbiology*. Blackwell Publishing, UK.

Climate Change and its Impact on Fisheries 2 (2+0)

Objectives

i. To understand global warming, its impact on the aquatic environment and fisheries
ii. To know about the different legislation across the country to combat climate change

Theory

Weather and climate, Greenhouse effect, Radiative balance, Climatic migration, Carbon Sequestration and trading, Projected trends of climate change and disasters. Climate change, its impacts, Aquatic ecosystem, Capture and culture fisheries, Carbon footprint in fisheries and aquaculture. Oceanographic factors in fisheries: Effects of physio-chemical and biological oceanographic factors on adaptation; Behaviour, abundance and distribution of aquatic organisms;

Primary and secondary productivity in ocean under changing climate. Ocean acidification, Global Ocean circulation, Upwelling and circulation patterns, El Nino and Southern Oscillation, IPCC and its reports, UNFCCC, Kyoto Protocol, Politics of climate change. Forecasting systems: Fisheries forecasts – Interpretation and use of ocean thermal structure; Fisheries forecasting system in India and other countries: Application of Remote sensing and GIS in fisheries; Application of echo-sounders and SONAR; Potential fishing zones. Factors affecting marine fisheries. Adaptation and mitigation measures for Climate change; Vulnerability assessment; Climate-resilient aquaculture; Climate-smart villages.

Suggested Readings

1. Galappaththi E K, Susarla V B, Loutet S J, Ichien S T, Hyman A A and Ford J D. 2022. Climate change adaptation in fisheries. *Fish and Fisheries*, 23(1): 4-21.
2. Grasshoff K, Ehrhardt M and Kremling V. 1983. *Methods of Seawater Analysis*. Verlag Chemie, Weinheim.
3. Hulme M. 2009. *Why we Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity*. Cambridge University Press.
4. Kennish M J. 1989. *Practical Handbook of Marine Science*. CRC Press, New York.
5. Laevastu T and Hayes M L. 1981. *Fisheries Oceanography and Ecology*. Fishing News Books, Farnham, U.K.
6. Miller C B. 2004. *Biological Oceanography*. Blackwell Publications, Oxford.
7. Ninawe A S, Indulkar S T and Amin A. 2018. Impact of Climate Change on Fisheries. *In: Biotechnology for Sustainable Agriculture,* Woodhead Publishing pp. 257-280.
8. Phillips B F, Pérez-Ramírez M (Eds.). 2017. *Climate Change Impacts on Fisheries and Aquaculture: A Global Analysis (Vol-1)*. John Wiley & Sons.
9. Reddy M P M. 2007. *Ocean Environment and Fisheries*, Science Publishers, USA.
10. Schmutter K, Nash M and Dovey L. 2017. Ocean Acidification: Assessing the Vulnerability of Socioeconomic Systems in Small Island Developing States. *Regional Environmental Change*, 17(4):973-987

GIS and Remote Sensing in Fisheries — 2 (1+1)

Objective

To learn to use GIS and Remote sensing to foster the sustainable use of natural fisheries resource.

Theory

Aerial Photography: Basics of photography- terminologies- Photogrammetry - Stereoscopy - Principal points - Parallax and its measurement, Colours - Composite colour images. Remote Sensing - Electromagnetic Spectrum - Radiation laws - Interaction with atmosphere and surfaces, Spectral reflectance of earth materials and vegetation, Satellite Remote Sensing - Resolution - Scanning - Sensors, Land Observation Satellites - Visual image interpretation. Image and Data: Digital image processing, Image rectification and Image enhancement - Filtering - Band rationing, Image classification - Supervised and unsupervised classification, Remote sensing application

in soil and water conservation. GIS - Types, raster, vector, Database management systems, Data types, Spatial - non-spatial, Spatial data models, Spatial referencing, Map projections, Data input, Editing, Encoding, Raster data analysis, Vector data analysis. Satellite Application: NOAA and IRS-Satellites for Ocean and Fisheries studies, Digital image processing and interpretation, Application of remote sensing and GIS to fisheries and aquaculture planning and development. PFZ- Basics and application- Validation of PFZ data- INCOIS- Data Dissemination. Fishermen knowledge in PFZ.

Practical

Study of satellite information, interpretation of satellite pictures for resource management. Case studies on remote sensing and GIS applications. Development of GIS with local parameters related to fisheries. INCOIS data processing and interpretation. Collection and Validation of INCOIS and PFZ data. INCOIS data dissemination methods among coastal fishermen. Survey of effectiveness and usefulness of PFZ data.

Suggested Readings

1. Bhatia B. 2008. *Remote Sensing and GIS*, Oxford University Press, New Delhi.
2. Josef G. 2005. *Fundamentals of Remote Sensing*, Universities Press (P) Limited, Hyderabad.
3. Kumar S. 2005. *Basics of Remote Sensing and GIS,* Firewell Medi, Laxmi Publications, New Delhi.
4. Meaden G J and Aguilar-Manjarrez J. 2013. *Advances in Geographic Information Systems and Remote Sensing for Fisheries and Aquaculture.* FAO Fisheries and Aquaculture Technical Paper 552.

Responsible and Sustainable Fishing Methods 2 (1+1)

Objectives

i. To teach various responsible fishing techniques for conservation of biodiversity.
ii. To learn various fishing methods and gears for the sustainable exploitation of aquatic resources

Theory

CCRF: Scope and objectives of FAO Code of conduct for Responsible Fisheries, Articles of CCRF – Description of the code, Analysis of marine catch data (present and past); analysis of CCRF concept. Definition of sustainability, Rules and regulations for sustainable fishing, Properties of a sustainable fishery, Present scenario and problems of sustainable fishing, Trends in global and Indian fishery, Environmental defects. By-catch: Elaboration of Article 8 – Fishing operations; By-catch and discards – Definitions, By-catch estimation methods, by-catch reduction devices, turtle excluder devices, Finfish and shrimp excluder devices. Selective fishing gear and practices: Selectivity of trawls, gill nets and lines – Environmentally friendly fishing methods and fishing gears – Energy conservation and resource enhancement. Fish Aggregation Devices (FADs and Artificial reefs): Objectives, Types of FADs and artificial reefs; Design and construction of FADs and artificial reefs; Energy optimization in fisheries – Methods of energy conservation in fish harvesting. Remote Sensing and PFZ: Application of Remote sensing, PFZ and GIS in fisheries. IUU - Illegal, Unregulated and Unreported fishing methods; Destructive and prohibited fishing systems and practices. Effect of fishing on non-target species. Impacts of unsustainable

fishing: Habitat degradation due to bottom trawling, purse seining, Habitat modification, changing the ecosystem balance, Climate change, Ocean pollution, Disease and toxin. Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Conservation methods issues and implications for biodiversity. Remediation for sustainable fishery, Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Awareness campaigns, Sustainable fishing gears and devices, designing of eco-friendly long line, Eco-friendly gillnet, Eco-friendly trawl net, Techniques reducing the risk of unsustainability, Eco-friendly fishing methods and gears.

Practical

Study of design and operation of BRDs and TEDs. Preparation of document listing and prohibited fishing practices. Compilation of package of practices for energy conservation. Designing of eco-friendly fishing devices, square mesh cod end, traps with escape vents, designing of longline with circular hooks. Interpretation of SST and Ocean colour charts. Study of Potential Fishing Zone (PFZ) maps. Problems on fishing gear selectivity. Studies on impact of various fishing gears on the environment and biodiversity.

Suggested Readings

1. CIFNET Module III and IV. Code of Conduct for Responsible Fisheries. 61-69pp.
2. FAO. 1995. *Code of Conduct for Responsible Fisheries*. 41p. FAO, Rome.
3. FAO. 1996. Fishing Operations, *FAO Training Guidelines for responsible fisheries No.1,* 26p. FAO, Rome.
4. FAO. 2003. *Fisheries Management 2: The Ecosystem Approach to Fisheries*, FAO, Rome.
5. Maheswari K. 2011. *Sustaining Marine Fisheries,* Sonali publication, New Delhi.
6. Kaiser M J and de Groot S J. 2000. *Effects of Fishing on Non-Target Species and Habitats: Biological, Conservation and Socio-Economic Issues*. 399p. Fishing News Books. Blackwell Science: Oxford.
7. Sinha P C. 2007. *Fishing Conservation Management and Development*. SBS Publishers and distributers Pvt. Ltd, New Delhi.
8. Edwin L, Thomas S N, Remesan M P, Ashraf P M, Baiju M V and Manju Lekshmi N. 2020. *FAO Code of Conduct for Responsible Fisheries-Fishing Operations*. FAO, Rome.

Principles and Techniques of Seafood Analysis 2 (1+1)

Objective

To provide knowledge on various instrumental techniques in seafood analysis

Theory

Separation of molecules: General principles of separation of micro and macro-molecules, Selection of appropriate tools for analysis of fish samples, Outlines of common techniques involved in biochemical analysis. Filtration and centrifugation techniques: Different types of filtrations, Types of filters and means of using them; Types of centrifugations (preparative and analytical), concept of Svedberg unit, Selecting appropriate rotor, Relative centrifugal force. Viscoelastic

properties, Rheology, Tribology, TPA; IR and FTIR spectrophotometry, Spectro-fluorimetry, ICP, Atomic absorption mass spectrometry, Tandem MS/MS. Microscopy: Fluorescence microscopy, SEM, TEM, XRD. Electrophoresis: General principles, types (native, denatured PAGE, 2D). Chromatographic techniques; General principle, Types of chromatography: adsorption, partition, ion-exchange, molecular sieve, affinity, liquid and gas chromatography (GC), thin layer chromatography, HPLC, GCMS, LCMSMS.

Practical

Characterization of proteins based on solubility: sarcoplasmic, myofibrillar, and stroma; Estimation of proteins - Biuret techniques, Lowry techniques, Dye binding technique and electrophoretic techniques. Amino acid analysis by HPLC. Fatty acid analysis by GC MS, Minerals and heavy metals by Atomic Absorption spectroscopy. Texture analysis by TPA. HPLC- determination of histamine. Demonstration of GC-MS-MS.

Suggested Readings

1. Ewing G W. 1997. *Analytical Instrumentation Handbook*. Marcel Dekker.
2. Nollet L M and Toldrá F (Eds.). 2009. *Handbook of Seafood and Seafood Products Analysis*. CRC Press
3. Otles S. 2016. *Handbook of Food Analysis Instruments*. CRC Press.
4. Pare J R J and Belanger J M R. 1997. *Instrumental Methods in Food Analysis*. Elsevier.
5. Robyt J F and White B J. 1990. *Biochemical Techniques - Theory and Practice*. Waveland Press.
6. Wilson K and Walker J. 2000. *Practical Biochemistry - Principles and Techniques*. Cambridge University Press.
7. Wilson R H (Eds.). 1994. *Spectroscopic Techniques for Food Analysis*. CABI Digital Library

Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products 2 (1+1)

Objective

To create basic understanding about Trade Regulations, Certification and documentation in export of fish and fishery products.

Theory

Trade policy and Legislation on labelling and other standards: Foreign Trade Policy of Fish and Fishery Products in Indian context and world context, labelling requirements of Fish and Fishery products stipulated by National and International Organizations. Regulations: Export documentation- certificates of origin. Other certificates for Shipment of specific goods, Export licenses; Import regulations, SPS-TBT agreement. Export Certification systems: Consignment-wise, in process Quality, Self-Certification, Food safety management system, Pre-shipment inspection, Voluntary food certification scheme, Certificate for export (CFE), Health certificate. Other certification, Traceability issues for farm reared and wild aquatic products; Dealing with returned consignments; foreign trade regulations in India.

Practical

Documentation protocol for approval of fishing vessel, processing unit and technologist in processing plants. Labelling codes for Traceability of products in Export trade. Preparation of BOL and LC. Preparation of documents for seafood export to different destinations. Study of documents on customs and port procedures for seafood export and import.

Suggested Readings

1. Batra G S and Kaur Narinder. 1995. *Foreign Trade and Export Policy*. Anmol Publications
2. Cherian Jacob. 1997. *Export Marketing*, Himalaya Publishing House.
3. Mittal A C. 1991. *Export Management in India*. Om Sons Publications.
4. Rathore Kumkum. 1994. *Export Marketing*, Arihant Publishing House.
5. Shinoj P A, Kumar B G, Joshi P K and Datta K K. 2009. *Export of India's Fish and Fishery Products: Analysing the Changing Pattern/Composition and Underlying Causes.* Indian Journal of Agricultural Economics. 64(4): 541-556.
6. Suresh A, Panda S K, Chandrasekar V. 2023. *Export of Fishery Products from India: Status, Challenges and the Way Forward. Current Science*, 124(6): 664-670.

Marketing Intelligence and Business Analysis 2 (1+1)

Objective

To give an idea about the marketing intelligence and business analysis applied in the fisheries sector

Theory

Research methodology: The role of marketing intelligence in the firm, The process of marketing research, The difference between exploratory and confirmatory research, Secondary and primary data, Qualitative and quantitative research methodologies, Sampling theory. Requirements in business analysis: Management, Communication, Tracing, Configuration and change management, quality assurance, Development, Elicitation including stakeholders and/or product requirements development, Specification. Business analytics: Business Analysis, Internal analysis, External analysis, Business need definition, Gap analysis, Solution proposal (including feasibility analysis), Solution delivery or maintenance program/project initiation- Business process definition, Business goals, Business needs, Business requirements, Limitations and assumptions. Modelling and forecasting: Solution modelling, validation and verification, Solution evaluation and optimization, Assessing the solution options (proposals), Evaluating performance of the solution, Solution/business process optimization, Model Volatility with ARCH and GARCH for Time Series Forecasting. Marketing research: Definitions of the various methodological concepts -Various steps involved in designing a research plan, Data collection methods; Characteristics, Structure, Sources, Value, and use of Big Data. The relationship between digital analytics and inbound marketing strategies, Consumer information and measurement services, Rules for designing a questionnaire. Data analysis in marketing research: Data sources for assessing consumer preferences, firm performance, and market condition and competition- analyze

enterprise data, especially for purposes of segmentation, targeting, positioning, and evaluating consumer value- process of organizing, writing, framing, and refining analytics reports- delivering effective presentations, and aligning analytic results with stakeholder needs and preferences.

Practical

Marketing Research – ethics, standards and issues. Utilization of Secondary Data Resources for Customer Segmentation Pricing and Elasticity. Linear Regression, Basics; Using Linear Regression to Forecast. Conjoint Analysis; Digital Marketing Metrics Customer Lifetime Value; Cluster Analysis. Finding and interpreting secondary data. Suggesting a methodology for fisheries marketing research. Tools and concepts of data visualization.

Suggested Readings

1. Carlson C C and Wilmot W W. 2006. *Innovation: The Five Disciplines for Creating What Customers Want*, New York: Crown Business.
2. eNAM – National Agricultural Market https://enam.gov.in
3. Harrington H. James. 1991. *Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness. Inspires Innovation*, Harper Collins.
4. Malhotra N K. 2020. *Marketing Research: An Applied Presentation or Orientation or Presentation*. Pearson Publication.
5. MPEDA – Marine Products Export Development Agency – mpeda.gov.in
6. NFDB- National Fisheries Development Board – nfdb.gov.in.
7. Sharda R, Delen D, Turban E, Aronson J and Liang T. 2014. Business Intelligence and Analytics. *System for Decesion Support*.
8. Struhl S. 2015. *Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence*. Kogan Page Publishers.

ICT for Development 2 (1+1)

Objective

To orient students on advances in ICT initiatives, knowledge management process smart/ disruptive technologies and data analytics

Theory

ICTs – meaning, concepts, roles and initiatives, basics of ICTs, Global and National status, Types and functions of ICTs, Meaning of e-Governance, e-learning, m-Learning, Advantages and Limitations of ICTs. Knowledge management: Meaning, Approaches and Tools, Role of ICTs in Agricultural Knowledge Management, e-Extension, overview on Global and national e-Extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGOs in India**.** ICT applications: Knowledge centres (tele centres), CSC, Digital kiosks, Web portals, Community radio, Internet radio, Kisan call centres, Mobile based applications, INCOIS-PFZ advisories; Self-learning CDs on Package of practices, Augmented Learning, Virtual Learning, social media, Market Intelligence

and Information Systems-e-NAM, Agmarknet, etc. Expert System/ Decision Support System/ Management Information Systems, Farm Health Management and Intelligence System for Plant /Animal/ Soil Health, Fishery, Water, Weather, etc., National e-Governance Plan in Agriculture (NeGP-A). Networks and policies: Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Coursera, EduEx, etc.); Digital networks among extension personnel, Farmer Producers Organisations (FPOs) / SHGs/ Farmers Groups, Video conference, Live streaming and Webinars, types and functions of social media applications, Guidelines for preparing social media content, Engaging audience, Data-analytics and Info graphics. Smart technologies for extension: Open technology computing facilities, System for data analytics/ mining/ modelling/ Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU). Disruptive technologies Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), Blockchain technology, Social media and Big Data analytics for extension.

Practical

Content and client engagement analysis. Case studies and exercises on ICT-based interventions in fisheries and agriculture. Designing extension content for ICTs; Creating and designing web portals, blogs, social media pages. Development and use of online and offline e-learning modules in fisheries. Live streaming extension programs and organizing webinars. Visit to KCC; Exercises on developing mobile-based applications. Developing social media pages for disseminating fisheries-related information. Writing for digital media. Developing video content related to fisheries. Conducting exercise on remote sensing and GIS.

Suggested Readings

1. August E Grant and Jennifer H Meadows (*Eds.*). 2012. *Communication Technology Update and Fundamentals*, Focal Press, USA.
2. Batchelor S, Hearn S, Peirce M, Sugden S and Webb M. 2003. *ICT for Development: Contributing to the Millennium Development Goals - Lessons Learned from Seventeen info Dev Projects*, World Bank publications.
3. Elder L, Emdon H, Fuchs R and Petrazzini B. *(Eds.).* 2013. *Connecting ICTs to Development*: *The IDRC experience,* Anthem Press, London.
4. Heeks R. 2017. *Information and Communication Technology for Development (ICT4D).* Routledge
5. ICTs for Development (http://ict4dblog.wordpress.com/).
6. Shamsitdinova, M. 2020. Implementation of IT and ICT into Education: Multimedia Technologies in Creating and Using Electronic Books. *Theoretical & Applied Science,* 11: 5-10.

Semester-VIII

Student READY (Students Entrepreneurship Awareness Development Yojana) Program containing the following four components:

i) Rural Fisheries Work Experience (RFWE)
ii) Experiential Learning Program (ELP)
iii) In Plant Training/ Industrial Attachment
iv) Students Projects
v) Seminar

1. Rural Fisheries Work Experience (RFWE) Program**:** Students will be attached in the fisher's villages for a minimum of 8 weeks to accustom with the rural fisheries activities like fish farming, fish breeding, hatchery operation, fishing in the river and seas, preparation of fishing crafts etc. It will be conducted with the help of the fisheries extension officers of the state Govt. of the respective states and teachers appointed by the Dean of the respective college. A total of 6 credits are allotted for the program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college/university and fisheries officers engaged for the program.

2. Experiential Learning Program (ELP): Students will be completing an ELP at least in two areas which should be decided by each university/college. Areas of specialization for Experiential Learning Program are (i) Ornamental fish culture, (ii) Seed Production, (iii) Trade and export management, (iv) Aqua-clinic, (v) Post Harvest technology, (vi) Aqua- farming. A total of 6 credits are allotted for Experiential Learning Program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college.

3. In-Plant training/Industrial Attachment**:** Students will be attached in the fish farms/ hatcheries/ feed plant/ fish processing plant etc. in the Govt./ Private/ NGO organizations for a minimum of 8 weeks. The company/farms/organization will be issued a courses completion certificate of each student after completion of the course. A total of 5 credits are allotted for the program and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college/university.

4. Project work: Student will be selected relevant or interested area of specialization such as Ornamental Fish Production, Fish Genetics and Breeding, Fish Nutrition, Fish Pathology, Fish Health Diagnosis, Fish Pharmacology, Fish Toxicology, Fish Immunology, Fish Stock Assessment, Aquatic Pollution, Fish Value Addition, Fish Processing Waste Management, Quality Control and Quality Assurance of Fishery Products, Fish Products and By-products etc. He/she will prepare a research project plan and it will be presented in front of the committee appointed by the Dean of the respective college/university. Also, for each student, one advisor will be provided, who will guide the student in the completion of the proposed research plan. A total of 2 credits are allotted for project work and 1 credit for seminar (completed project work presentation). The evaluation for the same will be conducted by the committee appointed by the Dean of the respective college/university with the advisor of the student.

5. Seminar

SKILL ENHANCEMENT COURSES

- Students will be offered Skill Enhancement Course (SEC) consisting of courses from different areas to provide intensive Hands-on-training on campus or off Campus. Students may choose SIX Skill Enhancement Courses from the basket of SEC in 1st to 4th Semesters.
- University may introduce more Skill Enhancement Courses based on the available facilities and prospect of local employment and entrepreneurship development as well as expertise/ resources available
- Students may opt UGC recommended short skill enhancement courses also (a list of skill development training areas as given in the main report).

S. No.	Course Title	Credit Hours
Aquaculture		
SEC-I	Fish/Shellfish Breeding and Hatchery Operation	2 (0+2)
SEC-II	Fish/Shellfish Seed Rearing	2 (0+2)
SEC-III	Fish/Shellfish Grow-out Production Management	2 (0+2)
SEC-IV	Breeding and Culture of Ornamental Fish	2 (0+2)
SEC-V	Integrated Fish Farming	2 (0+2)
SEC-VI	Non-conventional/Diversified Farming Practices (Pearl Farming/ Seaweed Farming/ Aquaponics/Microalgae Production, etc.)	2 (0+2)
SEC-VIII	Fish Feed Production and Marketing	2 (0+2)
SEC-XIII	Aquarium Making, Decoration and Management	2 (0+2)
Aquatic Environment Management		
SEC-VII	Analytical Techniques (Testing of Water, Soil, Feed etc.)	2 (0+2)
Aquatic Animal Health Management		
SEC-IX	Laboratory Techniques for Fish Pathogen Detection	2 (0+2)
Fish Processing Technology		
SEC-X	Preparation and Marketing of Value-Added Products	2 (0+2)
SEC-XII	Preparation of Fish By-Products and Waste Utilization	2 (0+2)
SEC-XVI	Fish Handling, Transportation and Preservation	2 (0+2)
SEC-XVII	Bio-chemical Analysis of Fish and fisheries products	2 (0+2)
Fishing Technology and Engineering		
SEC-XIV	Net Making and Mending	2 (0+2)
Fishery Extension, Economics and Statistics		
SEC-XV	Start-up and Incubation in Fisheries	2 (0+2)
SEC-XVIII	Data Analysis and Computation	2 (0+2)
SEC-XIX	Fish Market Survey and Value Chain Analysis	2 (0+2)
Others		
SEC-XX	Any other relevant to the region, which may be decided by the College	2 (0+2)

ONLINE COURSES

- SAUs/CAUs will be free to include more online courses of 10 crdits (as per UGC guidelines for online courses) as a partial requirement for the B. F. Sc programme. Student will take in online mode, with approval from Dean of the SAU/CAU/College.

Indicative List of Online Courses on SWAYAM/MOOCs/Others

S. No.	Course Title	Duration	Credits
1.	Climate-smart fisheries and aquaculture (FAO)	16 weeks	4
2.	Food loss and waste in fish value chain (FAO)	12 weeks	3
3.	Biostatistics (SWAYAM)	12 weeks	3
4.	Econometric Analysis (SWAYAM)	15 weeks	4
5.	Fisheries Ecosystem Approach to Fisheries (FAO)	12 weeks	1
6.	Sustainable Management of Biodiversity (SWAYAM)	12 weeks	3
7.	Indian Agriculture Development (SWAYAM)	16 weeks	4
8.	Environment Sustainability (SWAYAM)	6 weeks	1
9.	Artificial Intelligence (SWAYAM)	15 weeks	4
10.	Communication Technology in Education (SWAYAM)	15 weeks	4
11.	Knowledge Society (SWAYAM)	15 weeks	3
12.	NGO'S and Sustainable Development	15 weeks	4
13.	Counseling Psychology	12 weeks	3
14.	Gender Sensitization: Society Culture and Change	16 weeks	4
15.	Psychology of Stress, Health and Well-being	12 weeks	3
16.	Environmental Law (SWAYAM)	16 weeks	4
17.	Food Microbiology and Food Safety (SWAYAM)	15 weeks	4
18.	Intellectual Property (SWAYAM)	15 weeks	4
19.	Introduction To R (SWAYAM)	12 weeks	3
20.	Research Methodology (SWAYAM)	15 weeks	4
21.	Nanotechnology Applications in Fisheries	8 weeks	2
22.	Personality Development and Communication Skills	8 weeks	2
23.	Public Speaking	8 weeks	2
24.	Personality Development	8 weeks	2
25.	Emotional Intelligence	8 weeks	2
26.	Yoga Practices 1	12 weeks	3
27.	Yoga Practices 2	12 weeks	3
28.	Ethics: Theories and Applications	12 weeks	3
29.	Information Sources and Library Services	6 weeks	1
30.	Qualitative Research Methods and Research Writing	12 weeks	3
31.	Extension and Communication Management	12 weeks	3

Minimum Standards for Establishing a College of Fisheries Science

- **Degree Nomenclature:** B. F. Sc (Bachelor of Fisheries Science)

1. **Minimum intake (per year):** 60
2. **Faculty**:

A. **Core faculty: 22**

Aquaculture (0+1+2), Fisheries Resource Management (0+1+2), Fish Processing Technology (0+2+2), Aquatic Environment Management (0+1+2), Fish Engineering (0+1+2), Aquatic Animal Health Management (0+1+2), Fisheries Extension Economics & Statistics (0+1+2)

B. **Allied faculty**: Faculty for Mathematics, computer science, Sociology, Psychology, English, Food Science and Technology, Microbiology, Agrometerology and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. **Land requirement (ha):** 10
4. **Essential Instructional units:**

Hatchery complex	0.5 ha
Nursery pond (4)	0.01 ha
Rearing pond (2)	0.1 ha
Stocking pond (2)	0.5 ha
Brooder pond (2)	0.5 ha
Laboratories and instructional facilities as per V Deans' Committee report.	-
ELP units to be established under skill development or Entrepreneurial mode	0.5 ha

5. **Divisons/Departments/Sections:**
   - Department of Aquaculture (AQ)
   - Fisheries Resource Management (FRM)
   - Department of Aquatic Animal Health Environment (AAHM)
   - Department of Aquatic Environment Management (AEM)
   - Department of Fish Processing Technology (FPT)
   - Department of Fish Engineering (FE)
   - Department of Fisheries Extension Economics & Statistics (FEES)

6. **Faculty Expertise**

Department	Faculty Expertise
Aquaculture	- Inland Aquaculture - Freshwater Aquaculture - Brackish water Aquaculture - Mariculture - Ornamental fish culture - Cage Culture - Culture of Fish Food organisms

Department	Faculty Expertise
	- Aquaponics - Finfish & shellfish breeding and seed production - Brood stock and hatchery management - Aquaculture Engineering - Fish Farm Management Fisheries
Resource Management	- Anatomy & Biology of Fishes - Population Dynamics - Stock Assessment - Taxonomy of Fishes - Marine, Inland & Brackishwater Fisheries - Fishery Regulations and Laws - Conservation & Biodiversity Fish
Processing, Technology	- Fishing gear & craft technology - Equipment Engineering & plant maintenance - Refrigeration Engineering - Marine Engines - Navigation & Seamanship - Fishing Technology - Freezing Technology - Thermal processing - Fish Processing, Product Development and waste utilization - Quality Control - Packaging Technology
Aquatic Environment Management	- Analytical Water & Soil Chemistry - Limnology - Meteorology - Physical, Chemical and Biological Oceanography - Geography - Aquatic Pollution - Aquatic Environment & Biodiversity - Planktonology
Fish Engineering Department of Aquatic Animal Health Management	- Fish Engineering - Fish Microbiology - Immunology - Parasitology - Pathology - Fish Disease diagnostics and management

Department	Faculty Expertise
Fisheries Extension, Economics, and Statistics	- Anat - Fisheries Administration - Project Formulation & Finance - Extension Programme Planning - Co-operative & Marketing management - Computer Science - Fisheries Statistics - Fisheries Economics - Rural Sociology & Extension education - Communication Skills - Business Organisation &Personnel Management

7. Non-Teaching Staff:

Department	Assistant	Attendant/ Messenger	Clerk	Laboratory Assistant/ Attendant
Aquaculture	1	2	1	4
Fisheries Resource Management	1	2	1	2
Fish Processing, Technology	1	1	1	4
Aquatic Environment Management	1	1	1	2
Fish Engineering	1	1	1	2
Department of Aquatic Animal	1	1	1	2
Health Management Fisheries Extension, Economics, and Statistics	1	1	1	2
Total	**7**	**9**	**7**	**18**

8. Manpower Requirements of Dean s Office

Manpower	Number
Dean	1
A. Establishment	
PA to Dean	1
Administrative Officer	1
Superintendent	3
Steno	1
Assistant	3
Operator (Audio Visual)	1
Attendants/Messengers	4
Clerk (LDC)	4
Electrician	1

Manpower	Number
Plumber	1
Store Keeper	1
Security, Sanitation, transport and Landscaping	To be outsourced
B. Central Instrumentation Facilities	
Computer Assistant	1
Laboratory Technicians	2
Laboratory Assistant	1
Laboratory Attendant	3
C. Library Staff Assistant Librarian	1
Library Assistant	1
Clerk	1
Library attendant	2
D. Instructional Fish Farm & Hatchery Farm Manager	1
Field Assistant	1
Laboratory Assistant	1
Field Attendant	2
Field Staff / Fishermen	20
Security	(to be outsourced)
E. Students Welfare Assistant Director (Students' Welfare)	1
Medical Officer	1
Assistant Professor (Physical Education for Boys and Girls)	1+1
F. Hostel (Boys and Girls) Wardens	1+1
Assistant Wardens	1+1
Clerk (LDC)	2
Attendants	4
Security, Sanitation, Boarding and Landscaping	To be outsourced

9. Floor Space Requirement

A. Central Facilities

Sl. No.	Details	Number of Rooms	Dimensions (ft)
1.	Dean office	1	20 × 24
2.	PA room	1	20 × 12
3.	Committee room with video conferencing facility	1	20 × 48

Sl. No.	Details	Number of Rooms	Dimensions (ft)
4.	Administrative officer room	1	20 × 12
5.	Admin. Staff rooms	3	20 × 36 each
6.	Examination cell	1	20 × 12
7.	Evaluation room	1	20 × 36
8.	Faculty room	1	20 × 12 each
9.	Placement cell	1	20 × 48
10.	Smart Lecture rooms	8	Seating capacity –50
11.	Auditorium (optional)	1	Seating capacity – 300
12.	Library/Book bank	1	30 × 72
13.	Examination hall (optional)	1	Seating capacity – 300
14.	Multipurpose room	1	20 × 36
15.	Laboratories	25	30 × 48 each / as per requirement
16.	Hostels	2 Hostels	UG and PG Boys, UG and PG Girls
17.	Generator shed	1	20 × 36
19.	Toxic chemical waste storage/disposal Unit	1	20 × 24
20.	Canteen	1	20 × 12 (kitchen) and 20 × 36 (Seating)
21.	Toilets		2 sets for each floor
22.	Parking space	As per requirement	For college and hostels
23.	Vehicles: Office car Staff car/Jeep/Bus/Pick-up van	1311	

B. Departments

Sl. No.	Detail	Number of rooms	Dimensions (ft)
1.	Head of the Department	8 (one for every Department)	20 × 24 each
2.	Administrative Staff	8 (one for every Department)	20 × 36 each
3.	Faculty room	21 (as per faculty strength)	20 × 24 (3 rooms)
			20 × 12 (18 rooms)
4.	Rooms for Research Scholars	8 (one for every Department)	20 × 24 each
5.	Committee room cum library	8 (one for every Department)	20 × 36 each
6.	Smart Lecture cum seminar room	8 (one for every Department)	Seating capacity–50 each

10. Equipments Requirement

A. Central Instrumentation Facility

Sl.No.	Name of the Equipment	Number
1	Cold room -20°C	1
2	-80°C freezer	1
3	Chill room 4°C	1
4	High Speed Centrifuge	1
5	HPLC	1
6	GCMS	1
7	Gel doc system	1
8	Real time PCR	1
9	Research Vessel	1
10	Ultra Centrifuge	1
11	Programmable Freezer (Cryopreservation)	
12	Water Purification Unit	As per requirement
13	Ice flaker	1
14	Freeze Dryer	1
15	Atomic Absorption Spectrophotometer (AAS)	1
16	Automatic Tissue Processor	1
17	Microtome	1
18	Inverted Microscope	1
19	Generator	1

B. Instructional Farm Facilities

Sl.No.	Name of the Equipment	Number
1.	1 Nursery ponds	20
2.	2 Rearing Ponds	8
3.	3 Stocking ponds	4
4.	4 Brood stock ponds	4
5.	5 Chinese Circular hatchery	1
6.	6 Wetlab facilities	As per requirement
7.	7 Re-circulatory Systems	1

C. Departmental Laboratories

Sl. No.	Name of the Equipment	Total number
1.	–20°C Freezer	7
2.	–80°C Freezer	3
3.	Autoclaves	7
4.	Biosafety Cabinet	3

Sl. No.	Name of the Equipment	Total number
5.	Centrifuge	7
6.	Refrigerated Centrifuge	7
7.	Cryo-cans	6
8.	Analytical balance	7
9.	Stirrer	7
10.	Spectrophotometer	7
11.	Research Microscope	70
12.	Micropipette set	7
13.	Thermocycler	7
14.	Waterbath (Digital)	7
15.	Salino meter (Refracto meter)	6
16.	Dissolved oxygen analyzer	2
17.	Hot air oven	7
18.	Kjeltec for protein estimation	1
19.	Soxhlet for fat estimation	1
20.	Muffle furnace	2
21.	Microtome	1
22.	Fish deboning machine	1
23.	Fish drying & smoking kiln	1
24.	Vacuum packing machine	1
25.	Modified atmosphere packaging	1
26.	pH meter	7
27.	Computers	7
28.	Incubator	7
29.	Digital colony counter	3
30.	Binocular Microscope	140
31.	Bomb Calorimeter	1
32.	Automatic Water Analyzer	2

FOOD NUTRITION AND DIETETICS

Course Curricula For Undergraduate program in Food Nutrition and Dietetics: UG- Certificate in Food Nutrition and Dietetics; UG-Diploma in Food Nutrition and Dietetics; B.Sc. (Hons.) Food Nutrition and Dietetics

INTRODUCTION

Food Nutrition and Dietetics is a linking discipline between the agricultural food production system and the human health management system. It deals with the science which manages normal nutrition and health situations of the entire population of the country. The Food Nutrition and Dietetics program had come under the umbrella of ICAR in the 5th Deans' Committee Report, and the program is currently running in six agricultural universities, namely, MPUA&T, Udaipur; PAU, Ludhiana; CAU, Tura; TNAU, Madurai; AAU, Assam and SDAU, Gujarat. This program was taken up by the ICAR because improvement in food production has not improved the nutrition situation among Indians. In order to meet global nutrition targets by 2030, India needs a food distribution system, nutrition education, nutritional intervention and a continuous program monitoring team. However, there is dearth of nutritionists and dieticians in the country. Research estimates indicate that India lacks around 2.5 lakh dieticians. The Government is keenly observing the nutrition situation of the population and has rolled out several programs like Prime Minister's Overarching Scheme for Holistic Nutrition (POSHAN Abhiyan).

To strengthen the professional landscape for allied and healthcare services in India, the Government of India enacted the *National Commission for Allied and Healthcare Professions Act, 2021,* as notified in the Gazette. The Act, which aims to standardized and regulate the education and practice of various allied and healthcare professions, defines an Nutrition Science Professional as a person who follows a scientific process to assess, plan, and implement programmes to enhance the impact of food and nutrition on health, promote good health, prevent and treat disease, and optimize the health of individuals, groups, communities, and population, as well as human health, with training in food and nutritional science, nutrition, and dietetics. This includes both Dieticians (including Clinical

Dieticians, Food Service Dieticians) and Nutritionists (including Public Health Nutritionists, Sports Nutritionists). Recognizing the growing importance of such roles, the curriculum for Food Nutrition and Dietetics has been developed and revised in alignment with the National Education Policy (NEP) 2020.

The present report is an outcome of the valuable suggestions and recommendations of 6th Deans' Committee members after multistage, in-depth deliberations and discussions in virtual meetings and personal communications with the Deans and faculty members. The restructuring process followed consultations with Deans of Home Science/ Community Science colleges, Heads of Department senior faculty members of food and nutrition, meetings with stake holders like students, industry partners, government officials, dieticians etc. After several rounds of consultations, the contents of the restructured course curricula have been developed. The restructuring of undergraduate programs in Food Nutrition and Dietetics was undertaken in accordance with the National Education Policy (NEP) 2020 to build a strong foundation of knowledge among students, coupled with enhanced practical exposure and skill development, thereby fostering competence and confidence in applying acquired knowledge. The curriculum has been designed to include core essentials while promoting holistic learning through critical thinking, inquiry, discovery, discussions analysis, and problem-solving. The program emphasizes holistic development—learning now to learn, character building, and nurturing well-rounded individuals. Key features include basic skill enhancement courses, exposure visits, case studies, industry attachments, flexible course selection through fourth-year electives and online offerings, and advanced skill development via project work or experiential learning. The structure also incorporates multiple entry and exit options in line with NEP 2020 guidelines.

HIGHLIGHTS

- The whole course program of 4 years B.Sc. (Hons.) Food Nutrition and Dietetics will be of 177 credit hours, which will have 167 credits offered by the parent university and 10 credit hours of online courses taken by the student as per his/ her choice.
- After the admission of students in the university, the students will register for the Foundation program of 2 weeks' duration in the 1st semester. The course will include discussions on operational framework of academic process in university, sessions from alumni, business leaders, academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills.
- Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The students will have to do common courses under following categories like Multi- Disciplinary Courses, Value-Added Courses, Ability Enhancement Course, NSS/NCC etc.

- The first year of the course is dedicated for skill development in Food, Nutrition and Dietetics areas with few introductory courses. The skill enhancement courses (SEC) of 8 credit hours will be offered during Semester-I and Semester-II of first year with flexibility to students as per NEP-2020 guidelines. After satisfactory completion of 43 credits of courses in two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Food Nutrition and Dietetics on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- An institution (university or college) may work independently or in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running various skill enhancement courses. In such cases, while the parent institution will control admission process, develop the content, delivery module of the program and monitor the learning and skill development by students, the evaluation can be done jointly by the collaborating partners.
- The second year has been designed with the basic courses as well as fundamental courses in food science, human nutrition and normal dietetics with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications in the discipline. Students will be studying 4 credits of SEC in second year also. After satisfactory completion of the courses of 2nd year (total 84 credits for the two years) and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Food Nutrition and Dietetics on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- University/HAEI may offer courses in any area as identified by it, based on institutional expertise/capabilities/resources.
- Any of the Skill Enhancement Courses (SEC) as suggested by UGC can be considered for inclusion in the curriculum.
- The third-year courses have been designed to impart specialized knowledge to the students in the major disciplines i.e. Food Science, Nutrition Science and Dietetics and Hospitality Management. Students may opt courses from one or more options. The students, from other disciplines, who wish to take minor courses from Food Nutrition and Dietetics may opt any one elective module and take desired number of credits in consultation with faculty mentor.
- During the 5th semester, the students will have a study tour/ industry visit of 10-14 days duration, which will be of 2 credits (Non-gradial).

- Students shall have elective courses in VII Semester for the award of degree i.e. B.Sc. (Hons.) Food Nutrition and Dietetics.
- In the fourth year of the course the focus is on strengthening of the knowledge and skill, and also on developing confidence of the students to take up either nutrition counselling or therapeutic counselling for patients. entrepreneurship, hands-on-training internship, in-plant training and project work has been kept in addition to the basket of elective courses. The student will have the option to choose the internship or training module in consultation with a faculty mentor. In-plant training may be conducted in split manner in more than one industry/ organization/ institutions.
- There will be adequate choice of electives/ specialization for the students, in the 4th year. The Universities will have flexibility to include more courses as Electives depending on specific needs and expertise available. The objective is to enable the student to acquire deeper understanding in any particular field.
- The core and elective courses can also be modified maximum up to 30% with approval from competent authority of the University.
- The students will take 10 credits of online courses either from MOOC/Swayam/ NPTEL/ mooKIT/ edX/ Coursera or any other portal accepted by the University preferably during the third and fourth year as a partial requirement for the B.Sc. (Hons.) Food Nutrition and Dietetics.
- The online courses may relate with the main discipline or from any other discipline like social science, psychology, anthropology, economics, business management, agriculture, veterinary, language/humanity, music, etc. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.
- These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- After satisfactory completion of fourth year course requirements of 167 credits and online courses of 10 credits, the student will become eligible for the award of Degree in B.Sc. (Hons.) Food Nutrition and Dietetics.

Entry and Exit Options

The entry and exit options for the B.Sc. (Hons.) program in Food Nutrition and Dietetics are shown in the Figure 1 below:

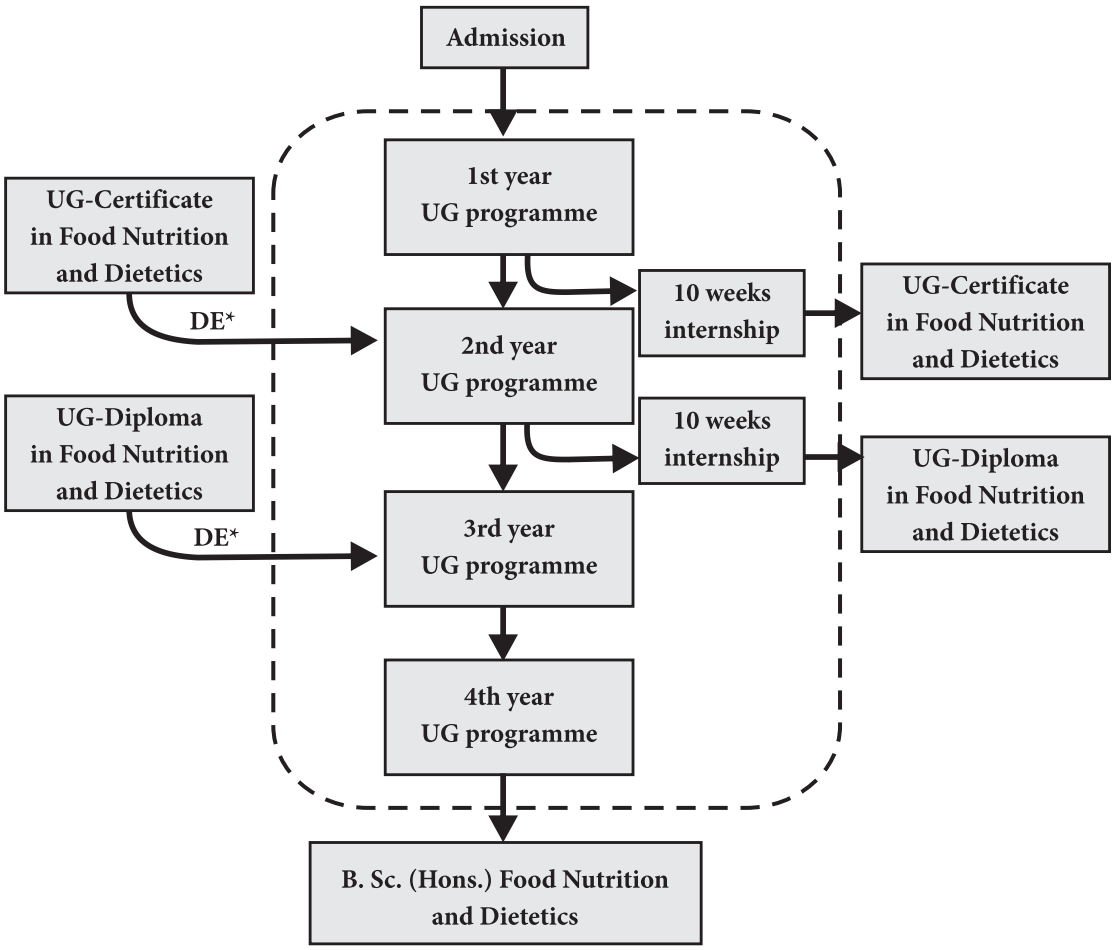


Fig.1 Entry and Exit options for the UG programs in Food Nutrition and Dietetics

DE* Direct Entry in the Respective Year

Exit options

- **UG-Certificate in** Food Nutrition and Dietetics (Exit after first year and completion of 10 weeks' internship)
- **UG-Diploma in** Food Nutrition and Dietetics (Exit after second year and completion of 10 weeks' internship)
- **B.Sc. (Hons.)** Food Nutrition and Dietetics (On successful completion of four-year degree requirements)

Admission Eligibility for entry into 1st year UG Programme: 10+2 Science with Biology or Mathematics as one subject/Agriculture or as per the admission criteria of SAU/ICAR/HAEI.

ACADEMIC PROGRAM

Semester	Course Title	Credit Hours	Total Credits
First Year			
Semester I			
1.	*Deeksharambh* (Induction cum Foundation Course)	2 (0+2) NG Non-gradial	**22 (9+13)**
2.	Introduction to Food Science and Nutrition	3 (3+0)	
3.	Principles and Practices of Food Preparation	2 (1+1)	
4.	Indian Cuisinology	2 (0+2)	
5.	Nutritional Status Assessment	3 (2+1)	
6.	Convenience and Health Food Formulation	2 (0+2)	
7.	Farming based Livelihood Systems	3 (2+1)	
8.	Skill Enhancement Courses (SEC-I)*	2 (0+2)	
9.	Skill Enhancement Courses (SEC-II)*	2 (0+2)	
10.	Communication Skills	2 (1+1)	
11.	NSS-I/ NCC-I	1 (0+1)	
Semester II			
1.	Bakery Science and Technology	3 (2+1)	**21 (8+13)**
2.	Nutritional Program Surveillance	3 (1+2)	
3.	Food Preservation and Storage	2 (0+2)	
4.	Personality Development	2 (1+1)	
5.	Entrepreneurship Development and Business Management	3 (2+1)	
6.	Environmental Studies & Disaster Management	3 (2+1)	
7.	Skill Enhancement Courses (SEC-III)*	2 (0+2)	
8.	Skill Enhancement Courses (SEC-IV)*	2 (0+2)	
9.	NSS-II/NCC-II	1 (0+1)	
Post-II Semester (Only for exit option for UG-Certificate)			
1.	Internship** (10 weeks)	**10 (0+10)***	
Second Year			
Semester III			
1.	Principles of Human Nutrition	4 (4+0)	**22 (15+7)**
2.	Fundamentals of Food Science	2 (1+1)	
3.	Community Nutrition and Education	3 (2+1)	
4.	Human Physiology	3 (2+1)	
5.	Economics and Food Business Management	2 (2+0)	
6.	Food Psychology	2 (2+0)	
7.	Skill Enhancement Courses (SEC-V)*	2 (0+2)	
8.	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
9.	Food Nutrition and Agriculture	2 (2+0)	

Semester	Course Title	Credit Hours	Total Credits
Semester IV			
1.	Normal Nutrition and Meal Planning	3 (2+1)	**20 (13+7)**
2.	Public Health Nutrition	3 (2+1)	
3.	Nutritional Biochemistry	3 (3+0)	
4.	Food Standards and Quality Control	3 (2+1)	
5.	Skill Enhancement Courses (SEC-VI)*	2 (0+2)	
6.	Agriculture Marketing and Trade	3 (2+1)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
Post-IV Semester Internship (Only for exit option for award of UG- Diploma)			
1.	Internship*** (10 weeks)	**10 (0+10) ***	
Third Year			
Semester V			
1.	Therapeutic Nutrition	4 (3+1)	**21 (13+8)**
2.	Food Analysis	3 (2+1)	
3.	Current Food Processing Technologies	3 (2+1)	
4.	Statistical Methods	3 (2+1)	
5.	Diet and Nutrition Counselling	3 (0+3)	
6.	Nutraceuticals and Health Foods	2 (2+0)	
7.	Introduction to Clinical Nutrition	3 (2+1)	
8.	Educational Tour (10-14 days)	2 (0+2) Non-gradial	
Semester VI			
1.	Food and Nutrition Security	2 (1+1)	**21 (13+8)**
2.	Nutrition, Body Composition and Physical Fitness	3 (2+1)	
3.	Food Microbiology	3 (2+1)	
4.	Milk Processing and Technology	3 (2+1)	
5.	Cereals and Millets: Processing and Technology	3 (2+1)	
6.	Sustainable Nutrition	3 (2+1)	
7.	Hospitality Management	2 (1+1)	
8.	Food Hygiene and Sanitation	2 (1+1)	
Fourth Year			
Semester VII			
S. No.	**Course Title**	**Credit Hours**	**20**
1.	Ethics in Human Research	1(1+0)	
2.	Seminar	1(0+1)	
3.	Elective courses (totaling credit hours of 18)* * From basket of a valuable elective courses	18	
	Total	**20**	

Semester	Course Title	Credit Hours	Total Credits
	Semester VIII		
	Student READY **Option A (Any Two)**	10 (0+10)	**20**
	I. In-Plant Training (10 weeks) **** II. Student Project***** III. Hands on Training (Experiential Learning) **Option B** Internship******	10 (0+10) 10 (0+10) 20 (0+20)	**166**

*From the basket of available SEC modules
**Mandatory requirement for UG-Certificate.
*** Mandatory requirement for UG-Diploma.
**** In plant training / attachment with Industry/ Research Institute.
***** The student project will be R&D based/ field study based/ entrepreneurship based (incubation/ experiential learning)
****** The internship can be taken in service Industry (e.g. Hospital or Hotel) OR in Production Industry (e.g. Food/ nutraceuticals Industry) OR in Food Quality and Analysis Laboratories

Department/ section wise course breakup

	Course Title	Credits	Total
Foundation courses			
	Deeksharambh (Induction-Cum-Foundation Course (2 weeks)	0+2 (NG)*	4 (0+4) *Credits not included in the total
	Physical Education, First Aid, Yoga Practices & Meditation	2 (0+2)	
Common Courses			
Multidisciplinary courses (MDC) 9 credits	Farming based livelihood systems	3 (2+1)	21 (12 + 09)
	Entrepreneurship Development & Business Management	3 (2+1)	
	Agriculture Marketing and Trade	3 (2+1)	
Value Added courses(VAC) (6 credits)	Environmental Studies and Disaster Management	3 (2+1)	
	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
Ability Enhancement Courses (AEC) 8 credits	NSS-I/ NCC – I	2 (0+2)	
	Communication Skills	2 (1+1)	
	Personality Development	2 (1+1)	
Nutrition and Dietetics			
Core courses	Nutritional Status Assessment	3 (2+1)	50 (34+16)
	Nutritional program Surveillance	3 (1+2)	
	Principles of Human Nutrition	4 (4+0)	
	Community Nutrition and Education	3 (2+1)	
	Human Physiology*	3 (2+1)	
	Normal Nutrition and Meal Planning	3 (2+1)	
	Public Health Nutrition	3 (2+1)	
	Nutritional Biochemistry	3 (3+0)	
	Therapeutic Nutrition	4 (3+1)	

	Course Title	Credits	Total
	Diet and Nutrition Counselling	3 (0+3)	
	Nutraceuticals and Health Foods	2 (2+0)	
	Introduction to Clinical Nutrition	3 (2+1)	
	Food Nutrition and Agriculture	2 (2+0)	
	Food and Nutrition Security	2 (1+1)	
	Nutrition, Body Composition and Physical Fitness	3 (2+1)	
	Sustainable Nutrition	3 (2+1)	
Skill Enhancement Courses under SEC Modules	Assessment of clinical signs and symptoms	2 (0+2)	08 (0+8)
	Development of nutritional educational material	2 (0+2)	
	Web designing and multimedia production	2 (0+2)	
	Development of audio-visual aid	2 (0+2)	
Food Science			
Core courses	Introduction to Food Science and Nutrition	3 (3+0)	32 (19+13)
	Principles and Practices of Food Preparation	2 (1+1)	
	Convenience and Health Food Formulation	2 (0+2)	
	Bakery Science and Technology	3 (2+1)	
	Food Preservation and Storage	2 (0+2)	
	Fundamentals of Food Science	2 (1+1)	
	Food Standards and Quality Control	3 (2+1)	
	Food Analysis	3 (2+1)	
	Current Food Processing Technologies	3 (2+1)	
	Food Microbiology	3 (2+1)	
	Milk Processing and Technology	3 (2+1)	
	Cereals and Millets: Processing and Technology	3 (2+1)	
Skill Enhancement Courses under SEC Modules	Jam jelly preparation	2 (0+2)	18 (0+18)
	Cake making	2 (0+2)	
	Indian traditional sweets	2 (0+2)	
	Cake decoration and icing	2 (0+2)	
	Pickle preparation	2 (0+2)	
	Candy making	2 (0+2)	
	Savory Snack preparation	2 (0+2)	
	Ready to eat snacks	2 (0+2)	
	Sugar processing and confectionary	2 (0+2)	
Institutional Food Service and Hospitality Management			
Core courses	Indian Cuisinology	2 (0+2)	18 (12+6)
	Food Psychology	3 (2+1)	
	Economics & Food Business Management*	2 (2+0)	
	Hospitality Management	3 (2+1)	
	Food Hygiene and Sanitation	3 (2+1)	

	Course Title	Credits	Total
Skill Enhancement Courses under SEC modules	Hygiene management in food service units	2 (0+2)	10 (0+10)
	Quality control in food processing units	2 (0+2)	
	Development of project proposals	2 (0+2)	
	Laboratory analysis	2 (0+2)	
	Practical Skills in Writing and Speaking	2 (0+2)	

- In addition, there are courses/ credits for internship, in plant training, project, online courses; as per the specific program.
- *Basic Supporting Course

Table 1. Credits Allocation Scheme of UG Food Nutrition and Dietetics program (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3[2]		1[3] + 2[4]	4	-	22	2[1]		**10**
II	8	3[5]	3[6]	1[3] + 2[7]	4	-	21	-	10[12]	
III	18	--		2[8]	2	-	22	-		
IV	12	3[9]	3[10]	----	2	-	20	-	10[13]	
V	21	-	-	-	-	-	21	2[11]		
VI	21	-	-	-	-	-	21	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167+10***	**4**		**10***

[1] *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2weeks duration)

[2] Farming based Livelihood systems

[3] NCC/NSS

[4] Communication Skills

[5] Entrepreneurship Development and Business Management

[6] Environmental Studies and Disaster Management

[7] Personality Development

[8] Physical Education, First Aid, Yoga Practices & Meditation

[9] Agriculture Marketing and Trade

[10] Agriculture Informatics & Artificial Intelligence

[11] Study tour (10-14 days)

[12] Only for those opting for an exit with UG-Certificate

[13] Only for those opting for an exit with UG-Diploma

Summary of credit distributions

Type of courses		Credits
Core courses (major and minor/s)	:	112
Skill Enhancement Courses (SEC)	:	12
Common courses (MDC+VAC+AEC)	:	23
Elective courses	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	**167+10****

Food Nutrition and Dietetics is a multi-disciplinary subject and have perfect amalgamation of many disciplines. Hence, choice of skill based and Elective courses will be offered to student from basket of Skill Enhancement Course modules to develop required skill competency in both first year and second year for UG Certificate in Community Science or UG-Diploma in Community Science at the first exit or second exit, respectively. The online learning through digital environment like MOOC's/SWAYAM, courses will further complement and open new avenues to pursue the passion of the student within the whole span of four years of the degree program.

**Massive open online courses

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Course)- Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Helpings in for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in University
3. Instilling life and social skills
4. Social awareness, ethics and values, team work, leadership, creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Introduction to Food Science and Nutrition 3 (3+0)

Objectives

i. To make student understand basic nutrients, their functions, requirements and availability in different food groups

ii. To understanding of the changes that occur in foods during preparation, processing and preservation.

iii. To understanding the nutritive value of different foods and methods of preserving them during cooking.

Theory

Introduction and overview of basic principles of nutrition. Relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition - recommended dietary allowances, balanced diet, health, functional foods, phytochemicals, nutraceuticals, dietary supplements, food groups. Concepts of food science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.). Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavors, colors, miscellaneous bioactive compounds, important reactions). Food microbiology (bacteria, yeast, molds, spoilage of fresh and processed foods, production of fermented foods). Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.). Food and nutrition, malnutrition (over and under nutrition), nutritional disorders. Energy metabolism (carbohydrate, fat, proteins). Balanced/ modified diets. Menu planning. New trends in food science and nutrition. Food Groups.

Suggested Readings

1. Gopalan C, Rama Sastri B V and Balasubramanian S C. 2011. *Nutritive Value of Indian Foods*. National Institute of Nutrition, ICMR, Hyderabad.
2. Gurtherie H A. 1989. *Introductory Nutrition*. Times Mirror, St. Louis.
3. Joshi S A. 1999. *Nutrition and Dietetics*. Tata McGraw Hill Publishing Co Ltd, New Delhi.
4. Khader V. 2003. *Food, Nutrition and Health*. Kalyani Publishers, Ludhiana.
5. Potter N. 2005. *Food Science*. CBS Publishers and Distributors, Delhi.
6. Roday Sunetra. 2010. *Food Science and Nutrition.* Oxford University Press, New Delhi.
7. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition.* DIPA, Indian Council of Agricultural Research, New Delhi.
8. Srilakshmi B. 2005. *Food Science.* New Age International (P) Ltd., Publishers, New Delhi.
9. Srilakshmi B. 2015. *Nutrition Science.* New Age International Pvt. Ltd., New Delhi.

Principles and Practices of Food Preparation 2 (1+1)

Objectives

i. To understand effect of heat transfer on texture, flavour, taste and appearance of food

ii. To demonstrate correct use of small equipment and appliances

iii. To identify and apply scientific principles of food selection and preparation, prepare and handle food using safe, sanitary practices; in order to retain Nutritive value and produce quality food products

iv. To demonstrate and understand ingredient substitution for recipe and describe characteristic properties of quality food products

Theory

Kitchen attire and equipment, cooking of food, heat and heat transfer cooking methods, effect of cooking on food and their nutritive value, basics of culinary practice, thickening and binding agents, basic flavoring stocks essence and glazes sauces soups garnishes, basics of cookery of various food - cereals, pulses, egg, fish, meat and poultry, principles and practice of boiling, steaming, frying, stewing, roasting, baking, grilling and combined methods of cookery

Practical

Kitchen Equipment - Identification, Description, Uses and handling. Market survey to assess the types and availability of processed products. Identification and Selection of Ingredients. Preparation of cereal products and pulse products- boiling and steaming, puffing. roasting methods. Basic dry heat cooking methods. Basic medium fat cooking – Roasting, grilling, frying. Milk cookery – pudding, custard and ice creams. Preparation of Vegetable- Boiled vegetables and Glazed vegetables. Preparation of Vegetable- Fried vegetables and Stewed vegetables. Egg cookery - Boiled (Soft and Hard), Fried, Poaches, Scrambled, Omelets. Preparation of Simple Salads: Potato salad, Beet root salad, green salad, Fruit salad, Preparation of baked products. Cold desserts - Caramel Custard, Bread and Butter Pudding, Soufflé – Lemon / Pineapple, Mousse (Chocolate Coffee Apricot Pudding HOT desserts - Steamed Pudding. Preparation of meat and products. Preparation of Continental Stock: White stock, brown stock, chicken stock and emergency stock. Preparation of confectionery products - fudge, fondant, candies, toffees and chocolates, Identification of meat cuts of lamb, Curing of meat – sugar, salt and nitrite, Cost reporting system – daily, monthly and for special managerial decisions. Visit to kitchen equipment stores

Suggested Readings

1. Brown A. 2018. *Understanding Food: Principles and Preparation*. Wadsworth Publishing Co Inc., 10 Davis Drive, Belmont.

2. Chambers M D. 2009. *Principles of Food Preparation: A Manual for Students of Home Economics*. Boston Cooking-School Magazine Company.

3. Sethi M. 2007. *Catering Management – An Integrated Approach*. New Age International (P) Limited Publishers, New Delhi.

4. The BC Cook Articulation Committee. 2015. *Basic Kitchen and Food Service Management*. BC Campus, British Columbia.

Indian Cuisinology 2 (0+2)

Objectives

i. To impart a hands-on, skill oriented intense curriculum on Indian Cuisine and Culture

ii. To examine the central place of cuisine in Indian culture and society

iii. To understand the importance of cuisine in cultural practices

Practical

Exploring Indian regional cuisines - North India, North East, South India, Western and Eastern India. Familiarization and identification of Indian herbs and spices. Preparation of dry/wet masalas, pastes and curries/gravies. Preparation of common recipes and meals of North, South, East, West and central zones of the country. Preparation of Mughlai cuisines. Preparation of food according to festivals in India. Preparation of non-alcoholic Indian beverages. Use of modern crockery/cutlery for presentation. Special meals during fasting. Street foods of India – Exploration and preparation.

Suggested Readings

1. Achaya K T. 1998. *Indian Food: A Historical Companion*. Oxford University Press, USA.
2. https://www.unigoa.ac.in/uploads/syllabus/bsc-culinary-arts_syllabus_33020210830.055146.pdf (Accessed on 12-01-2025).
3. https://www.uou.ac.in/sites/default/files/syllabus/BHM-401T.pdf (Accessed on 10-12-2024).
4. Martl Richard E and Derek Eelsy A. 1998. *Textbook of Basic Cookery: Fundamental Recipes and Variations*. Butterworth-Heinemann Ltd, Oxford.
5. Mehta N. 2013. *Cookbook of Regional Cuisines of India*. Snab Publishers, India.
6. O'Brien C. 2012. *Food Guide to India*. Penguin India.
7. Pant P. 2007. *Cuisines – Incredible India*. Wisdom Tree, India.
8. Shukla S. 2022. *Plant-Based India: Nourishing Recipes Rooted in Tradition*. The Experiment.

Nutritional Status Assessment 3 (2+1)

Objectives

i. To cover the basic concepts of malnutrition, describes how nutritional status is assessed, and identifies the most commonly used nutrition indicators

ii. To explain the criteria to consider when selecting the indicators in specific contexts and situations

Theory

Major Nutritional Problems–Global and India. Nutritional Status assessment – Direct and Indirect method, Anthropometric and Body composition methodology (indexes and references), Biochemical Methods of Nutritional Assessment, Clinical nutrition methodology, Dietary Assessment methods. Nutrition Intervention programs and policies, Sustainable Nutrition Goals, Mental Health and well-being. Rapid assessment methods. Nutritional assessment of infants, -children, adults, elderly, pregnant and lactating women

Practical

Assessment of nutritional status of community using dietary surveys, clinical, surveys, anthropometric Measurements-Data collection, tabulation, data analysis (indexes and references), interpretation and report writing. Target group selection from pediatrics, adults, elderly, pregnant and lactating women, tabulation, interpretation and report writing of their tested biomarkers.

Suggested Readings

1. Bamji S M, Rao N P and Reddy V. 1996. *Textbook of Human Nutrition.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Beghan I, Cap M and Dajardan B. 1988. *A Guide to Nutritional Status Assessment.* WHO, Geneva.
3. Dahiya S, Boora P and Rani V. 2013. *A Manual on Community Nutrition.* Department of Foods and Nutrition, published under ICAR Assistance Scheme.
4. Fidanza F. 1991. *Nutritional Status Assessment*. Springer Science Business Media
5. Latham M C. 1997. *Human Nutrition in the Developing World.* Food and Agricultural Organization of the United Nations
6. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. Westville Publishing House, New Delhi, India
7. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. DIPA, Indian Council of Agricultural Research, New Delhi

Convenience and Health Food Formulation 2 (0+2)

Objectives

i. Imparting understanding of convenience foods among students
ii. Nutritional and health benefits of various healthy food recipes and convenience foods

Practical

Importance and need for convenience foods. Usefulness and types of convenience foods. FSSAI standards on health food formulations. Health foods-definition, classification and types. Food safety and quality control issues in product development. Packaging of convenience foods. Needs for effective marketing of convenience and health foods. Market survey of convenience and health foods. Cereal based traditional convenience foods and snacks. Convenience foods of millets. Ready to eat breakfast cereals. Pasta products. Legume/pulse based traditional convenience foods and snacks. Extruded products. Milk based products and mixes. Vegetable and fruit-based convenience foods. Food adjuncts (Pickles, chutneys, papad/vadi etc. Soup mixes. Fried products.

Suggested Readings

1. Arya S S. 1990. *Grain-based Snack and Convenience Foods.* Indian Food Packer. Sept–Oct: 17-34
2. Chattopadhyay P K. 2007. *Cereal Food Technology*. National Institute of Industrial Research, pp. 137-139

3. Chaughan G S, Verma N S and Bains G S. 1985. *Effect of Extrusion Processing on the Nutritional Quality of Protein in Rice–Legume blends*. Die Nahrung
4. Fast R B and Caldwell E F. 2000. *Breakfast Cereals and How They Are Made*. American Association of Cereal Chemists, St. Paul, Minnesota
5. Guy R. 2001. *Extrusion Cooking: Technologies and Applications*. Woodhead Publishing Limited, Abington and Cambridge
6. Khatkar B S. 2007. *Food Science and Technology*. Daya Publishing House, Delhi
7. Pant P. 2006. *Indian Fast Food*. Roli Books Pvt Limited
8. Selves J and Devipriya J. 2010. *Health Foods as Soya Bean.* Beverages and Food World. Feb: 64
9. Shiby V K, Sinija V R and Mishra H N. 2007. *Ready-to-Eat Health Foods: A Promising Concept*. Indian Food Industry Nov-Dec: 47-53
10. Shukla S. 2022. *Plant-Based India: Nourishing Recipes Rooted in Tradition*. The Experiment, New York.

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming-based livelihood systems in agriculture
ii. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood- Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start- Ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development*. Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience*. Department for International Development, London, UK, Vol. VII.
3. Bhatt B P, Kumar A, Thakur P K, Dey A, Kumar U, Jha B K, Kumar L, Pathak K N, Hassan A, Singh S K, Singh K K and Singh K M. *Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar.* ICAR Research Complex for Eastern Region, ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar.
4. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa*. Consultation Document, FAO, Rome, Italy.
5. Dixon J, Gulliver A and Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO and World Bank, Rome, Italy and Washington, DC, USA.
6. Evenson R E. 2000. *Agricultural Productivity and Production in Developing Countries.* In The State of Food and Agriculture, FAO, Rome, Italy.
7. Indian Dietetic Association https://idaindia.com (Accessed on 12-11-2024)
8. National Institute of Nutrition https://www.nin.res.in (Accessed on 13-01-2025)
10. Reddy S R. 2016. *Farming System and Sustainable Agriculture*. Kalyani Publishers, New Delhi.
12. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Barbara Pease & Allan Pease.2006. *Definitive Book of Body Language*. RHUS, USA
2. Brown Michele and Gyles Brandreth. 1994. *How to Interview and be Interviewed*. Sheldon Press, London.
3. Carnegie Dale. 1997. *The Quick and Easy Way to Effective Speaking*. Pocket Books, New York.
4. Francis Peter S J. 2012. *Soft Skills and Professional Communication*. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. *Communication Skills*. Oxford University Press, India.
6. Neuliep James W. 2003. *Intercultural Communication A Contextual Approach*. Houghton Mifflin SAGE Publication Inc. London.
7. Pease Allan. 1998. *Body Language*. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. *Business Communication*. Oxford University Press, India.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press, India.
10. Shital Kakkar Mehra. 2020. *Executive Presence*. Harper Business. India.
11. Partha Sarathi Basu. 2015. *Mid- Career Crisis*. Harper Collins. India.
12. Mark Goulston. 2015. *Just Listen. Reprint Edn*. AMACOM. Harper Collins. India.

National Cadet Corps (NCC- I) 1(0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning
- Sizing, numbering, forming in three ranks, open and close order march, and dressing
- Saluting at the halt, getting on parade, dismissing, and falling out
- Marching, length of pace, and time of marching in quick/slow time and halt Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control

National Service Scheme (NSS-I) 1 (0+1)

Objectives

i. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work

ii. To be skillful in executing democratic leadership, developing skill in program

iii. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness activities

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health

- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society

Semester II

Bakery Science and Technology 3 (2+1)

Objectives

i. To understand the process of different products, how their ingredients play a role in preparation of breads, cakes, biscuits, etc., their quality testing and how to modify products with desirable nutritional requirements

ii. To provide individuals with key knowledge of packaging, labeling, food safety and food laws that can be applied directly in existing products and also in development of new products of bakery

Theory

Introduction to baking science. Basic materials used in bakery and confectionery, selection, properties and functions. Flours- constituents, functions and characteristics of good flour and tests. Different types of flour mixtures used bakery, egg structure, composition and its functions in bakery. Different types of fats and oils used in bakery and their functions. Sugars and functions and types of sugars used in bakery and confectionery, Salt and its functions in bakery and their functions, Yeast and types of yeast used in bakery and their functions. Improvers, leavening agents and emulsifiers used in bakery and their functions. Tools, equipment and techniques used in bakery.

Practical

Bakery unit: importance of sanitation and personal hygiene. Use of different bakery equipment microwave baking, balancing the formula for bakery products , demonstration on standard method of making different types of biscuits, salt, coconut and fruit biscuits Demonstration on standard method of making different types of cookies, preparation of different types of cookies, plain sponge cake, chocolate cake, pineapple upside down cake, walnut cake, madeira cake, fruit / plum cake, carrot cake, Demonstration on standard method of making of pastries, pastries, icings and cake decoration.

Suggested Readings

1. Ashok Kumar Y. 2012. *Textbook of Bakery and Confectionery*. PHI Learning, India.
2. Mathuravalli S M D. 2022. *Handbook of Bakery and Confectionery*. CRC Press, Boca Raton, Florida.
3. NIIR Board of Consultants and Engineers. 2014. *The Complete Technology Book on Bakery Products (Baking Science with Formulation and Production)*. NIIR Project Consultancy Services, New Delhi.
4. Scott D. 2020. *Bread Baking for Beginners: A Simple Essential Guide to Kneading and Baking Bread*. Kindle Edition, Amazon.
5. US Wheat Associates. 1994. *Bakers Handbook on Practical Baking*. New Delhi.

Nutritional Program Surveillance 3 (1+2)

Objectives

i. To understand the concept of nutritional status and its relationship to health
ii. To know aims, objectives, methods used for assessment of nutritional status
iii. To identify the factors responsible for the malnutrition

Theory

Nutrition monitoring and surveillance – definition, introduction, need and significance. Principles of a food and nutrition surveillance system and implementation steps. Nutrition surveillance in developed and underdeveloped countries. Setting up food and nutrition surveillance system activities -strengthening a food and nutrition surveillance system. Nutritional programs – implementation, monitoring and evaluation. Concept of E-surveillance on the Nutritional situation in the country. Elements of the nutritional assessment - individual and population assessment - measuring malnutrition. Sampling of population. Supervision, monitoring and evaluation. Real time monitoring system. Malnutrition – causative factors. Food security assessment, health assessment and its significance in nutrition surveillance. Indicators of food and nutrition security – types and characteristics of indicators. Application and usefulness of indicators for different objectives and nutritional problems. Selection of indicators and levels of assessment.

Practical

Surveillance of National nutrition programs: ICDS, mid-day meal, availability of iodized salt in markets and households, distribution of iron-folifer tablets. Visit to ICDS centers, PHCs, *Aaganwadis*, assessing nutritional status, data analysis and report writing, visit to mid-day meal kitchen, supervising food preparation in hygienic manner, report writing.

Suggested Readings

1. Bamji M S, Rao P N and Reddy V. 2003. *Textbook of Human Nutrition*. pp 197-201. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Beghan I M and Dajardan B. 1988. *A Guide to Nutritional Status Assessment*. WHO, Geneva.
3. Fidanza F. 1991. *Nutritional Status Assessment*. Springer Science Business Media.
4. Gopaldas T and Seshadri S. 1987. *Nutrition Monitoring and Assessment*. Oxford University Press, India.

5. Jelliffe D B. 1966. *The Assessment of the Nutritional Status of the Community (With Special Reference to Field Surveys in Developing Regions of the World)*. World Health Organization, Geneva.
6. Mason J B, Habicht J P, Tabatabai H and Valverde V. 1984. *Nutritional Surveillance*. WHO.
7. Saln D R, Lockwood R and Scrimshaw N S. 1981. *Methods for the Evaluation of the Impact and Nutrition Program*. United Nations University.
8. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. DIPA, Indian Council of Agricultural Research, New Delhi.
9. Spinello S. 2018. *The Duties of a Community Nutritionist*. Retrieved from: https://careertrend.com/list-6526713-duties-community-nutritionist.html.
10. WHO. 2014. *Food and Nutrition Surveillance Systems: A Manual for Policy-Makers and Program Managers*. WHO.

Food Preservation and Storage 2 (0+2)

Objectives

i. To provide information about the shelf-life of different food products, different preservations and processing techniques
ii. To provide Students hands on experience and knowledge about handling of food items on scientific lines to prepare and develop different preserved food product

Practical

Market survey of raw and preserved products. Preparation of preserved products- Squash, cordial, crush, jams, jellies, marmalade, candy, preserves, *murabbas*, pickles with and without oil, chutneys, ketchup, sauces, candies, toffees, cheese and syrup. Drying of blanched and unblanched fruits and vegetables by solar dryer, sun and oven drying methods. Shelf life and sensory evaluation of developed products Packaging of fruits and vegetables. Labelling and costing of products. Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Preparation of *papad, wadian* utilizing cereals and legumes and their storage. Visits to food processing and preservation units, canning bottling units, grain storage institute.

Suggested Readings

1. Bhutani R C. 2011. *Fruit and Vegetable Preservation*. Daya Publishing House, New Delhi.
2. Jood S and Khetarpaul N. 2002. *Food Preservation*. Geeta Somani, Agrotech Publishing Academy, Udaipur.
3. Kalia M and Sood S. 2010. *Food Preservation and Processing*. Revised Edition. Kalyani Publishers, New Delhi.
4. Potter N N. 1996. *Food Science*. The AVI Publishing Company, Inc., Westport, Connecticut.
5. Sehgal S, Grewal R B, Kawatra A and Kaur Y. 1997. *Practical Aspects of Food Preservation*. Directorate of Publications, Haryana Agricultural University, Hisar.
6. Sivasankar B. 2002. *Food Processing and Preservation*. PHI Learning Pvt. Ltd., Delhi.
7. Srivastava R P and Kumar S. 2019. *Fruits and Vegetable Preservation: Principles and Practices*. Revised and Enlarged 3rd edn. CBS Publishers and Distributors, New Delhi.

8. Subbulakshmi G and Udipi S A. 2006. *Food Processing and Preservation*. New Age International Publishers, New Delhi.
9. Vijay K. 1999. *Textbook of Food Storage and Preservation*. Kalyani Publishers, New Delhi.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types . The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, FIRO-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

1. Carnegie Dale & Hill Napoleon. *World Gratest book for Personal Growth & Wealth*. Prakash Books India Pvt Ltd. India.
2. Heller Robert. 2002. *Effective Leadership. Essential Manager Series.* Penguin. UK.
3. Hindle Tim. 2009. *Reducing Stress. Essential Manager Series*. D K Publishing. India.
4. Kumar Pravesh. 2005. *All about Self- Motivation*. Goodwill Publishing House. New Delhi.
5. Lucas Stephen. 2001. *Art of Public Speaking*. Tata - Mc-Graw Hill. New Delhi.
6. Mile D.J. 2004. *Power of Positive Thinking*. Penguin Random House India Pvt Ltd. India.
7. Shaffer D. R. 2009. *Social and Personality Development.* (6th Edn.). Wadsworth Pub Co. USA.
8. Smith B. 2004. *Body Language*. Rohan Book Company, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide an insight into the concept and scope of entrepreneurship
ii. To expose various aspects of establishment and management of a small business unit
iii. To develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity- scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises.* Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management.* Himalaya Publishing House, New Delhi.
3. Grover I. 2008. *Handbook on Empowerment and Entrepreneurship.* Agrotech Public Academy, Udaipur.
4. Gupta C B. 2001. *Management Theory and Practice.* Sultan Chand and Sons, New Delhi.
5. Khanka S S. 1999. *Entrepreneurial Development.* S. Chand and Co, New Delhi.
6. Mehra P. 2016. *Business Communication for Managers.* Pearson India, New Delhi.
7. Pandey M and Tewari D. 2010. *The Agribusiness Book.* IBDC Publishers, Lucknow.
8. Singh D. 1995. *Effective Managerial Leadership.* Deep and Deep Publications, Delhi.
9. Singhal R K. 2013. *Entrepreneurship Development and Management.* Katson Books, New Delhi.
10. Tripathi P C and Reddy P N. 1991. *Principles of Management.* Tata McGraw Hill, Noida, Uttar Pradesh.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

i. To expose and acquire knowledge on the environment

ii. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth- Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution. Light pollution.

Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment:

Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness.

Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. Bharucha E. *Textbook for Environmental Studies.* University Grants Commission, New Delhi.
2. De A K. 2010. *Environmental Chemistry*. Published by New Age International Publishers, New Delhi, ISBN: 13–978 81 224 2617 5, 384 p.
3. Dhar Chakrabarti P G. 2011. *Disaster Management - India's Risk Management Policy Frameworks and Key Challenges*. Published by Centre for Social Markets (India), Bangalore, 36 p.
4. Parthiban K T, Vennila S, Prasanthrajan M and Umesh Kanna S. 2023 (In Press). *Forest, Environment, Biodiversity and Sustainable Development*. Narendra Publishing House, New Delhi.
5. Prasanthrajan M and Mahendran P P. 2008. *A Textbook on Ecology and Environmental Science*. (1st Edn.). ISBN 81-8321-104-6, Agrotech Publishing Academy, Udaipur.
6. Prasanthrajan M. 2018. *Objective Environmental Studies and Disaster Management*. ISBN 9789387893825, Scientific Publishers, Jodhpur. 146p.
7. Sharma P D. 2009. *Ecology and Environment.* Rastogi Publications, Meerut.
8. Tyler Miller and Scot Spoolman. 2009. *Living in the Environment (Concepts, Connections, and Solutions)*. Brooks/Cole, Cengage Learning Publication, Belmont, USA.

National Cadet Corps-II 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice- versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding

north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.

- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme-II 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post- Semester II (Only for exit option for UG-Certificate)

S. No.	Course Title	Credit Hours
1.	Internship*(10 weeks)	**10 (0+10)***

*Internship (only for exit option for award of UG-Certificate) 10 weeks 10 (0+10)

Objectives

To provide students with an opportunity to put into practice the skills they have learned while in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and consider having their own startups.

i. Integrate theory and practice

ii. Assess interests and abilities in their field of study

iii. Develop work habits and attitudes necessary for job success
iv. Develop communication, interpersonal and other critical skills in the job interview process
v. Explore career alternatives prior to graduation

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in associated industry, food service centres, etc. The College/ University will facilitate attaching the students to the organisations. After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Principles of Human Nutrition 4 (4+0)

Objectives

At the end of the course, the student will have knowledge of

i. Different types of carbohydrates, lipids and fatty acids and proteins and amino acids required for human nutrition
ii. Energy requirement and expenditure in the human body during rest and physical activity
iii. Physiological and biochemical role of water, minerals and vitamins and their metabolism in the human body
iv. Diseases and symptoms resulting from deficiency of major and minor nutrients
v. Biochemical monitors used to assess the nutritional status of different nutrients

Theory

Historical development and the relationship of nutrition to health, growth and human welfare. Definitions of terms used in nutrition- Recommended dietary allowances, balanced diet, health foods, functional foods, phytochemicals, Nutraceuticals, dietary supplements, ethnic foods, organic foods, fabricated foods, extruded foods, convenience foods, junk foods, GM foods and proprietary foods. Food groups (Four, Five, Seven, Nine, Eleven), Food pyramid, my plate concept, Bioavailability, enrichment, fortification and restoration of nutrients. Energy units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of body, physical activity and thermogenic effect of food, Respiratory Quotient, SDA, BMR- methods of measurement, factors affecting BMR, Energy expenditure in different activities, Energy balance. Carbohydrates- Types, functions, sources, requirement, Digestion and absorption of carbohydrates, health conditions affected by carbohydrates, Dietary Fiber-Classification, sources, composition, properties and nutritional significance. Lipids- Types, functions, sources, requirement, Digestion and absorption of lipids health problems associated with lipids. Proteins- Types, functions, sources, requirement, Digestion and absorption of proteins, quality evaluation, improvement and deficiency

and protein energy malnutrition. Vitamins- Classification, functions, sources, requirement, deficiency and toxicity of fat soluble-(A, D, E, K), (water soluble – C, B Complex (thiamine, riboflavin, niacin, B_6, Pantothenic acid, B_{12} and folic acid). Minerals-Classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc, factors affecting bio availability of calcium and iron and other minerals. Water- functions, sources, distribution in body. Water balance and electrolyte balance.

Suggested Readings

1. Agrawal A and Udipi A S. 2022. *Textbook of Human Nutrition.* Jaypee Brothers Medical Publishers.
2. Bamji M S, Krishnaswamy K and Brahmam G N V. 2009. *Textbook of Human Nutrition.* Oxford and IBH Publishing Company Pvt. Ltd.
3. Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K. 2017. *Indian Food Composition Tables*, National Institute of Nutrition, ICMR, New Delhi.
4. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. India: Westville Publishing House, New Delhi.
5. *Short Report of Nutrient Requirements for Indians: Recommended Dietary Allowances and Estimated Average Requirements – A Report of the Expert Group, 2020*. Indian Council of Medical Research, National Institute of Nutrition, Hyderabad.
6. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. ICAR Publication, New Delhi.
7. Wilson E D, Fisher K H and Garcia P A. 1980. *Principles of Nutrition.* John Wiley and Sons, New York.

Fundamentals of Food Science 2 (1+1)

Objectives

i. To introduce students to the field of food science
ii. To cover possible jobs, food harvest, production methods, food chemistry, preserving methods, meeting nutritional needs, grading procedures used and the science involved
iii. To understand both fundamental and applied aspects of food science
iv. To provide for fundamental understanding of food chemistry, and food microbiology
v. To gain insights about role of specific nutrients in maintaining health and identifying nutrient specific foods

Theory

Cooking- Objectives, cooking methods, their types, merits and demerits. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery, gelatinization, dextrinization, antinutritional and retrogradation of starch. Legumes, nuts and oil seeds - Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Milk and milk products – Composition, types, products, effect of acid on pigments, effect of acid on milk cookery, uses and functions. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish- Types, structure, composition, pigments, factors affecting

tenderness, post-mortem changes and changes during cooking. Sugars- Types, composition, manufacturing process, effect of heat and acid, crystallization factors affecting crystallization, functions of sugar in cookery, fondants and fudge. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats; Methods of improving nutritive value of foods – germination, fermentation, malting, mutual supplementation etc. Brief overview of beverages; Condiments and spices, importance in daily life.

Practical

Orientation to kitchen equipment and their uses, weighing and measuring food items. condiments and spices. Cooking of foods using different methods. Cereal cookery– Practical exercise on dextrinization and gelatinization of rice starch, gluten formation in wheat. Legumes – Identification and cooking methods. Nuts and oilseeds- Use in food preparations. Preparations using Germination, fermentation, mutual supplementation. Vegetable cookery- Different preparations with vegetables and effect of heat and alkali on pigments. Preparation of soups, salads and beverages. Milk and milk products- Maillard reaction, Use in various preparations. Egg cookery - Preparations showing functions of egg as binding, coating agent: poached egg, boiled egg, scrambled egg, omelet, egg curry. Meat, poultry and fish cookery – Preparations involving various methods of cooking. Sugar – Preparations showing functions of sugar in cooker- caramelization, coating agent, crystallization, syrups of different consistencies, sweets, chocolates, candies. Fats and oils–Demonstration of smoking point, use in various preparations like deep fat frying, shallow fat frying, shortening effects of oil, factors affecting absorption of oil.

Suggested Readings

1. Fox B F and Cameron A G. 1970. *Food Science - A Chemical Approach*. University Press, London.
2. Raghuvanshi R S and Bisht K B K. 2010. *Uses of Soybean: Products and Preparation*. In: CABI eBooks, pp. 404–426.
3. Raghuvanshi R S and Singh D P. 2009. *Food Preparation and Use*. (In) *CABI eBooks*, pp. 408–424.
4. Shakuntala Manay N and Shadaksharaswamy M. 1998. *Foods, Facts and Principles*. New Age International Publishers, New Delhi.
5. Sharma A. 2017. *Textbook of Food Science and Technology*. CBS Publication, New Delhi.
6. Singh Guriqbal (Ed.). 2010. *The Soybean: Botany, Production and Uses*. CAB International, U.K.
7. Swaminathan M. 1988. *Handbook of Food Science and Experimental Foods*. BAPPCO, Bangalore.

Community Nutrition and Education 3 (2+1)

Objectives

At the end of the course, the student will have knowledge of

i. Causes, prevalence and consequences of the major nutritional problems existing in India and its control measures
ii. Methods of nutritional status assessment of individual and group both directly and indirectly
iii. To inculcate concept of food and nutrition security and government and international program running in the field of community nutrition for ameliorating nutritional status of population
iv. To enable students to assess nutritional status and impart nutrition education among rural and needy people

Theory

Basic concept of community nutrition role of nutritionist in improving nutrition in community Food habits and influencing factors, Food taboos, Mortality and morbidity pattern of vulnerable groups and their causes. Nutritional needs of normal infants, prelacteal feeding, exclusive breast feeding, feeding of full term and premature infants. Importance of breast feeding and supplementary foods in combating malnutrition in infants and young children. Growth monitoring Malnutrition. Definition and causes, classification of grades of malnutrition. Assessment of nutritional status-Nutritional Anthropometry-Need and importance, standard for reference, techniques of measuring Length/ height, weight, head, chest and arm circumference, skinfold thickness, interpretation of these measurements. Use of growth chart, Clinical signs of deficiencies specially PEM (Kwashiorkor, marasmus), vitamin A deficiency, Anemia, Rickets, B-Complex deficiencies. Bio chemical and biophysical assessment. Diet survey: Need and importance, methods of dietary survey, Interpretation - concept of consumption unit, individual and total distribution of food in family, adequacy of diet in respect to RDA, concept of family food security. Major nutritional problems in community. National programs and policies for improving nutritional status of community. Role of national and international agencies in improving nutritional status of the community. Nutrition education: objectives, methods, channels and its role in control of malnutrition in community nutrition education -Objectives, principles and importance of nutrition education in a community nutritional survey – NFHS.

Practical

Assessing nutritional status of hostel inmates and local community dwellers. Assessing nutritional status of community as per socio-economic status. Visit to local health centres to identify clinical signs and symptoms of nutritional problems. Visit to Anganwadi centres, MDM and evaluation of feeding provided at these centres. Community survey for nutritional deficiency disorders -Data collection, tabulation, analysis, interpretation report writing. Development of audio- visual aids. Planning, implementation and evaluation of nutrition education program for a target group.

Suggested Readings

1. Bamji S M, Rao N P and Reddy V. 1996. *Textbook of Human Nutrition*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dahiya S, Boora P and Rani V. 2013. *A Manual on Community Nutrition*. Dept. of Foods and Nutrition, published under ICAR Assistance Scheme.Das S. 2022. *Textbook of Community Nutrition*. Academic Publishers.
3. Latham M C. 1997. *Human Nutrition in the Developing World*. Food and Agriculture Organization of the United Nations.
4. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.

Human Physiology 3 (2+1)

Objectives

i. To understand the role of molecules, cells, tissues, organs, and organ systems (endocrine, nervous, muscular and immune systems) in human health and disease

ii. To understand the physiology –the functioning of a living organism and its component parts

iii. To acquire an understanding of how and why the body functions the way it does, and what happens when it does not function properly

Theory

Introduction to anatomy and physiology and structural organization of body. The cell – Structure, its organelles, functions and multiplications, different types of cells and their functions, movement of particles across cell membrane - Active transport and passive transport ,Body fluids and its compartments and functions ,Water output and input into the body and maintenance of water balance in human body , the tissues – Types, structure and their functions, the skeletal system - Anatomy and functions, structure, formation and development of bones, different types of bones and types of joints and their movements, Circulatory system - The blood - Composition and function, blood clotting and blood grouping, Heart – Structure, functions, types of circulatory systems, blood pressure and heart rate and factors affecting it, electrocardiogram, the respiratory system - anatomy, functions, mechanism of breathing and respiratory volumes, gas transport and respiratory adaptation, the digestive system - anatomy and functions of alimentary tract and accessory organs, process of digestion of food, absorption and assimilation of digested food, enzymes involved in digestion of food, liver - Structure and functions, Pancreas – Structure and functions, the urinary system - Anatomy and functions, formation and composition of urine, the endocrine system - important ductless glands of the body and their functions, the reproductive system - Male reproductive system – Anatomy and functions, female reproductive system – Anatomy and functions, menstrual cycle, the nervous system - elementary study of (anatomy and functions), sensory organs – (anatomy and functions). Glossary of terms used in physiology.

Practical

Study of a compound microscope, microscopic structure of epithelial, muscular and connective tissue, bone and cartilage, Measurement of body temperature, Basal Metabolic Rate, Recording of systemic arterial blood pressure, Pulmonary function test, Pulse rate and respiratory rate, Effect of posture and exercise on blood pressure. Visit to anatomy and physiology lab, estimation of hemoglobin, red blood corpuscles, estimation of white blood corpuscles, determination of blood groups assessment of blood group, determination of bleeding time (bt) and clotting time (ct). Determination of blood glucose qualitative tests with urine samples -urine sugar and albumin.

Suggested Readings

1. Vander Arthur J, Sherman James H and Luciano Dorothy S. 1998. *Human Physiology – The Mechanisms of Body Function*. Tata McGraw Hill Publishing Company, New Delhi.

2. Guyton Arthur C. 1976. *Textbook of Medical Physiology*. (5th Edn.). W.B. Saunders Company, Philadelphia, London.

3. Keele C A and Neil B (Eds). 1961. *Samson Wright's Applied Physiology*. (10th Edn.). Oxford University Press, New York.

Economics and Food Business Management 2 (2+0)

Objectives

i. To study food from a scientific perspective and the food industry from a business point of view
ii. To have opportunities to create new food products and develop new ways to manufacture, preserve, and package food products
iii. To study food production, development, and commercialization

Theory

Economics definition and key concepts; business economics. The working of competitive markets: business in a competitive market; demand and supply population and growth food production availability, price and output determination; elasticity of demand and supply; Government intervention in competitive markets (FCI, Food Subsidies). Background to demand: marginal utility theory and demand and the firm. Background to supply: cost and production; short vs long-run. Revenue and profit maximization. Market Structures: Perfect competition, monopoly, monopolistic competition. Business in an international environment: globalization (key concepts). Business Management- Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line and staff, matrix, hybrid.

Suggested Readings

1. Dewett K K and Navalur M H. 2010. *Modern Economic Theory*. S. Chand and Sons, New Delhi.
2. Dorfman J H. 2013. *Economics and Management of the Food Industry*. Taylor and Francis.
3. Jain S P and Narang K L. 2017. *Financial Accounting*. Kalyani Publications, Ludhiana.
4. Koontz H. 2004. *Principles of Management*. Tata McGraw-Hill Education Private Limited, New Delhi.
5. Prasad L M. 2001. *Principles and Practices of Management*. (9th Edn.). S. Chand and Sons, New Delhi.
6. Rao P Subba. 2012. *Human Resource Management*. Himalaya Publications, New Delhi.
7. Thomas P C. 2007. *Managerial Economics*. (9th Edn.). McGraw Hill Higher Education.

Food Psychology 2 (2+0)

Objectives

i. To gain an understanding of the psychological factors that influence food choices, eating behaviors, and our relationship with food
ii. To explore the impact of sensory experiences (taste, smell, sight, touch) on food perception and preference
iii. To examine the psychology behind food marketing and advertising strategies
iv. To develop practical strategies to cultivate a mindful and healthy relationship with food

Theory

Introduction to Food Psychology, Interaction of Hunger and Satiety, Sensory Perception and Food Preferences, Role of positive and negative emotions on selection / choice of foods – eating behavior. Meal composition and effect of specific nutrients on mood / stress., Understanding and Managing Cravings, Anorexia nervosa and binge eating behaviour, Mindful Eating Practices, Social Cues and Dining Environments, Psychological influence of Food Marketing and Advertising, digital food marketing – public health challenge, Cultural Food Traditions and Practices, Food and Mental Well-being, Practical Applications of Food Psychology, Overeating, Disordered Eating, and Body Image Concerns, Strategies for Individual and Community Health.

Suggested Readings

1. Cardoz F. 2009. *India: The Cookbook*. HarperCollins Publishers, India.
2. Hardcastle S J, Thøgersen-Ntoumani C and Chatzisarantis N L. 2015. *Food choice and nutrition: A social psychological perspective*. Nutrients **7**(10): 8712-8715.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices
ii. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga,

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (cricket, football, table tennis, badminton, volleyball, basketball, kabaddi and kho-kho) and athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Food Nutrition and Agriculture 2 (2+0)

Objectives

i. Develop skills to apply and evaluate innovative solutions that place nutrition at the heart of a sustainable food system

ii. Students will learn about the components of the food system and their link to nutrition and acquire the skills to implement and evaluate nutrition-sensitive interventions

Theory

Food production and consumption situation in India and in the world; Food production and consumption trends, food balance sheets; Role of nutrition in agricultural planning and national development. Linkages between agricultural practices, food production, food distribution and nutritional status; Factors affecting food distribution at macro and micro level, per capita food availability and consumption; Food and nutrition security at national and household level; Role of agriculture in enhancing food security; Urbanization and food security. Sustainable food systems; Food crop failure and malnutrition, poverty and vicious cycle of low food production. Innovative approaches to enhance local food production and improve food distribution systems. Effect of food production and economic policies on food availability; Impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post-harvest processing of foods on food and nutrition situation; Nutritional composition of commonly consumed foods. Implementation of nutrition policy, agricultural programs; nutritional impact of agricultural programs, food price control and consumer subsidy; Contribution of National and International organization in agricultural development.

Suggested Readings

1. Albert J L (Ed.). 2000. *Food, Nutrition and Agriculture*. FAO Publication.
2. FAO. 2017. *The State of Food and Agriculture - Leveraging Food Systems for Inclusive Rural Transformation*. Food and Agriculture Organization, Rome.
3. FAO. 2017. *The State of Food Security and Nutrition in the World*. Food and Agriculture Organization, Rome.
4. Global Food Security Index (GFSI). Available at: https://economist.com (Accessed on 17-01-2025).

5. GOI. 2001. *India 2001: A Reference Annual*. Publication Division, Ministry of Information and Broadcasting, Government of India.
6. GOI. 2011. *Census of India*. Government of India.
7. GOI. 2017. *Agriculture - Statistical Year Book India*. Ministry of Statistics and Program Implementation, Government of India.
8. GOI. 2018. *A Reference Manual*. Publication Division, Ministry of Information and Broadcasting, Government of India.
9. Home - Global Nutrition Report. Available at: https://globalnutritionreport.org (Accessed on 15-01-2025).
10. Raghuvanshi R S. 2013. Nutritional security through diversified food production. (In) *Agrarian Change and Small Farmers, Supermarkets, Viability and Food Policy*. Bhatt K N and Bhargava P (Eds). Concept Publishing Company Pvt. Ltd., New Delhi.

Semester IV

Normal Nutrition and Meal Planning 3 (2+1)

Objectives

i. To study general nutrition, principles of meal planning, food safety, consumer guidelines, and management techniques for lab experiences
ii. To cover a variety of experiences, designed around the actual preparation of foods.
iii. To cover vocabulary, reading and following recipe and/or modelled directions, selection and storage of food items, cooking methods, and related techniques
iv. To successfully complete this course as it is a prerequisite to enrolment in Culinary Arts.

Theory

Basic principles of menu planning, planning menus for individual and family. Classification of vegetarianism. Factors influencing food intake and food habits. Basic principles of meal planning, planning meals for individual and family. Factors affecting food requirements of individuals, families and different groups of people. Meal planning for special occasions. Steps involved in meal planning. Food groups and their use in meal planning. Recommended dietary allowances of macro and micro nutrients for different age groups. Food exchange list. Use of food exchange list in diet planning, planning breakfast, lunch, tea, dinner, packed lunch and snacks; considering RDA for individuals Importance of balanced diets. Food and nutrient requirement of adults and diet planning (male and female of all activities level), pregnant women, lactating women, old age. Breast feeding, advantages of breast feeding, prelacteal feeding, breast feeding during illness, feeding of pre term baby, feeding problems. Complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, geriatric nutrition- physiological and psychological factors affecting the diet plan.

Practical

Standardization of serving sizes, portion, cost of locally available common foods. Food exchange list: method of using and portioning. Planning preparation and nutrient calculation of

diets of preschool children, school going children, adolescents, adults and senior citizens, packed lunches for school children. Practice in formal and informal table setting and table manners.

Suggested Readings

1. e-PG Pathshala. Available at: https://epgp.inflibnet.ac.in/ (Accessed on 22-01-2025).
2. Gopalan C and Krishnaswamy K. 2000. *Nutrition in Major Metabolic Diseases.* Oxford University Press, New Delhi.
3. ICMR. 2020. *Recommended Dietary Allowance for Indians.* Indian Council of Medical Research, Delhi.
4. Joshi S A. 2021. *Nutrition and Dietetics.* (5th Edn.). Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K. 2017. *Indian Food Composition Tables.* National Institute of Nutrition, ICMR, New Delhi.
6. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy.* Westville Publishing House, New Delhi, India.
7. Raghuvanshi R S and Mittal M. 2019. *Upcharatmak Poshan (Diet Therapy)*. Brillion Publishing House, New Delhi, pp. 1-352. (Hindi).
8. Robinson and Weicley. 1984. *Basic Nutrition and Diet Therapy.* Macmillan Publishing Co. Inc., New York and London.
9. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. Indian Council of Agricultural Research, New Delhi.
10. Sharma S. 2006. *Human Nutrition and Meal Planning*. Jnanada Prakasham (P and D), Delhi.

Public Health Nutrition 3 (2+1)

Objectives

i. To equip students with the knowledge of community nutrition, national and international nutrition programs and interventions

ii. To develop, implement and evaluate the nutrition programs and policies to address the different nutritional problems with greater impact and efficiency

iii. To develop an evidence-based approach to address the nutritional problems and to reduce the risk for malnutrition in different populations.

Theory

Concept of Health, Public health, Public Health Nutrition, Nutritional Epidemiology and Community nutrition- Demography, demographic cycle; Health Indicators and their significance – Birth and death rates, IMR, MMR, TFR, U5MR etc. Health Care System in India – Primary, Secondary and Tertiary, National Health Policy, National Nutrition Policy and National Nutrition Mission-An overview. Public health problems of India, nutrient deficiency diseases and other diseases, their etiology, prevalence, prevention and monitoring. Indicators and data sources from existing macro and micro systems of information in India (NFHS, NSSO, ICDS, Census). National programs relevant for public health. Vitamin A deficiency disorder control program, National diarrhoeal disease program, National iodine deficiency disorder control program, Iron deficiency anemia prophylaxis program, National malaria eradication program, national immunization

program, national program for control of tuberculosis, national AIDS control program, other health and nutrition programs. Communicable and infective disease control: Nature of communicable diseases, infections, contamination, transmission, vector borne diseases, environmental agents, control and prevention. National Malaria Eradication program, National Filarial control program, National Leprosy Eradication program, Japanese Encephalitis control and other national control programs (Blindness, Mental Health, etc.) National Mental Health program (NMHP. Universal Immunization program and child survival and safe motherhood program. COVID-19, its origin, life cycle of virus, mutation, detection, case tracking, vaccine development, and vaccination program. Principles and elements of public health care. Role of NNMB.

Practical

Visit to PHC to study the prevalence of the communicable disease. Epidemiological approach to study individual disease in a community. Analysis of data and report writing. Discussion for preventive and therapeutic strategies. Public health campaign in a village. Understanding the uses of screening tools.

Suggested Readings

1. DeMaeyer E M. 1989. *Preventing and Controlling Iron Deficiency Anemia through Primary Health Care: A Guide for Health Administrators and Program Managers*, World Health Organization, Geneva.
2. International Institute for Population Sciences (IIPS) and ICF. 2021. *National Family Health Survey (NFHS-5), 2019-21: India*. IIPS, Mumbai.
3. McLaren D S. 1976. *Nutrition in the Community.* John Wiley and Sons, London.
4. Michael J, Gibney, Barrie Margetts M, Kearney J M and Arab Lenore. 2004. *Public Health Nutrition*. Blackwell Science Ltd, UK.
5. Park K. 2016. *Textbook of Preventive Medicine*. New Age International (P) Limited.
6. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
7. Vyas S. 2021. *Public Health Nutrition: A Textbook.* Vishwagyan Prakashan.
8. WHO. 2001. *Assessment of Iodine Deficiency Disorders and Monitoring Their Elimination: A Guide for Program Managers*. (2nd Edn.). World Health Organization.
9. World Health Organization. *WHO Website on COVID-19*. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019 (Accessed on 13-01-2025).

Nutritional Biochemistry 3 (3+0)

Objectives

i. To understand the chemical characteristics of different classes of nutrients with reference to their physical properties, and to relate this to their functions in the body
ii. To explain the processes of digestion, absorption and metabolism of the macronutrients and micronutrients in the context of different meals
iii. To consider the main features of metabolism using the concept of energy flux through metabolic pathways as a focus

iv. To explore the integration of pathways for the metabolism for fat, protein and carbohydrate and to examine the mechanisms for the regulation of flux through these pathways

v. To discuss the established functions of micronutrients and to examine the clinical and biochemical effects of depletion

Theory

Recapitulation of basic chemistry and biology Water, pH and buffers, Acid-base balance Cellular constituents, Structure and function: Amino acid and proteins, Carbohydrates, Lipids and bio membranes, Nucleic acids– Vitamins and minerals. Enzymes, function, properties, mechanism, Metabolism of cellular constituents. Basic concepts of Bioenergetics Carbohydrates metabolism: glycolysis and glycogenolysim, HMP pathway, TCA Cycle, Electron transport chain, Gluconeogenesis, Lipids metabolism: Beta-oxidation, Ketone bodies, Fatty acid synthesis. Amino acid metabolism: General reactions of nitrogen assimilation and excretion Biosynthesis of DNA, RNA and Protein replication, transcription, translation and genetic code regulation of gene expression, Enzymes - specificity, classification, factors affecting enzyme activity. Amino acid metabolism: General catabolic reactions of amino acids, Digestion and absorption. Estimation of total carbohydrates by Anthrone method, Estimation of proteins by Biuret method.

Suggested Readings

1. Conn E E and Stumpf P K. 2009. *Outlines of Biochemistry*. John Wiley and Sons, London.
2. Hames B D, Hooper N M and Houghton J D. 1997. *Instant Notes in Biochemistry*. BIOS Scientific Publishers, England.
3. Jayaram T. 1981. *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi.
4. Nelson D L and Cox M M. 2004. *Lehninger: Principles of Biochemistry*. (5th Edn.). MacMillan, India.
5. Plummer D. 1988. *An Introduction to Practical Biochemistry*. (3rd Edn.). Tata McGraw Hill, New Delhi.
6. Satyanarayana U and Chakrapani U. 2008. *Essentials of Biochemistry*. Books and Allied PVt. Ltd., Kolkata, west Bengal.
7. Voet D, Voet J G and Pratt C W. 2007. *Fundamentals of Biochemistry*. John Wiley and Sons, London.

Food Standards and Quality Control 3 (2+1)

Objectives

i. To develop qualified and competent human resource in the field of the food standards and quality management for regulators, industry, academic/research institutions, certifying and accreditation bodies, food trade, food testing and training

ii. To delve in depth on various aspects of food standards and quality management i.e. food standards, harmonization with global benchmarks, quality management systems, food analysis, instrumentation, risk analysis /management, traceability and auditing to transform the food ecosystem

iii. To nurture a positive and disciplined food standard and quality culture among the professionals

iv. To conduct research studies on emerging food standard issues and formulation of science based regulatory framework

Theory

Importance of food quality control and assurance. Food Standards and Regulations in India: FSSAI, Prevention of Food Adulteration Act, Fruit Product Order, AGMARK, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards, Food and Drug Administration (FDA). Food additives, preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents. Various methods for the assessment of quality of different foods. Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws Food packaging, packaging material. Adulteration, heavy metals. Quality criteria of foods – food grains, fruits, vegetables and animal foods. Quality criteria of processed foods. Physical, chemical and microbial contamination of foods. Food adulteration – common adulterants – health hazards. Tests to detect adulterants in food. Pesticides-Mechanisms of Toxicity-Residues in Food, Acceptable daily limits. FosTac - Food Safety Training and Certification, Sensory Evaluation of Food Quality – Introduction - Panel Screening - Selection of Panel Members Objective/ Instrumental analysis of Quality Control. Statistical Quality Control of Foods Determination of Sensory thresholds and taste Interactions. Fundamentals of Food regulations-pertaining to Additives and Contaminants, SOP for Milk and milk products, Meat products, Fruit and vegetable products. Safety in handling of Food Additives.

Practical

Visit to FSSAI, FCI, AGMark, Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products. Identification of food logos. Study of food labelling. Identification of critical control points in a product line. Sensory evaluation of different food samples. Visit to quality control laboratory/food processing industries and note the procedures and parameters used for quality assessment. Estimation of quality parameters- cereals, pulses, fruits and veg. Market survey and quality analysis of street foods. Estimation of quality parameters – cereals, pulses, fruits and vegetables - Evaluation of food quality – objective and subjective methods - Market survey and quality analysis of street foods.

Suggested Readings

1. Detect Adulteration with Rapid Test (DART) booklet, FSSAI. Available at: https://www.fssai.gov.in/flipbook.php?bookid=201#book2/7 (Accessed on 02-02-2025).
2. *Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011.*
3. Jellinek G. 1985. *Sensory Evaluation of Foods: Theory and Practice*. Ellis Honwood Ltd., Chichester, England.
4. Kalia M and Sood S. 2010. *Food Preservation and Processing*. Revised edn. Kalyani Publishers, New Delhi.
5. *Manual of Food Standards and Quality Control*. 2014. Dept. of Foods and Nutrition, CCS HAU, Hisar.
6. Curtis Patricia A. 2005. *An Operational Textbook: Guide to Food Laws and Regulations*. Wiley-Blackwell.
7. Potter N N. 1996. *Food Science*. The AVI Publishing Company Inc., Westport, Connecticut.
8. Radonit Lassztity. 2008. *Food Quality and Standards*. Encyclopedia of Life Effort Systems, USA.

Agriculture Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Publishers, New Delhi.
3. Kohls R L and Uhl J N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi.
4. Kotler P and Armstrong G. 2005. *Principles of Marketing.* Pearson Prentice-Hall.
5. Lekhi R K and Singh J. 2006. *Agricultural Economics*. Kalyani Publishers, New Delhi.
6. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi.
7. Pandey M and Tewari D. 2004. *Rural and Agricultural Marketing*. International Book Distributing Co. Ltd., New Delhi.
8. Sharma R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii. To provide basic knowledge of computer with applications in agriculture.
iii. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm

decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WoRD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages. Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology. Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA). AR/VR demonstration.

Suggested Readings

1. Date C J. 2006. Introduction to database systems. (In) *Foundations of Database Design/Foundations of Database Design Series*. Pearson Education, pp. 1–16.
2. Rajaroman V and Adabala Neeharika. 2014. *Fundamentals of Computer*. PHI Learning Pvt. Ltd.
3. Sethi D P and Manoranjan. *Concepts and Techniques of Programming in C*. Wiley India, India.

Post- Semester IV (Only for exit option for UG- Diploma)

S. No.	Course Title	Credit Hours
1.	Internship (10 weeks)	**10 (0+10)***

*Mandatory requirement for UG-Diploma.

Semester V

Therapeutic Nutrition 4 (3+1)

Objectives

i. To acquire basic knowledge of nutrient requirements, recommended dietary allowances, and dietary modification under different physiological conditions

ii. To acquire basic knowledge of food groups, food exchange system and their nutritional significance, and application of knowledge acquired for healthy eating

iii. To develop practical skills in planning and management of diets for the different age groups under normal/ physiological conditions keeping in mind the dietary guidelines

iv. To gain knowledge on the nature and scope of therapeutic nutrition; and understand the principles of dietary modification and apply in planning

v. To understand nutrition-related diseases of the: gut, liver, gallbladder, pancreas, and heart

vi. To know the etiology, incidence, nature, clinical symptoms, diagnosis, and medical and dietary management of disease

vii. To modify the diet plans to suit the disease condition

Theory

Terminologies used in the therapeutic nutrition; Use of food groups and food pyramid. Importance and components of diet history; Different principle of therapeutic diets, Therapeutic modifications of normal diet in terms of consistency and nutrients; Normal and artificial feeding methods, Role of Dietician in medical nutrition therapy, Diet during malnutrition- undernutrition and over nutrition; Diet during infection and fever; Diet during Gastro intestinal disorder-esophagitis, diarrhea, constipation, peptic ulcers, IBD/IBS. Liver and gall bladder disorders-dietary management of jaundice, hepatitis, liver cirrhosis, cholelithiasis. Kidney disorders- dietary management of nephrosis, nephritis, renal failure, renal calculi and dialysis. Arthritis and gout, Cardiovascular disorders- dietary management of atherosclerosis, hypertension and stroke and congestive heart failure. Diabetes mellitus- dietary management during diabetes mellitus and complications, glycemic index and glycemic load of food items. PCOD/PCOS: etiology, signs and symptoms, types, risk factors and dietary management. Cancer- dietary management; Inborn errors of metabolism; allergies and intolerance, burns and trauma; Common auto immune diseases/ disorders.

Practical

Planning of food exchange list, taking diet history. Planning and preparation of diet modified in consistency and nutrients for severely ill patients. Plan a diet for artificial feeding patients. Plan a diet patient with malnutrition, infections and fevers - PEM, typhoid, tuberculosis, influenza. Plan a diet for a patient with during atherosclerosis, hypertension. Plan a diet for patient with diarrhea, constipation, peptic ulcers and esophagitis. Plan a diet for a patient suffering from liver cirrhosis, jaundice, hepatitis and cholelithiasis. Plan a diet for a diabetic patient. Plan a diet of a patient renal failure, renal calculi. Plan a diet for a patient with cancer. Plan a diet for patient with lactose intolerance and celiac diseases.

Suggested Readings

1. Mahan L K and Escott-Stump S. 2000. *Krause's Food, Nutrition and Diet Therapy.* W.B. Sanders Company, Philadelphia.

2. National Institutes of Health. Diet History Questionnaire. https://www.nih.gov (Accessed on 04-01-2025).

3. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy.* Westville Publishing House, New Delhi, India.

4. Raghuvanshi R S and Mittal M. 2016. *Clinical Nutrition Chikitskeey Poshan.* Vikas Publishing House Pvt. Ltd., New Delhi.
5. Robinson C H, Lawler M R, Chenoweth W L and Garwick A E. 2013. *Normal and Therapeutic Nutrition.* Macmillan Publishing Company, New York, pp 1-16.
6. Sharma A. 2017. *Principles of Therapeutic Nutrition and Dietetics*. CBS, New Delhi.

Food Analysis 3 (2+1)

Objectives

i. To impart knowledge to students on principles and techniques of food analysis by using physical, chemical, biological methods
ii. To apply their knowledge and skills acquired to solve real-world problems associated with food analysis

Theory

Terminologies associated with food analysis, Rules and regulation of food analysis. Different official methods of analysis. Familiarization to terms and calculations used in preparation of various standard solutions. Sample and sampling techniques. Principles, techniques and applications of: spectrophotometer, colorimeter, pH meter, refractometer, electrophoresis, centrifuge, HPLC, GLC, TLC, GCMS, UPLC, AAS, AES. Proximate composition analysis methods. Moisture analysis- direct and indirect methods of analysis. Protein analysis method – dumas, Biuret, Lowry's, dye binding and Spectroscopy method, amino acid analyzer. Mineral analysis- dry ashing, wet ashing, titrimetric, gravimetric, colorimetric and instrumental methods-AAS, AES. Physical characteristic of foods, rheological properties of food. Anti-nutrients in foods: phytate, tannins, oxalates, saponins, trypsin and chymotrypsin. Animal assay: Principles, techniques and applications. Principles for estimation of water- and fat-soluble vitamins.

Practical

Orientation of food analysis laboratory. Calculation and preparation of various standard solution. Preparation of sample for food analysis. Proximate composition of analysis- moisture, Kjeldahl method of protein analysis, Fat analysis – soxhlet, soxplus, estimation of free fatty acid (FFA), ashing and CHO by difference. Estimation of sugar, reducing and non-reducing sugars and starch. Mineral analysis- iron, calcium. Testing acidity of foods. Estimation of anti-nutrients: phytate/ tannins/oxalates/saponins. Estimation of rancidity in foods and peroxide values. Functioning and use of HPLC, GLC and pH meter, GCMS, UPLC. Visit to food quality control lab.

Suggested Readings

1. AOAC. 2012. *Association of Official Analytical Chemists*. Washington, DC.
2. Nielsen S. 2010. *Food Analysis*, Springer Science and Business Media. United States.
3. Oser B L. 1979. *Hawk's Physiological Chemistry*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
4. Pearson D. 1973. *Laboratory Techniques in Food Analysis*. Wiley, United States.
5. Pomeranz Y. 2013. *Food Analysis: Theory and Practice*. Springer US, United States.

6. Raghuramulu N, Madhavan Nair K and Kalyanasundaram S. 2003. *A Manual of Laboratory Techniques*. National Institute of Nutrition (India).
7. Ranganna S. 2000. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Current Food Processing Technologies 3 (2+1)

Objectives

i. To explain major food preservation techniques and underlying principles
ii. To understand the technology available for food processing
iii. To determine suitable methods of processing techniques for a chosen food
iv. To understand novel food processing methods including non-thermal food processing techniques
v. To understand the purpose and principles of food packaging
vi. To develop an understanding of major packaging materials used in food packaging
vii. To evaluate the suitability of packaging material for a particular type of food
viii. To understand the operations involved in packaging material manufacture
ix. To gain knowledge of the legal, environmental and quality aspects associated with packaging materials and operations used in the food industry

Theory

Current scenario in food processing industry, post-harvest loss and losses in post-harvest operation. Upcoming trends in food processing-thermal treatment, ultrasound, freezing, pulse electric field, shockwave technology. Minimal processing- application of Ultra sonic food processing techniques – membrane processing – applications in food processing industries – robotics – applications and opportunities – issues and obstacles Food preservation using chemicals, radiation and hurdle technology. Nanotechnology in food preservation, food processing, agriculture and in packaging. Processing of convenient cereals and millets, processing of pulses and legumes, oilseed processing. Principle and method of preservation by- pasteurization, canning, bottling, sterilization. Advance dehydration technologies- Freeze drying, microwave dehydration, electric dehydrator, osmotic dehydration, hybrid drying technologies, vacuum drying methods, spray drying methods. High pressure processing- principle, safety and stability of high-pressured processed food. Encapsulation technology – principle, mechanism involved, encapsulation agents and uses. 3D printing and application in food manufacture. Government policy on import and export of processed fruits and vegetables.

Practical

Processing of breakfast cereals, Processing of pulses into flour, flakes and fermented Demonstration of dehydration of foods via- freeze drying, osmotic dehydration, spray drying, vacuum drying, microwave dehydration. Processing of fruits and vegetables via- canning using brine and syrup. Blanching in food items. 3D printed foods. Preservation using pasteurization and sterilization. Visit to food processing unit and nanotechnology lab

Suggested Readings

1. Chakraverty A. 1995. *Post-Harvest Technology of Cereal, Pulses and Oilseeds*. (3rd Edn.). Oxford and IBH Publishing Co. Pvt. Ltd.
2. Fellows P J. 2017. *Food Processing Technology: Principles and Practice*. (4th Edn.). Woodhead Publishing Ltd., Cambridge.
3. Hartel R W and Heldman D. 2012. *Principles of Food Processing*. Aspen Publishers Inc., New York.
4. Potter N N. 2003. *Food Science*. AVI Publishing Company Inc., Westport, Connecticut.
5. Shafiur Rahman M. 2007. *Handbook of Food Preservation*. (2nd Edn.). CRC Press, London.
6. Sivshankar B. 2002. *Food Processing and Preservation*. Prentice-Hall of India Pvt. Ltd., Delhi.
7. Srivastava R P and Kumar S. 1994. *Fruit and Vegetable Preservation*. International Book Distributing Co., Lucknow.

Statistical Methods 3 (2+1)

Objectives

i. To organize, manage and present data
ii. To analyze statistical data graphically using frequency distributions and cumulative frequency distributions
iii. To analyze statistical data using measures of central tendency, dispersion and location
iv. To use the basic probability rules, including additive and multiplicative laws, using the terms, independent and mutually exclusive events
v. To translate real-world problems into probability models
vi. To derive the probability density function of transformation of random variables
vii. To calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables
viii. To analyze Statistical data using MS-Excel

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 × 2 Contingency Table. Introduction to Analysis of Variance, Analysis of One-Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data)

with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 × 2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal B L. 2006. *Basic Statistics*. New Age International Publisher, New Delhi.
2. Cleveland W S. 1994. *The Elements of Graphing Data*. (2nd Edn.). Chapman and Hall, Boca Raton, Florida.
3. Sprent P. 1993. *Applied Non-Parametric Statistical Methods*. (2nd Edn.). Chapman and Hall, Boca Raton, Florida.
4. Wetherill G B. 1982. *Elementary Statistical Methods*. Chapman and Hall, Boca Raton, Florida.

Diet and Nutrition Counselling 3 (0+3)

Objectives

i. To understand, critically assess and know how to use and apply information sources related to nutrition, food, lifestyle and health

ii. To be able to provide nutrition counselling and education to individuals, groups, and communities throughout the lifespan using a variety of communication strategies

Practical

Qualities of counsellor (confidence, knowledge, communication skills, patient listener, empathetic. Self- assessment of role as a dietitian – Pre-test on role, summary of competencies. Developing diet history questionnaire and taking diet history. Preparation of standard protocol based on case studies and group discussion. Preparation of overweight and underweight fact list handout and development of counselling guidelines for weight loss and weight gain. Weight loss counselling – Use of role play technique, counselling on diet, exercise and life style Visit to hospitals with therapeutic kitchen setup. Diabetic diet counselling development of dietary fat facts list, cholesterol facts list, sodium facts list. Development of dietary counselling tips for different cardiovascular disorder and counselling; cardiac patients using role play technique, presentation in gathering. Diet exhibition cardiovascular disorders in a specialty hospital / general hospital, preparation of handouts on ulcer facts list, high fibre facts list, low residue facts list, low lactose facts list, counselling for patients suffering from diarrhoea, constipation, gastro-esophageal reflex (GERD, colitis, diverticulosis and ulcer. Preparation of SOAP notes and gall bladder facts list handout and counselling a patient of gall stones. Preparation of liver disease facts list handout, collection of case history of patient suffering from hepatitis, cirrhosis of liver, alcoholics. Counselling the patient and conducting group discussion. Preparation of kidney disease facts list handout and development of counselling tips for kidney disorders, dietary counselling in a specialty hospital / diet and nutrition counselling centre for kidney disorder and diet exhibition for kidney disorder. Preparation of cancer facts list handout, Preparation of list of parenteral and enteral products available in the market for use

during counselling. Setting up a unit for nutrition counselling. Role play exercises for counselling. Supervised counselling of patients/clients.

Suggested Readings

1. Antia P. 1986. *Clinical Dietetics and Nutrition*. Oxford Univ., Bombay.
2. ICMR. 2020. *Recommended Dietary Allowance for Indians*. ICMR, Delhi.
3. Moris E S. 1994. *Modern Nutrition in Health and Disease*. Lea & Febiger, USA.
4. Park K. 1997. *Textbook of Preventive and Social Medicine*. (1st Edn.). Banarsidas Bhanot, Jabalpur.
5. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. Westville Publishing House, New Delhi.
6. Raghuvanshi R S and Mittal M. 2016. *Clinical Nutrition Chikitskeey Poshan*. Vikas Publishing House Pvt. Ltd., New Delhi.
7. Robinson C H, Lawler M R, Chenoweth W L and Garwick A E. 1982. *Normal and Therapeutic Nutrition*. pp. 1-16. Macmillan Publishing Company, New York.

Nutraceuticals and Health Foods 2 (2+0)

Objectives

i. To provide an overview of the field of functional foods, nutraceuticals and natural health products

ii. To understand the functional food concept as related to ingredient efficacy and safety

iii. To familiarizes students with: examples of bioactive ingredient-disease relationships and the importance of clinical study support; regulatory aspects of functional foods; requirements for standards of evidence of efficacy for health claims; and market determinants of the functional food industry

Theory

Nutraceuticals and functional food definition, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues including CODEX, FSSAI Regulation. Classification of nutraceutical substances based on food sources and based on mechanism of action, and based on chemical nature. Nutrition claims by FSSAI. Regulatory issues for nutraceuticals including national and international standards. Potential health benefits of major nutraceuticals, omega-3, lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc, Metabolism, bioavailability and pharmacokinetics of nutraceuticals. Concept of angiogenesis, nutraceuticals for joint heath, cardiovascular diseases, cancer, diabetes, obesity, eye health, cholesterol management. mental health, immune enhancement, age-related macular degeneration, endurance performance and mood disorders. Clinical testing of nutraceuticals and health foods - interactions of prescribed drugs and nutraceuticals; adverse effects and toxicity aspects of nutraceuticals; Nutrigenomics – an introduction and its relation to nutraceuticals. Current research in functional foods.

Suggested Readings

1. Aluko R E. 2012. *Functional Foods and Nutraceuticals*. Springer Publishing.
2. Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food, and Novel Food) Regulations, 2016.
3. Robert E C. 2013. *Handbook of Nutraceuticals and Functional Foods*. (2nd Edn.). CRC Press, Wildman.
4. Saarela M. 2011. *Functional Foods*. (2nd Edn.). Elsevier Publishing, India.
5. Sarkate A P, Patil M A and Agharde P V. 2021. *Nutraceuticals and Human Health*. Brillion Publishing, New Delhi.

Introduction to Clinical Nutrition 3 (2+1)

Objectives

i. To acquire a basic understanding of the various clinical changes related to nutrition, which are seen in different diseases, both deficiency and otherwise
ii. To understand the etiology, prevalence, clinical signs and symptoms of nutritional deficiency diseases (Vitamin A deficiency, anemia, IDD, PEM etc.)
iii. To gain understanding of physiology in health and pathophysiology in disease complications occurring in various conditions and the inter relationships thereon

Theory

Metabolic changes and clinical diagnosis in various diseases: Nutrient deficiency diseases like Anemia, vitamin B complex deficiencies, Vitamin A deficiency disease, Iodine deficiency disorders, Calcium and vitamin D deficiency diseases, ascorbic acid deficiency. Metabolic changes and clinical diagnosis in degenerative diseases: Diabetes, Cardiovascular diseases, renal disorder, liver diseases, cancer. Normal cut-off values for blood and urine parameters. Interpretation of report of blood and urine in different disease conditions. Drug and nutrient interaction, effect of drugs on nutritional status. Effect of diet and nutritional status on drug effectiveness. Depletion and repletion studies; Nutrient balance studies; Use of isotopically labelled nutrients. Nutrition screening and assessment methods (Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA), Patient-Generated Subjective Global Assessment (PG- SGA), Malnutrition Universal Screening tool (MUST), disease specific tools. Nutrition care process- Assessment, Diagnosis, Interpretation, Monitoring, and Evaluation (ADIME).

Practical

Identification and interpretation of clinical signs of nutritional deficiency diseases- sampling of blood and urine for nutritional status, estimation of hemoglobin. Estimation of glucose in blood and urine in normal and diabetic persons. Estimation of lipid profile in normal and heart patients. Estimation of Glycosylated Hemoglobin, Estimation of serum total protein and serum albumin, visit to a clinical laboratory.

Suggested Readings

1. Bamji M S, Krishnaswamy K and Brahmam G N V. 2019. *Textbook of Human Nutrition*. (4th Edn.). Oxford and IBH Publishing Co. Pvt. Ltd.
2. Connie W B and Christine S R. 2016. *Handbook of Clinical Nutrition and Ageing*. Humana Press.
3. E-PG Pathshala - Nutrition Science (Accessed on 21-12-2024).
4. Gibney M J, Elia M, Ljungqvist O and Dowsett J. 2013. *Clinical Nutrition*. Wiley Blackwell Publishing Company, Boston.
5. Gibney M J, Macdonald I A and Roche H M. 2011. *Nutrition and Metabolism*. Wiley Blackwell Publishing Company, Boston.
6. Gopalan C and Krishnaswamy K. 2000. *Nutrition in Major Metabolic Diseases*. Oxford University Press, New Delhi.
7. Joshi Y K. 2004. *Basics of Clinical Nutrition*. Jaypee Brothers, New Delhi.
8. Lee R D and Nieman D C. 1993. *Nutritional Assessment*. Brown and Benchmark, USA.
9. Oser B L. 1979. *Hawk's Physiological Chemistry*. Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
10. Pathak N N. 1997. *Analytical Techniques in Clinical Nutrition (Manual)*. Centre of Advanced Studies in Animal Nutrition, IVRI, Izatnagar.
11. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. Westville Publishing House, New Delhi.
12. Width M and Reinhard T. 2017. *The Essential Pocket Guide for Clinical Nutrition*. LWW Publishing, New York.

Educational Tour (Non-gradial) **2 (0+2)**

Semester VI

Food and Nutrition Security **2 (1+1)**

Objectives

i. To explain the concepts of food and nutrition, malnutrition, food security and livelihoods. Understanding these concepts is important to assess the nutrition situation, design and implement programs, investments and policies that address nutrition problems (also called nutrition- sensitive), and evaluate the nutritional outcomes of programs, investments and policies.

ii. To introduce the concepts and tools used in food security analysis. It defines food security and its relationship to the concepts of vulnerability, hunger, malnutrition and poverty

iii. To provide guidelines on how to interpret and use conceptual frameworks for analyzing food security

Theory

Food Security: Concept and definition, pillars and determinants. Global Food Security Index. Global hunger index and its indicator and how they measured. Global challenges to food and

nutrition security. Inter- relationship between hunger and food insecurity. Strategy to achieve food security at household, national and global level. Role of nutrition in human health and sustainable development. Relationship between nutrition, diet and lifestyle. Growing global concern for non-communicable diseases. Opportunities and challenges of nutrition and food preferences as a means of preventing the spread of chronic and non- infectious diseases. Impact of social, cultural and economic factors on the food and nutrition security. Nutrition security: Concept and definition, pillars and determinants. Nutrition sensitive approaches to combat malnutrition. Dietary diversity for nutrition security. Dietary diversification through utilization of bio-fortified crops, indigenous and under-utilized foods. Millennium Development Goals, Sustainable Development Goals (SDG) II and way ahead. National and international policies and programs related to food and nutrition security: POSHAN Abhiyan, NARI (Nutri-sensitive Agricultural Resources and Innovations), NFSA (National Food Security Act), NFSM (National Food Security Mission), NNM (National Nutrition Mission), WFP (World Food program), FAO (Food and Agricultural Organization). Public distribution system in context to food and nutrition security, International Fund for Agriculture Development (IFAD) etc.

Practical

Household survey for assessment of indicators of Food insecurity. Proforma dev, survey, report writing, validation. Assessment of dietary diversity, quality, food security, nutrition security. Food product development and formulation for intervention of nutri-sensitive approaches and strategies to eradicate poverty and malnutrition. Impact of nutritional policies and programs on the nutritional status of the vulnerable group. Framing questionnaire to conduct dietary survey – using Food Frequency Questionnaire.

Suggested Readings

1. Coates J, Swindale A and Bilinsky P. 2007. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide*, Version 3. Food and Nutrition Technical Assistance III Project (FANTA).
2. Ruel M T, Garrett J, Yosef S and Olivier M. 2017. Urbanization, food security and nutrition. *Nutrition and Health in a Developing World*. Springer, pp. 705-735.
3. Pingali P, Alinovi L and Sutton J. 2005. *Food Security in Complex Emergencies: Enhancing Food System Resilience. Disasters 29(s1): 5-24*. Springer.
4. Raghuvanshi R S. 2013. Nutritional Security through Diversified Food Production. *In: Agrarian Change and Small Farmers, Supermarkets, Viability and Food Policy*, Bhatt K N and Bhargava P (Eds.). Concept Publishing Company Pvt. Ltd., New Delhi.
5. Sunderland T, Powell B, Ickowitz A, Foli S, Pinedo-Vasquez M, Nasi R and Padoch C. 2013. *Food Security and Nutrition*. Center for International Forestry Research (CIFOR), Bogor, Indonesia.
6. Swindale A and Bilinsky P. 2006. *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*. Vol. 2. FHI 360/FANTA, Washington, D.C.
7. Willett W. 2013. *Nutritional Epidemiology*. Oxford University Press, India.

Nutrition, Body Composition and Physical Fitness 3 (2+1)

Objectives

i. To provide understanding of the interactions between nutrition and exercise by integrating metabolism and physiology concepts in the context of recreational physical fitness training

ii. To identify and describe disordered eating and exercise patterns

iii. To gain an understanding of the training and experience necessary to obtain various nutrition and exercise credentials

Theory

Body composition, methods of assessment- tools and techniques, changes in Body composition with age and fitness. Interrelationship between physical fitness and performance. Basic structure of a muscle with the help of a diagram - Functions and locations of muscles in the body - muscle groups –Major skeletal muscles. Basics of exercise regime - FITT formula – Frequency, Intensity, Time and Type of exercises for fitness. - Warm up exercises - Cool down exercises: Exercises - Benefits of regular and adequate exercise - Types of exercises and health benefits with suitable examples. Anaerobic exercises Flexibility exercises. Effect of nutrition in physical fitness and sports performance and athletics. Concept of energy balance - factors affecting energy – equations to assess BMR. . Aerobic exercise to increase cardiovascular endurance – benefits and examples -Treadmill, Elliptical cycle, Stationary cycle. Aerobics workouts Macronutrients metabolism in exercise – Carbohydrates: lactose intolerance, Diabetes, hypoglycemia; Lipids and Oils, Fatty Acids, Triglycerides, Phospholipids, Sterols. Functions of fats, needs, deficiencies. Role of water and electrolytes in performance. Vitamins metabolism in sports - Free radicals in exercise role of antioxidants in exercise - Minerals and trace minerals metabolism in exercise and essential minerals and trace minerals in sports. Sports nutrition products - supplements related to energy metabolism - weight reduction and botanical and herbal supplements - sports nutrition theory to practice –, Special consideration in sports nutrition- Women, young, diabetic, vegetarian athletes - Sport specific nutrition – Gymnastics, weight lifters, skiers, cyclists, swimming, skating, Winning recipes for peak performance. Assessment of Physical fitness Functional tests: Cardiorespiratory and muscular assessment; Type of measurement and protocol for evaluation and interpretation of performance; Aerobic Power or VO2max; Anaerobic Threshold; Economy of Movement. Fitness assessment: Types of exercise, Components of physical fitness and its evaluation in health and performance. Activity Recording: Self-reporting of activities vs. Direct monitoring of activities. Techniques to measure energy expenditure and energy intake. Techniques to assess physical fitness. Aging theories, physiology, mechanism and role of nutrients in arresting aging process.

Practical

Recording of Dietary intake by 24-hour recall method for 3 consecutive days. Recording of energy expenditure by 24-hour recall method by using multipliers for 3 consecutive days. Calculation of energy balance by using above data. Demonstration and use of body composition analyzer calculation of total fat and fat free muscle mass. Calculation of fat % and BC of adults, equations to assess BMR. Physical tests: Harvard STEP test, Treadmill test to assess heart health, muscular grip test. Visit to established fitness center.

Suggested Readings

1. eGyanKosh - *Unit 3* (Accessed on 12-01-2025). https://egyankosh.ac.in/bitstream/123456789/42208/3/Unit-3.pdf.
2. Falkner F and Tanner J M. 1978. *Human Growth - Principles and Prenatal Growth*. Vol. I. Springer-Verlag New York Inc.
3. Falkner F and Tanner J M. 1980. *Human Growth Methodology: Ecological, Genetic, and Nutritional Effects on Growth*. Vol. III. Plenum Press, New York.
4. Fik H H and Mikesky A E. 2015. *Practical Application in Sports and Nutrition*. (4th Edn.). Jones and Bartlett Learning, Burlington, MA.
5. Srilakshmi B, Suganthi V, Ashok and Kalaivani C. 2017. *Exercise Physiology, Fitness and Sports Nutrition*. (1st Edn.). New Age International (P) Ltd. Publishers, New Delhi.

Food Microbiology 3 (2+1)

Objectives

i. To understand scope of food microbiology and food safety
ii. To understand important genera associated with food
iii. To learn techniques for enumeration of microbes and methods (traditional to advanced) for preserving food
iv. To understand role of different microorganisms in food spoilage, food fermentation and food-borne diseases
v. To learn about microbiological quality control and food-borne illnesses investigation procedures for ensuring food safety and hygiene
vi. To learn food safety rules and regulations, Food Safety Management System (FSMS), and Microbiological Risk Assessment

Theory

The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Difference between prokaryotic and eukaryotic cells. Basic aspects and scope of food microbiology; Intrinsic and extrinsic factors that affect microbial growth in foods. Food preservation - Physical methods. Chemical preservatives and natural antimicrobial compounds, biology-based preservation system. Importance and scope of microorganisms in food. Primary sources of microorganisms in food. Assessment of microbial load in foods-microscopic, cultural, immunological and DNA based methods. Fermentation: methods, applications, fermented foods. Lactic acid bacteria – production of cultures for food fermentation. Fermented foods- cereals, dairy products, vegetables and fruits. - bread, beer, yoghurt, butter, cheese, kefir, kumiss, sauerkraut, olives, pickles, wine, vinegar. Control of microorganisms by use of low and high temperature, asepsis, water activity, drying, preservatives, radiation and pressure for control of microorganisms; Microbiology of milk and milk products; Sources of contamination, spoilage and prevention; Microbiology of fruits and vegetables; cereal and cereal products; meat and meat products; fish and other sea foods; poultry and eggs; sugar and sugar products; salts and spices; contamination, spoilage and prevention. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; chemical changes caused by microorganisms;

control of spoilage. Food borne diseases and safety measures. Present problem in food production / food processing / fresh food handling industries are facing several restrictions in different stages both from domestic and global players and consumers.

Practical

Changes in practices: General laboratory practices in microbiology laboratory, Equipment used in food microbiology laboratory, Aseptic methods, Sterilization methods, Morphological studies, Preparation of media, Isolation and enrichment of microorganisms, Microbial analysis of food products and water. Isolation of molds from foods. Microbial examination of cereal and cereal products, vegetable and fruits, meat and meat products, fish and other sea foods, Eggs and poultry, milk and milk products; sugar, salts and spices. Preparation of fermented whey beverages.

Suggested Readings

1. Adams M R and Moss M O. 2008. Food Microbiology. (3rd Edn.). RCS Publishing, UK.
2. Frazier J and Westhoff D C. 2017. Food Microbiology. (5th Edn.). McGraw Hill, India.
3. Jay J M, Loessner M J and Golden D A. 2005. Modern Food Microbiology. (7th Edn.). Springer.
4. Ray B. 2004. Fundamentals of Food Microbiology, 3rd edn. CRC, New Delhi.
5. Steinkraus K S. 1996. Handbook of Indigenous Fermented Foods. Marcel Dekker, Abington, UK.
6. GITAM eResource Food Microbiology (Accessed on 02-02-2025). http://www.gitam.edu/eresource/
7. Centers for Disease Control and Prevention (Accessed on 11-01-2025). http://www.cdc.gov.
8. U.S. Food and Drug Administration - Foodborne Illness Contaminants (Accessed on 13-02-2025). http://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/UCM297627.pdf.

Milk Processing and Technology 3 (2+1)

Objectives

i. To understand chemistry of milk constituents. Milk and various dairy products are discussed from the perspective of the chemical, physical and biological changes that occur during processing
ii. To be able to describe the composition of milk, identify the approximate content of individual types present, and describe physicochemical characteristics of the main components
iii. To learn to integrate knowledge of food chemistry/engineering/microbiology and physical properties of foods to understand the processing of dairy products
iv. To be able to explain how dairy products (such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved

Theory

Introduction, importance and scope of fluid milk industry in India and abroad: Brief history and present status. Composition of milk, nutritive value of milk of cow and buffalo. Physico-chemical properties of milk and milk constituents: Physical state, acidity, pH, density and specific gravity, freezing point, color and flavor. Microbiology of milk. Types of microorganisms, their production

and consequent results in milk production. Types of milk: Sterilized Milk; Homogenized Milk; Flavored Milks; Standardized Milk; Reconstituted/Re-hydrated Milk; Recombined Milk; Toned Milk. Milk products- traditional products- butter, ghee, khoa, cheese in theory. Steps of milk processing: collection, chilling, standardization, pasteurization, homogenization, bactofugation, and principles of dehydration. Management of processing plant: Various kinds of designs and layouts of plants Value addition for fluid milk. Fortification of milk Waste management, Quality control aspects of milk: Status of antibiotics, pesticides, heavy metals etc., good manufacturing practices, implementation of HACCP standards, cleaning and sanitization of fluid plant: Indian standards for milk and milk products as per PFA, BIS, AGMARK etc., cleaning and sanitization procedures. Judging and grading of milk, defects in milk, their causes and prevention.

Practical

Platform test of raw milk (clot on boiling (COB) test, alcohol test). Adulteration in milk and its detection. Sampling of milk. Estimation of fat, SNF, TS platform tests. Cream separation. Detection of adulterants Microbiological quality evaluation of milk and milk products Preparation of milk products. Paneer, chenna, ice-cream, khoa, burfi, flavored milk, rasogulla. Visit to modern milk processing and manufacturing plants.

Suggested Readings

1. Aneja R P, Mathur B N, Chandan R C and Banerjee A K. 2002. *Technology of Indian Milk Products*. Dairy India Yearbook.
2. Lampert L M. 1970. *Modern Dairy Products*. Chemical Publishing Company Inc., New York.
3. Srinivasan M R and Anantkrishnan C P. 1964. *Milk Products of India*. ICAR.
4. Sukumar De. 2001. *Outlines of Dairy Technology*. Oxford University Press, New Delhi.
5. Swarup A. 2013. *Milk Processing Technology*. Discovery Publishing House Pvt. Ltd, New Delhi.

Cereals and Millets: Processing and Technology 3 (2+1)

Objectives

i. To create understanding about the processing of major cereals like paddy, maize etc.
ii. To study the storage and handling techniques of cereals
iii. To study about the by products obtained during processing along with their uses
iv. To gain knowledge on processing and milling of pulses

Theory

Production and consumption scenario of cereals and millets; Structure, Chemical composition and nutritive value of cereals and millets. General unit operations in agricultural process engineering and importance of these unit operations in grain processing, Structure and composition of cereals, millets. Morphology, physico-chemical properties of cereals, major and minor millets, Chemical tests- sedimentation test, flour swelling volume; Conventional and modern milling technology of paddy processing, estimation of milling efficiency, quality characteristics of milled cereals and millets. Parboiling of rice, bran stabilization and methods. Wheat milling and processing: purification and reduction system. Different types wheat flour, Quality characteristics of flour. Characteristics of wheat flour suitable for baking. Milling and processing of oats, corn, barley, sorghum. Primary and

secondary products of cereal processing. Processing of breakfast cereals: flaked, puffed, expanded, extruded and shredded. Malted cereals and cereal products. By-products of cereals and millets processing. Structure and composition of major millets - maize, sorghum - wet and dry milling methods - processing and by products. Composition of minor millets – pearl millet, finger millet, little millet, kodo millet, foxtail millet and barnyard millet. Processing of minor millets. Structure, composition and processing of oats and barley. Malting of cereals and millets - production of weaning and supplementary foods, nutrient dense foods – amylase rich foods (ARF).

Practical

Study of physicochemical properties of cereals; Parboiling of paddy; Cooking quality of rice, milling of rice; Conditioning and milling of wheat; Production of cereal flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of cereal malt. Determination of gelatinization temperature by amylograph; Processing of value-added products from millets. Estimation of gluten content in wheat flour. Preparation of snacks based on cereals and millets (roasting, popping, pearling, flaking, malting). Study of different unit operations and machineries in rice mills; wheat/ flour mills; Study of extrusion process.

Suggested Readings

1. Chakraverty A and Singh R P. 2014. *Post-Harvest Technology and Food Process Engineering*. CRC Press, Boca Raton, FL, USA.
2. Chakraverty A, Arun S, Mujumdar G S, Raghavan Vijaya and Ramaswamy H S. 2003. *Handbook of Post-Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. Marcel Dekker, Inc., New York, USA.
3. Dash S K, Bebartta J P and Kar A. 2012. *Rice Processing and Allied Activities*. Kalyani Publishers, New Delhi.
4. Dendy D A V and Dobraszczyk B J. 2001. *Cereal and Cereal Products: Technology and Chemistry*. Springer-Verlag, USA.
5. Khader V. 2001. *Textbook of Food Science and Technology*. Directorate of Information and Publications of Agriculture, ICAR, Krishi Anusandhan Bhawan, Pusa, New Delhi.
6. Khan K and Shewry P R. 2009. *Wheat: Chemistry and Technology*. (4th Edn.). AACC International, Inc., St. Paul, MN, USA.
7. Manay N S and Shadaksharaswamy M. 2001. *Foods: Facts and Principles*. Wiley Eastern Ltd., New Delhi.
8. Pillaiyar P. 1988. *Rice: Post Production Manual*. Wiley Eastern Ltd, Noida.

Sustainable Nutrition 3 (2+1)

Objectives

i. To explore the relationship between health, nutrition, environment and sustainability
ii. To investigate the potential causes of unhealthy eating patterns
iii. To discover the importance of a sustainable diet

Theory

Sustainable development goals and sustainable nutrition. Definition of sustainable diets, dimensions of sustainable diets. Aims and guiding principles of sustainable diets. Climate change

and sustainable and healthy diets. Indicators and measures of sustainable diets. Assessing the environmental impact of diet. Nutritional indicators of sustainability. Sustainable diet: Social and cultural perspective. Sustainable diets and food-based dietary guidelines. Traditional food at the epicentre of the sustainable food system. Determinants of food choice and dietary change. Organic food and sustainable nutrition. Indian diets and sustainability. Attaining healthy and sustainable diets. Economics, food waste, biodiversity, The environmental impact and sustainability of existing food systems. Sustainable Healthy Diets: Models and Measures - the dietary dimension, the economic dimension, the sociocultural domain, the environmental domain. Metrics for Characterizing Sustainable Nutrition Security: Nutrient Adequacy of Foods, Diets and the Food Supply, Ecosystem Stability, Food Affordability and Availability, Sociocultural Wellbeing, Resilience, Food Safety, Waste and Loss Reduction.

Practical

Develop a meal plan for nutritional adequacy and sustainability; Undertake a market survey of food products with sustainable or climate-friendly labels; Assess the 7-day food menu served in university hostels in terms of sustainability; Pilot study on assessment of food choice motives of university students.

Suggested Readings

1. Burlingame B and Dernini S. (Ed.). 2019. *Sustainable Diets: Linking Nutrition and Food Systems*. CABI, Wallingford, Oxfordshire; Boston, MA.
2. Contento I R. 2011. Overview of Determinants of Food Choice and Dietary Change: Implications for Nutrition Education. *Nutrition Education: Linking Research, Theory, and Practice*. (2nd Edn.). pp. 26–42. Jones and Bartlett Publishers Burlington, Massachusetts 01803, US.
3. FAO. 2012. Sustainable Diets and Biodiversity—Directions and Solutions for Policy, Research, and Actions. (In) *Proceedings of the International Scientific Symposium: Biodiversity and Sustainable Diets United Against Hunger*. Food and Agriculture Organization of the United Nations. Available at: www.fao.org/3/i3004e/i3004e00.htm. (Accessed on 13-02-2025).
4. FAO and WHO. 2019. *Sustainable Healthy Diets – Guiding Principles*. Available at: www.fao.org/3/ca6640en/ca6640en.pdf. (Accessed on 13-02-2025).
5. Green R F, Joy E J M, Harris F, Agrawal S, Aleksandrowicz L, Hillier J, Macdiarmid J I, Milner J, Vetter S H, Smith P, Haines A and Dangour A D. 2018. Greenhouse gas emissions and water footprints of typical dietary patterns in India. *Science of The Total Environment*. 643, 1411–1418. https://doi.org/10.1016/j.scitotenv.2018.06.258
6. Joshi N and Raghuvanshi R S. 2025. Exploring environmental footprints and socio-demographic characteristics of Indian diets. *Science of The Total Environment*. 967, 178781. https://doi.org/10.1016/j.scitotenv.2025.178781(Accessed on 13-02-2025).
7. Kerry Group. *Sustainable Nutrition Profiling Whitepaper*. Available at: https://www.kerry.com/content/dam/kerry/sustainability/people/nutrition-health/Sustainable-Nutrition-Profiling-Whitepaper.pdf (Accessed on 13-02-2025).
8. Macdiarmid J, Kyle J, Horgan G, Loe J, Fyfe C, Johnstone A and McNeill G. 2011. *Livewell: A balance of healthy and sustainable food choices*. WWF. Rowett Institute of Nutrition and Health, University of Aberdeen.
9. Pathak H, Jain N, Bhatia A, Patel J and Aggarwal P K. 2010. Carbon footprints of Indian food items. Agriculture Ecosystems & Environment, 139(1–2), 66–73.

10. Sarilo S. 2018. *Towards Healthy and Sustainable Diets: Perspectives and Policy to Promote the Health of People and the Planet*. Springer Briefs in Public Health, Switzerland.
11. WHO. 2019. *Healthy diet* (WHO-EM/NUT/282/E; p. 19). WHO Regional Office for the Eastern Mediterranean. https://iris.who.int/bitstream/handle/10665/325828/EMROPUB_2019_en_23536.pdf (Accessed on 13-02-2025).

Hospitality Management 2 (1+1)

Objectives

i. To develop industry-ready professionals for the hospitality sector
ii. To gear students for operational and supervisory roles in all sectors
iii. To prepare students for each food production and service roles

Theory

Food preparation- Principles of food purchasing, Methods of food purchasing; Storages of foods; Different kitchen equipment- Heavy and Light equipment, Care and maintenance and their use; Management- Principles of management, Steps of effective management, techniques of effective management; Attitude towards work, behavior and personal hygiene, Do's and don'ts while working in the kitchen; Understanding the functioning of Food Production Dept. in any catering establishment / setup- Organizational structure, layout, Duties and responsibilities; Menu planning- Definition and Principles of menu planning, Types of menus; Financial management- Introduction, Principles, Costing, Budgeting. Accounting. Food cost control methods, Factors affecting food cost, labour cost, operating cost and overhead cost; Standardization of recipe- Definition of standardization of recipe, Standard recipe format and uses, portioning equipment, portion control; Personnel management- Introduction, Personal management concepts. Staff employment, Employee benefits, Methods of selection, Orientation, Training and development, Supervision, Motivation of employees.

Practical

Menu planning for industrial canteen/ hospital canteen/ cafeteria/ snack bar/ residential hostel. Standardization of recipes suitable for fast food outlet/ industrial canteen/ hospitals/ college hostel. Multiplication of standard recipes for quantity food production, quantity food management, portioning and fixing of cost. Visit to any one canteen attached to hospital and dietary department cafeteria, 3-star hotel/restaurant, 5-star hotel / restaurant, industrial canteen. Presentation of report on hospital canteen, cafeteria, 3-star hotel / restaurant, 5-star hotel / restaurant in terms of organizational set up, production, preparation and service. Calculate food cost, labour cost, operating cost and overhead cost of any standardized recipe.

Suggested Readings

1. Gregoire M B. 2017. *Foodservice Organizations: A Managerial and Systems Approach*. (9th Edn.). John Wiley, India.
2. Sethi M and Malhan S. 1993. *Catering Management: An Integrated Approach*. Wiley Eastern, India.

Food Hygiene and Sanitation 2 (1+1)

Objectives

i. To present the rules of personal hygiene and the importance of adhering to safety rules and regulations

ii. To introduce the causes and prevention of food poisoning and to introduce the requirements of safety in the workplace

iii. To introduce local legislation relating to the food service industry

Theory

Meaning and principle of food hygiene. Interrelationship of health, hygiene and sanitation Food Hazards. Personal hygiene. Water Requirement and use, sources of water supply, water pollution, purification of water, portable water and its Quality-Criteria and standards, hardness of water and its treatment, defluorination of water. Food hygiene: Contamination of foods from various sources. Green plants and fruits, animals, sewage, soil, air and water and their health hazards. Food spoilage. Perishable, semi perishable and non-perishable foods. Sanitary procedures for preparation, handling and storage of foods Food borne infection and intoxication. Food poisoning caused by bacteria: *Salmonella, Staphylococcal poisoning, Botulinum, Clostridium perfringens* and *B. cerus.* Sources, incubation period, mechanism of action. Investigation of Food Poisoning, prevention and control. Food Poisoning caused by agents other than microorganism. Poisonous plants, animals, chemicals, metals and pesticides etc. Pests and Rodent Control. Hygiene Requirements for Licensing and Sale. Health status of Food Handlers. Cross- contamination and its prevention methods. Introduction to HACCP principles and their application. Concept of TQM, GMP and Risk Assessment.

Practical

Identification of microorganism, preparation of slides, preparation of media. Collection of water samples. Testing of water for: (i) Physical quality (ii) Bacteriological quality. Survey of hygienic and sanitary condition in food shops/food vendors/ canteens. Report writing.

Suggested Readings

1. Adams M R and Moss M O. 2000. *Food Microbiology*. Panima Corp., New Delhi.
2. Frazier W C and Westhoff D C. 1996. *Food Microbiology*. (4th Edn.). Tata McGraw-Hill Company Limited.
3. Longree K L and Blaker G C. 1982. *Sanitary Techniques in Food Service*. John Wiley and Sons, New York.
4. Park K. 1997. *Textbook of Preventive and Social Medicine*. (1st Edn.). Banarsidas Bhanot, Jabalpur.
5. Srivastava A. 2013. *Food Hygiene and Sanitation*. Neha Publishers and Distributors, New Delhi.
6. Yadav S. 1997. *Food Hazards and Food Hygiene*. (1st Edn.). Annual Publication Ltd., New Delhi.

Semester VII

S. No.	Course Title	Credit Hours
1.	Ethics in Human Research	1(1+0)
2.	Seminar	1(0+1)
3.	Elective courses (totaling credit hours of 18)*	18
* From basket of a valuable elective courses	**Total**	**20**

Semester VIII

S. No.	Course Title	Credit Hours
1	Student READY **Option A (Any Two)** I. In-plant training (10 weeks) * II. Student Project** II. Hands on Training **Option B** Internship***	 10 (0+10) 10 (0+10) 10 (0+10) 20 (0+20)
	TOTAL	**20**

*Internship/ In plant training / attachment with Industry/ Research Institute (May be conducted in split manner in more than one industry/ institution/ organization)

** The student project will be R & D based, field study based or entrepreneurship based (incubation/ experiential learning)

*** The internship can be taken in service industry (e.g. hospital or hotel) OR in production industry (e.g. food/ nutraceuticals industry) OR in food quality and analysis laboratories

1. Internship Options in 8th Semester

A. In-plant training in hospitals

Understanding role of dietitian – role, concept, the recipients, duties, work schedule, Licenses, Certifications, and Registrations. Preparation of SOAP notes based on case studies and group discussion. Planning component. Preparation of list of parenteral and enteral products. Diabetic diet counselling- organizing exhibition in for the benefit of public- food exchange list and software used in diabetic diet counselling. Cardiovascular diseases- planning and presentation of different types of diet for disease conditions. Practicing diet counselling for CV patients. Preparation of diet chart for different types of liver diseases, collection of case history of patient suffering from hepatitis, cirrhosis of liver and alcoholics. Kidney diseases- preparation of facts list handout and development of counselling tips- dietary counselling in a specialty hospital and diet exhibition for kidney disorder. Diet for gastro intestinal disorders- preparation of handouts- ulcer, high fiber, low residue- counselling- diarrhea, constipation, colitis, diverticulosis and ulcer. Preparation of overweight and underweight fact list handout and development of counselling guidelines, workshop for patients, Weight loss counselling– use of role play technique and workshop for patients at obesity clinic and fitness centers. Diet for pre- and post-surgery, burns. Preparation of cancer facts list handout. Home care for critically ill and requiring long term nutrition support. Planning normal and therapeutic diets – diabetes, cardiovascular diseases, liver diseases, kidney diseases, gastrointestinal disorders. Role play exercises for counselling. Supervised counselling of patients/clients.

B. In-plant training in testing labs

Role of regional testing laboratories - methods of sample collection- handling and storage of samples, physical, chemical and microbiological. FSSAI - Role of Food Safety officer, method of inspection, processing of license, conducting awareness camps for stakeholders. Analysis of energy, protein, fat, vitamin, mineral and antioxidants in food groups. Attachment with food testing laboratories.

C. In-plant training in food processing units

Attachment with – primary processing cereal, pasta making, flaking and puffing, cereal based convenience foods manufacturing, primary pulse processing, RTE / RTU foods manufacturing, fruit beverage manufacturing, Canning, pickling, preserve/ candy/ jam manufacturing, banana processing, milk processing, oil manufacturing, bakery and confectionary units.

ELECTIVE COURSES

Course Number	Course	Credit Hours
Elective-1 Nutrition and Dietetics		
1.	Diet Therapy for Hospitalized Cases	4 (1+3)
2.	E-applications for Dietetics	4 (1+3)
3.	Nutrigenomics	2 (2+0)
4.	Nutrition for Special Conditions	3 (2+1)
5.	Nutrition through Life Cycle	3 (2+1)
6.	Fundamentals of Research Methodology and Library Search	2 (1+1)
7.	Sports Nutrition	3 (2+1)
8.	Diet and Immunity	3 (2+1)
9.	Global Nutrition	2 (2+0)
Elective-2 Food Science		
1.	Food processing and packaging	4 (3+1)
2.	Fruits and Vegetables Processing and Technology	4 (2+2)
3.	Food Safety and Packaging	2 (1+1)
4.	Food Toxicology and Quality Testing	3 (2+1)
5.	Food Chemistry	3 (3+0)
6.	Meat Processing and Technology	3 (2+1)
7.	Pulses and Oilseeds: Processing and Technology	3 (2+1)
8.	Sensory Evaluation of Foods	2 (1+1)
Elective-3 Institutional Food Service Management		
1.	Institutional Food Service Management	3 (0+3)
2.	Event Management	3 (0+3)
3.	Food Processing and Packaging	4 (3+1)
4.	Ergonomics in Food Service	2 (2+0)
5.	Food Standards and Quality Control	3 (2+1)

Course Number	Course	Credit Hours
6.	Food Toxicology and Quality Testing	3 (2+1)
7.	Print and Electronic Journalism	3 (0+3)
8.	Tourism and Hospitality Management	3 (1+2)

*The institutions may formulate additional Elective courses as per specific local needs and facilities/ expertise available.

Students of other disciplines may choose any minor from the list of following elective courses in Food Nutrition and Dietetics.

Course Number	Course	Credit Hours
Nutrition and Dietetics		
1.	Diet Therapy for Hospitalized Cases	4 (1+3)
2.	E-applications for Dietetics	4 (1+3)
3.	Nutrigenomics	2 (2+0)
4.	Nutrition for Special Conditions	3 (2+1)
5.	Nutrition Through Life Cycle	3 (2+1)
6.	Fundamentals of Research Methodology and Library Search	2 (1+1)
7.	Sports Nutrition	3 (2+1)
8.	Diet and Immunity	3 (2+1)
Food Science		
1.	Fundamentals of Food Science	2 (1+1)
2.	Principles of Human Nutrition	4 (4+0)
3.	Food Processing and Packaging	4 (3+1)
4.	Food Preservation and Storage	2 (0+2)
5.	Fruits and Vegetables Processing and Technology	4 (2+2)
6.	Meat Processing and Technology	3 (2+1)
7.	Pulses and Oilseeds: Processing and Technology	3 (2+1)
8.	Sensory Evaluation of Foods	2 (1+1)
Institutional Food Service Management		
1.	Food Psychology	2 (2+0)
2.	Fundamentals of Food Science	2 (1+1)
3.	Principles of Human Nutrition	4 (4+0)
4.	Normal Nutrition and Meal Planning	3 (2+1)
5.	Food Standards and Quality Control	2 (1+1)

6.	Sensory Evaluation of Foods	2 (1+1)
7.	Event Management	3 (0+3)
8.	Ergonomics in Food Service	2 (2+0)
9.	Food Processing and Packaging	4 (3+1)
10.	Print and Electronic Journalism	3 (0+3)

ELECTIVE COURSES

Diet Therapy for Hospitalized Cases 4 (1+3)

Objectives

i. To learn about specialized dietary regimes or meal plans

ii. Nutritional requirement of hospitalized cases

iii. Learning to apply of principles of therapeutic nutrition in hospital settings

Theory

Enteral and parenteral feeding, feed formulation, diseases antagonism and synergism, use of nutraceuticals and supplements for hospital cases, diet for bariatric surgery. Reading prescription, interaction with drug, taking diet and medical history, duration hospitalization in following conditions: GIT disorders, surgery (liver, kidney, CVD), cancer, ICU patients, burns, injury, sepsis, trauma, pre- and post-operative conditions, hospitalization due to diabetes, malnourished neonates, premature infants, multiple organ problems. Neoplastic diseases – goals of nutritional care for cancer patients.

Practical

Planning and preparation of a clear fluid, full fluid diet, soft diets and tube feeding formula for prep and post-operative patients. Diet plan and nutrient calculation for peptic ulcer, dysentery, diarrhea and constipation. Preparation of SOAP for liver disorders. Diet plan and nutrient calculation for fatty liver, hepatitis cirrhosis, cholecystitis and cholelithiasis of liver. Preparation of SOAP for obesity. Diet planning for obese patients and bariatric patients Preparation of SOAP for underweight and diet planning. Preparation of SOAP for diabetes mellitus and dietary modification. Formulation of carbohydrate, protein, fat, fiber and sodium exchange list. Preparation of SOAP for Cardiovascular diseases. Diet planning for atherosclerotic, and congestive heart failure. Preparation of SOAP for hyper tension and diet planning. Preparation of SOAP for kidney diseases. Diet planning for glomerulonephritis, nephrotic syndrome, nephrosclerosis syndrome, renal calculi, dialysis and renal failure, AIDS, tuberculosis and burns. Preparation of SOAP for allergy and diet planning. Diet planning for inborn errors of metabolism. Diet planning for cancer patient. Diet planning for protein energy malnutrition.

Suggested Readings

1. Eastwood M. 2000. *Principles of Human Nutrition*. Chapman and Hall, London.
2. Mahan L K and Escott-Stump S. 2000. *Krause's Food, Nutrition and Diet Therapy*. W.B. Sanders Company. Philadelphia.
3. Peckenpaugh N J and Poleman C M. 1999. *Nutrition Essentials and Diet Therapy*. W.B. Saunders Company, Philadelphia.
4. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. Westvill Publication New Delhi.
5. Suitor C W and Crowley M F. 2000. *Nutrition-Principles and Application in Health Promotion.* J.B. Lippin cott, Company. Philadelphia.
6. Towsend C E and Roth R A. 2000. *Nutrition and Diet Therapy*. Delmar Publishers. New York.
7. www.cellinteractive.com (Accessed on 13-02-2025).
8. www.fnic.nal.usda.gov (Accessed on 13-02-2025).
9. www.nutrition.org.uk (Accessed on 13-02-2025).

E-applications for Dietetics 4 (1+3)

Objectives

i. Introducing the concept AI among students

ii. Understanding the role of nutrition applications as the means for automatic dietary intake and energy expenditure measurements

Theory

Basic principles in developing a e-applications, Planning process, rules of web designing, Designing navigation bar, Page design, Home Page Layout, Design Concept. Audience requirement. audience requirement, Idea creation – Sketching – Wireframing - Graphic designing - Coding and programming, Importance of e-applications in Dietetics- role of AI. Diet and nutrition tracking App – Calorie calculating app – app for calculating energy expenditure – app for calculating energy requirement – Stages of developing nutri App for dieting. Six types of technology assisted instruments for dietary assessment -: interactive computer-based technologies - Personal Digital Assistants (PDAs) - web-based technologies - mobile devices, specialized cameras and tape recorders- scan and sensor technologies. Integration of e- Dietary Assessment tools into the care process. Food atlas -artificial intelligence in dieting. Advantages and disadvantages of e-dietary assessment methods. e-courses on nutrition and available platforms.

Practical

Apps listing- Commercially available AI Based food and nutrient assessment system- Nutrition facts, CRON-O-METER, Diet organizer, e-fit, Easy menu balanced meal planner, food file, Nutrition info. Software for nutrient intake calculation and Dietary assessment software, e-portals of NIN such as Count What you Eat, ICMR-NIN TATA Dashboard center, NUTRIFY INDIA NOW, Tracking commercial apps and developing inventory of available apps related to health and nutrition tracking. Diet history- Google forms, photography method, electronic household weighing, sensor based

health assessment for apps for tracking and measuring BP, blood sugar, hemoglobin, smart watches, fitness tracker, Online survey design for nutritional and dietary assessment for understanding current trends in dietary intake in particular group. Developing messages for public masses. Developing web page/blog/e-course. Info. graphic designing/posters/pamphlets. Attending training and workshops related to e-application/AI/coding or programming. Generating awareness using e-application. Organizing awareness camps among general public on use of nutrition related online platforms and application for tracking their dietary intake. Application based assignment- nutrient analysis/estimation, data collection – 24-h recall, diet history, food record, menu planning, nutrition counselling, food portion size estimation, standardized recipe formulation. Project to be submitted by student using any e-tool.

Suggested Readings

1. Côté M and Lamarche B. 2021. Artificial Intelligence in Nutrition Research: Perspectives on Current and Future Applications. *Applied Physiology, Nutrition, and Metabolism*. Advance Online Publication: 1–8. https://doi.org/10.1139/apnm-2021-0448
2. Taulli T. 2019. *Artificial Intelligence Basics: A Non-Technical Introduction*. Apress.
3. Tonkin E, Brimblecombe J and Wycherley T P. 2017. Characteristics of Smartphone Applications for Nutrition Improvement in Community Settings: A Scoping Review. *Advances in Nutrition* 8(2): 308–322. https://doi.org/10.3945/an.116.013748
4. Willard W. 2010. *Web Design: A Beginner's Guide*. 2nd edn. McGraw-Hill Education.

Nutrigenomics 2 (2+0)

Objective

To understand, in depth, the influence of genetics on micronutrient metabolism, and implications for human diseases including inherited inborn disease, metabolic disease, cancer, neurodevelopment, and neurodegenerative diseases, etc.

Theory

Introduction - role of nutrition in preventing risk of disorders – proposed strategies for management of nutrient disorders – personalized medicine – personalized nutrition; Introduction to genomics and its importance in health care, agriculture and environment – Introduction to Nutrigenomics Definition - role of Personalized nutrition in human diseases. Genes – structure – biochemical and molecular nature of genes; Central Dogma of Life; - regulation of gene expression –Role of diet/nutrition in regulation of gene expression – metabolic programming - Genetic basis of Dietary responses - Diet Vs Gene interactions. Genetic susceptibility to diets. Introduction to methods of developing nutritious foods/diet – intervention of biotechnology/genomics in producing nutritionally important molecules/compounds – production of therapeutic/medicinal proteins/ hormones/molecules through genetic engineering –Biotech processes in value addition of dietary foods - fermentation process, and genetic improvement of food grade microorganisms; crop varieties with enhanced nutrition. Introduction to transcriptomics, proteomics, metabolomics; applications in nutrition research - Metabolic Syndrome in humans - Nucleotide polymorphisms associated with common/major dietary disorders - inborn errors of metabolism – lactose intolerance,

gluten enteropathy and phenylketonuria. Biomarkers – importance, discovery and validation-screening for bioactive nutrients and compounds - Cell line testing – zebrafish model and animal model - Scientific, technological and resource constraints on genomics - important factors affecting development in nutrigenomics.

Suggested Readings

1. Carlsberg C, Ulven M S and Molnar F. 2016. *Nutrigenomics*. Springer Publishing.
2. Ferguson L R. 2013. *Nutrigenomics and Nutrigenetics in Functional Foods and Personalised Nutrition*. CRC Press.
3. Nestle M. 2003. *Safe Food: Bacteria, Biotechnology and Bioterrorism*. University of California Press.

Nutrition for Special Conditions 3 (2+1)

Objectives

i. To gain basic knowledge on changes occurring in the physiology and metabolism of human body as a result of change in extreme environment
ii. To know the nutrition in emergency, nutrition and health problems, food distribution strategies and dietary management
iii. To acquire basic knowledge about immune nutrition in acute and chronic inflammation

Theory

Nutritional requirements for extreme environments: Introduction - General adaptive mechanisms to environmental extremes and role of nutrition in successful acclimatization – decreased oxygen availability at high altitude – nutrition requirements for high altitude – Nutrition requirements in cold and polar environment- thermoregulation in cold –dietary guidelines for cold conditions. Nutrition requirements in hot environments- effect of heat stress – energy expenditure in hot environment. Nutrition on requirements for astronauts (space missions); Sea and air travel nutrition**:** introduction, need and scope for space travel, history of space travel; -changes in body composition during space expedition and nutrition requirements. Physiological changes in human body, psychological preparedness, health and nutritional problems, nutrient requirements and dietary management during sea and air travel. Nutrition in Emergencies: need and importance, types of emergency situations such as natural and manmade, nutritional and health problems in emergencies. Control of communicable diseases through sanitation and immunization- Food distribution strategies- nutrient requirement and dietary management during emergencies. Nutritional requirements during starvation: total starvation – biochemistry of starvation, conditions developing starvation, features of starved body – survival period, effects of starvation/human body adaptation, metabolic alterations and nutrition requirements during starvation. Immuno-nutrition: nutrients affecting the immune system at the physiological, cellular and genetic level. Nutrients involved in the inflammatory response, role of specific nutrients in immune suppression and in immune promotion. Acute inflammation- features, causes, vascular and cellular events, inflammatory cells and mediators. Chronic inflammation- causes, types, classification non-specific and granulomatous with examples, repair, and wound healing by primary

and secondary union, factors promoting and delaying the process. Healing in specific site including bone healing.

Practical

Studying the existing ration scale for army personnel in plains/high altitudes, space foods/ emergency ration foods, planning and preparation of diet for army person in the high altitudes, hot environment and cold environment, Planning and preparation of diet for space mission, preparation of snacks foods for space , fibre rich foods ,ergogenic foods / bars for high altitude, ready to eat appetizers - juices/candy, high energy foods for starvation, RTE/ RTC foods for emergencies, high protein foods, planning and preparation of diet for acute and chronic inflammation condition – Rheumatic arthritis/Asthma, Planning and preparation of diet for immunity

Suggested Readings

1. Aggarwal B B and Heber D. 2014. *Immuno-nutrition: Interactions of Diet, Genetics, and Inflammation*. CRC Press.
2. Corinne H R, Marilyn R L, Wanda L C and Garwick E. 1982. Normal and therapeutic nutrition. (In) *Normal and Therapeutic Nutrition*. Macmillan Publishing Company, New York, pp 1-16.
3. http://apps.who.int/disasters/repo/13849_files/i/nutrition_in_emergencies_ppt.pdf (Accessed on 11-02-2025).
4. http://spacelink.nasa.gov/products (Accessed on 11-02-2025).
5. https://www.cdc.gov/ncbddd/adhd/index.html (Accessed on 11-02-2025).
6. https://www.nasa.gov/sites/default/files/space_nutrition_book.pdf (Accessed on 11-02-2025).
7. https://www.unhcr.org/45fa745b2.pdf (Accessed on 11-02-2025).
8. https://www.unicef.org/media (Accessed on 11-02-2025).
9. Kathleen M L and Raymond J L. 2016. *Krause's Food and the Nutrition Care Process*. 14th edn. Saunders, Philadelphia.
10. Moris E S. 1994. *Modern Nutrition in Health and Disease*. Leaned Febinger, USA
11. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi.
12. WHO. 1997. *Applied Health Research Priorities in Complex Emergencies*. WHO Geneva.

Nutrition through Life Cycle 3 (2+1)

Objectives

i. To cover nutritional needs of individuals during critical stages of development

ii. To learn about the biological basis for nutritional requirements in normal development and maintaining health in adulthood

iii. To learn about consequences of over- and under-nutrition and how to identify and address these issues will be discussed

Theory

Infancy- Role of nutrition on physical and mental development, rate of growth-weight as an indicator, assessment of growth, nutrient requirement during infancy, feeding of infants, value of breast feeding on infants, breast feeding versus artificial feeding, types of milk and their use in infant feeding. Weaning and supplementary foods, weaning practices in community, feeding of premature and low-birth-weight infants. Nutritional disorders and common ailments in infancy, feeding the sick child, immunization schedule and growth charts Preschool age: Physical growth and mental development, prevalence of malnutrition in preschool years and food habits, nutritional requirements during preschool age and supplementary foods School age. Physical growth and mental development, nutritional requirements during school age, specific problems, specific problems in feeding school children Adolescence. Physical and physiological changes, nutritional requirements, food preferences and nutritional problems, problems, growth spurt and nutrition, adolescent fads influencing nutrition. Adulthood, Sex, occupation and income, nutritional requirements, biological and nutritional consequences and complications due to pollutants, vegetarianism. Nutrition, wok capacity and physical fitness. Nutrition, infection and immunity, nutrients and drugs interaction. Pregnancy. Eating disorders, Preconception nutrition. Nutritional related problems during pregnancy and lactation. Physiological changes in pregnancy, weight gain during pregnancy, food and nutrient requirements. Complications of pregnancy and their nutritional management, impact of nutrition on the outcome of pregnancy. Nutritional need of fetus during different stages of fetal cell growth and maternal nutritional needs. Psycho-physiology of lactation; milk synthesis and secretion, maternal needs during lactation, composition of colostrum and mature human milk, milk of mothers of pre-term babies. Non- nutritional factors of human milk; immunological factors, enzymes, hormones. Human milk banking. Elderly. Physical and physiological changes, nutritional requirements, problems of old age, nutrients influencing aging process

Practical

Grouping of foods based on richness of nutrients and quantifying foods to give uniform content of each nutrient. Planning and formulation of food exchange lists. Planning, preparation and evaluation of diet for adult men and women involved in different activities. Planning, preparation and evaluation of diets for pregnant women, , lactating mothers, weaning and supplementary foods for infants, preschool children, school going children, packed lunches for preschoolers and school children, adolescent boys and girls, elderly, preschool children with PEM and vitamin. A deficiency Planning diets for anemic children, adolescents and pregnant women.

Suggested Readings

1. Corinne H R, Marilyn R L, Wanda L C and Garwick E. 1982. *Normal and Therapeutic Nutrition*. (In) *Normal and Therapeutic Nutrition*. Macmillan Publishing Company, New York, pp 1-16.
2. Moris E S. 1994. *Modern Nutrition in Health and Disease*. Leaned Febinger, USA.
3. Srilakshmi B. 1995. *Dietetics*. Newage International Publishers, New Delhi.
4. Williams S R, Worthington R S, Sneholinka E D, Pipes P, Ress J M and Mahal K L. 1988. *Introduction to Nutrition Throughout the Life Cycle*. Times Mirror/Mosby College Publishers, St. Louis, Missouri.

Fundamentals of Research Methodology and Library Search 2 (1+1)

Objectives

i. To understand some basic concepts of research and its methodologies
ii. To identify appropriate research topics
iii. To select and define appropriate research problem and parameters
iv. To prepare a project proposal (to undertake a project)
v. To organize and conduct research (advanced project) in a more appropriate manner
vi. To write a research report and thesis
vii. To write a research proposal (grants)

Theory

Introduction to Research - Research: Meaning, Types, Scope and Significance, Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process. Guiding Principles in Selection of Research Problem; Research Objectives and Approaches, Problem Identification and Formulation, Research Question – Investigation Question Measurement Issues - Hypothesis - Qualities of a good Hypothesis, Null Hypothesis and Alternative Hypothesis. Hypothesis Testing - Logic and Importance. Research Process and Criteria of Good Research; Research Method ; Research Design – Meaning, Need, Key Components, Data Collection, Survey and Sampling, Data: Meaning, Nature, Types and Sources; Methods of Collecting Secondary Data, Surveys – Definition, Purpose and Scope; Survey Techniques and their Limitations., Questionnaires and Schedules – Definition and Differentiation; Types of Questionnaires; Salient Features of an Effective Questionnaire, Sampling and Sample Designs: Concept, Purpose and Types; Criteria for Selecting appropriate sampling Procedure; Data Analysis – Tools and Techniques, Use of proper statistical procedures, Preparation of Research Report, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

Practical

Identifying problem, formulating research hypothesis, questionnaire design, collection of secondary data, analysis and report writing. Use of reference management software, article writing.

Sports Nutrition 3 (2+1)

Objectives

i. To develop an understanding about the concept of diet planning for exercise and sports
ii. To gain knowledge of nutritional requirements for sports persons and making diet plans
iii. To understand the current theories on the relationships between diet and performance in sports, exercise, and health

Theory

Physical fitness – principles, types, components and its assessment. Introduction, Nutritional considerations for sports / exercising person as compared to normal active person. Energy substrate

for activities of different intensity and duration, aerobic and anaerobic activities. Fluid balance in sports and exercise, importance, symptoms and prevention of dehydration, Sports drink, Energy enhancers and other commercial sports food products. Macro Nutrients-Carbohydrate as an energy source for sport and exercise, Carbohydrate stores, Fuel for aerobic and anaerobic metabolism, Glycogen re- synthesis, CHO Loading, CHO composition for pre exercise, during and recovery period. Role of fat as an energy source for sports and exercise. Fat stores, regulation of fat metabolism, factors affecting fat oxidation (intensity, duration, training status, CHO feeding), effect of fasting and fat ingestion. Protein and amino acid requirements, Factors affecting Protein turnover, Protein requirement and metabolism during endurance exercise, resistance exercise and recovery process. Important micronutrients for exercise- B complex vitamin and specific minerals. Exercise induced oxidative stress and role of antioxidants. Chronic dieting and eating disorder. Female athletic triad, sports anaemia Dietary supplements and ergogenic aids (nutritional, pharmacological and physiological). Use of Nutritional supplements in strength/power sports and team sports- use, effects, efficacy and safety – Creatine monohydrate, Sodium bicarbonates, Nitrates – B-Alanine, Caffiene – Protein supplements – Fat burners.

Suggested Readings

1. Driskell J A and Wolinsky I (Eds). 2000. *Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition*. CRC Press, Boca Raton.
2. Jeukendrup A and Gleeson M. 2010. *Sport Nutrition: An Introduction to Energy Production and Performance*. (2nd Edn.). Human Kinetics, UK.
3. McArdle W D, Katch F I and Katch V L. 2009. *Sports and Exercise Nutrition*. Lippincott Williams and Wilkins, Walnut Street, Philadelphia.
4. Satyanarayan K, Nageshwar Rao C, Narsinga Rao B S and Malhotra M S. 1985. *Recommended Dietary Intakes for Indian Sportsmen and Women*. National Institute of Nutrition, Hyderabad.

Diet and Immunity 3 (2+1)

Objectives

i. To gain a comprehensive understanding of the immune system and its role in protecting the body from disease
ii. To explore the impact of various nutrients on immune function
iii. To understand the potential benefits of specific foods for immune health

Theory

Introduction to Immune System: Cells, Organs, and Functions, Innate and Adaptive Immunity Immunodeficiency and evaluation of Immune function. Alcohol and Immune function, Auto-antibodies, NCDs and Autoimmunity. The Importance of Gut Microbiome for Immune Health, Nutrient-Immune Interactions Essential Vitamins and Minerals for Immune Function, Role of Antioxidants in Immune Response, Impact of Macronutrients) on Immunity, Indian Diet and Immune System Benefits, Herbs, Medicinal plants and other Plant-Based Diets for immunity enhancement. , Role of Hydration in Immune Function, Understanding the Role of Dietary Fats and Immune Function, Intolerances and Immune System Response, Immunity Booster Foods, Diets

and Autoimmune Conditions, Technology and apps in promoting healthy eating habits for immune support.

Practical

Exploring local herbs and medicinal plants as immunity booster. Study of different pathogenic organism and their interaction with food compounds. Planning of individualized diet plan for different auto immune diseases. Planning of individualized diet plan for different conditions of food intolerances.

Suggested Readings

1. Bhaumik D and Chattopadhyay S. 2012. *Immunity and Ayurvedic Nutrition*. Springer India.
2. Chopra A and Singh V. 2017. *Ayurveda for Life*. Penguin Random House India Private Limited.
3. Gershwin M E, Nestel P and Keen C L. 2004. *Handbook of Nutrition and Immunity*. Humana Press, Totowa, New Jersey.
4. https://www.nin.res.in/ (Accessed on 22-01-2025).
5. Indian Council of Medical Research. 2010. *Dietary Guidelines for Indians - A Manual*. National Institute of Nutrition (India).
6. Sharma H L. 2014. *Cooking with Ayurveda*. Penguin Random House India Private Limited, India.

Global Nutrition 2 (2+0)

Objectives

i. To analyze the global burden of malnutrition and its various forms (undernutrition, overnutrition, micronutrient deficiencies)
ii. To explore the ethical considerations in global food systems, including food justice, sustainable practices, and corporate accountability
iii. To examine the role of technology and innovation in addressing global nutrition challenges
iv. To understand the effectiveness of international nutrition programs and initiatives

Theory

Defining Global Nutrition: Scope and Challenges, Nutritional Transition, Global Trends and Regional Differences in Food Systems and Nutrition, Sustainable Agriculture and Food Production Practices, Micronutrient Deficiencies, Nutritional Epidemiology, Food Traditions and Dietary Practices in Different Regions, Food Waste and Loss: Global Challenges and Solutions, Ethics of Industrial Food Production and Food Justice Issues, Global Nutrition Programs and Policies, National Governments and International Collaboration, Issues and Trends in Global Food and Nutrition Security.

Suggested Readings

1. Albert J L (Ed). 2000. *Food, Nutrition and Agriculture*. FAO Publication.
2. Branca F, Lardeux M and Leroy J. 2007. Food Security, Food Safety and the Right to Adequate Food. *Agriculture and Human Values* 24(3): 285-294.

3. Fanzo J, Hawkes C and Berry E M. 2013. Global Food Security and the Right to Food. *Public Health Reviews* 35(1): 22-31.
4. Home - Global Nutrition Report (Accessed on 02-02-2025).

Food processing and packaging 4 (3+1)

Objectives

i. To impart knowledge of various areas related to food processing and packaging
ii. To enable the students to understand food composition and its physic chemical, nutritional, microbiological and sensory aspects

Theory

Food processing and preservation techniques for cereals, milk, fruits and vegetables, oil seeds, meat, fish and poultry and their impact on physical and chemical characteristics. Physico-chemical characteristics, nutritional quality and shelf-life studies. Factors effecting quality of processed foods. Food packaging, package functions, requirement and packaging materials. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs.

Practical

Market survey for packaged processed food stuffs. Cereal cookery. Preparations showing dextrinization and gelatinization, gluten formation and influence factors. Vegetable cookery: effect of heat and alkali on pigment, preparation of soups, salads and beverages. Use of milk and milk products and egg in various preparations Estimation of shelf- life of packaged food stuffs.

Suggested Readings

1. Frank A and Paine H Y. 2003. *A Handbook of Food Packaging*. Springer Science and Business Media, UK.
2. Kalia M and Sood S. 2010. *Food Preservation and Processing*. (Revised Edn.). Kalyani Publishers, New Delhi.
3. Potter N N. 1996. *Food Science*. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Srilakshmi B. 2010. *Food Science*. (5th Edn.). New Age International Pvt. Limited Pub., New Delhi.

Fruits and Vegetables Processing and Technology 4 (2+2)

Objectives

i. To acquire a basic knowledge of in the field of fruit and vegetable processing
ii. To acquire a basic understanding of agriculture sector and processing of fruits and vegetables is of vital importance
iii. To develop an essential understanding of the scope of fruit and vegetable processing in the country
iv. To acquire a fundamental background of the methods of fruit and vegetable processing.
v. To practice the methods and techniques of fruit and vegetable processing at laboratory scale, and to evaluate the student`s produce in each lab

Theory

Importance and scope of fruits and vegetables in human diet. Scenario of fruit and vegetable production and processing at national and international level. General principles involved in preservation of fruits and vegetable products. Tools, equipment, lay out and other requirements of fruit and vegetable processing unit. Processing using sugar - principles and processing of jam, jelly, marmalade, fruit bar, preserves and candies. Unfermented and fermented products - fruit juices, RTS, nectar, cordial, squash, syrup, carbonated beverages, cider and vinegar. Processing using salt - principle – brining. Preservation of horticultural produces - preparation of pickles, ketchup and sauces. Tea, coffee and cocoa products Wine and fermentation technology. Drying and dehydration: definition, principle, method, suitability - types of driers - solar, cabinet, spray drier, drum drier, fluidized bed drier and freeze drying. Methods of concentration - open kettle, flash evaporators, thin film evaporators, vacuum evaporators, freeze concentration, dehydro- freezing, ultrafiltration and reverse osmosis. Processing of dehydrated fruits, vegetables and spice products and fruit pulp. Canning - principles, methods - preparation of canned products - spoilage of canned foods and its prevention. Preservation by low temperature: definition, principle, method, suitability - refrigeration, freezing, preparation of frozen foods. Preservation by controlled atmosphere, modified atmosphere - definition, principle, method, suitability. Processing by irradiation - definition, principle, method, suitability and application of irradiation in food industry.

Practical

Evaluation of pectin grade; Canning of mango/guava/papaya; Preparation and quality evaluation of fruit jam with fruits of regional importance; Preparation and quality evaluation of fruit jelly with fruits of regional importance ;Preparation and quality evaluation of fruit marmalade; Preparation and quality evaluation of fruit preserve and candy; Preparation and quality evaluation of fruit RTS; Preparation and quality evaluation of squash / syrup; Preparation of grape raisin / dried fig / dried banana; Processing of tomato products; Preparation and evaluation of dehydrated vegetables; Preparation and quality evaluation of wafers with vegetables / tubers; Preparation of fruit cheese; Preparation of pickle / mixed pickle; Preparation of dried ginger / mango powder (amchur).

Suggested Readings

1. Giridhari Lal, Sidappa G S and Tandon G L. 1979. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
2. GOI. 2018. *Horticulture at a Glance*. Government of India, Ministry of Agriculture and Farmers' Welfare, Department of Agriculture, Cooperation and Farmers' Welfare, Horticulture Statistics Division.
3. https://agritech.tnau.ac.in/postharvest/pht_intro.html (Accessed on 11-01-2025).
4. Kalia M and Sood S. 2010. *Food Preservation and Processing*. (Revised Edn.). Kalyani Publishers, New Delhi.
5. Singh I S. 2009. *Post-Harvest Handling and Processing of Fruits and Vegetables*. Westville Publishing House, New Delhi.
6. Sudheer K P and Indira V. 2007. *Post-Harvest Technology of Horticultural Crops*. New India Publishing Agency, Pitam Pura, New Delhi-110088.

7. Verma L R and Joshi V K. 2000. *Post-Harvest Technology of Fruits and Vegetables*. Vol. I & II. Indus Publishing Company, New Delhi.
8. www.cfs.purdue.edu/class (Accessed on 13-02-2025).

Food Safety and Packaging 2 (1+1)

Objective

To provide students with an insight into advanced packaging (technical and business) topics with a food safety focus

Theory

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors. General principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Food safety and standard regulations national and international standards. Food safety, safety hazards and risks, food related hazards, microbiological considerations in food safety, effect of processing and storage on microbial safety, microbiological methodology, HACCP as a method to prevent food borne illness, chemical hazards associated with foods. Types of Packaging systems, special solutions and packaging machines. Different types of packaging materials, their key properties and applications, Metal cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging. Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper plastic film and laminates aluminum foil glass containers (visual defects, color, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

Practical

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapors transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

Suggested Readings

1. Adams M K and Moss M O. 2000. *Food Microbiology*. Panima Crop, New Delhi.
2. Coles R, McDowell D and Kirwan M J. 2003. *Food Packaging Technology*. Blackwell Publishing Co, United Kingdom.

3. Gosby N T. 2001. *Food Packaging Materials*. Applied Science Publication, Basel, Switzerland.
4. John P J. 2008. *A Handbook on Food Packaging*. Narendra Publishing House, Delhi.
5. Kalia M and Sood S. 2010. *Food Preservation and Processing*. Revised edn. Kalyani Publishers, New Delhi.
6. Longree K L and Blaker G C. 1982. *Sanitary Techniques in Food Service*. John Wiley and Sons, New York.
7. Mahadevia M and Gowramma R V. 2007. *Food Packaging Materials*. Tata McGraw Hill, Noida.
8. Manay N S and Shadaksharswamy M. 2001. *Food Facts and Principles*. (2nd Edn.). New Age International (P) Ltd. Publishers, New Delhi.
9. Robertson G L. 2001. *Food Packaging and Shelf Life: A Practical Guide*. Narendra Publishing House.
10. Robertson G L. 2005. *Food Packaging: Principles and Practice*. (2nd edn.). Taylor and Francis Pub.
11. Roday S. 2011. *Food Hygiene and Sanitation with Case Studies*. 425 p. Tata McGraw-Hill Education.

Food Toxicology and Quality Testing — 3 (2+1)

Objectives

i. To give introduction to possible toxic effects of food additives and naturally occurring environmental toxins in food
ii. To be able to define toxicology
iii. To be able to define the most important contaminants in food, the toxicology of various additives and environmental toxins, as well as their sources
iv. To explain food safety, the substances that are of relevance for food safety
v. To be able to explain what risk analysis, assessment and management in relation to food safety is, and know which organizations are involved in this type of work nationally and internationally

Theory

Food toxicology – definition, introduction and significance. Classification of toxic constituents. Food poisoning –types, causative factors, signs and symptoms, preventive measures. Natural food toxins – pulses, oil seeds, sea foods, processed animal foods. Anti-nutritional factors, other food toxins, their harmful effects and methods of removal. General characteristics, occurrence, properties and inactivation of protease inhibitors, trypsin inhibitors, haemagglutinins, goitrogens, gossypol. General characteristics, occurrence, properties and inactivation of saponins, lathyrogens, avidin and other antimetabolites. Microbial toxins – classification, source of contamination, effect on health, preventive measures, methods of inactivation / destruction. General characteristics, occurrence and properties of mycotoxins, aflatoxin, ochratoxin and patulin. Methods to detect and prevention of mycotoxins. Chemical toxins – Pesticides - Pesticide and insecticide residual toxicity – sources and health hazards, insecticides, metallic and others. Mineral toxicity – Chlorine and Fluorine, Heavy metals toxicity – Lead and Chromium, Mercury, Arsenic and Iron, residual effects, preventive

measures, methods of removal. Food additives – classification, toxicity and effects. Toxins developed during processing. Food packaging material – Potential contaminants from food packaging material. Detection of toxins in food chain.

Practical

Methods of detect aflatoxin and gossypol**.** Methods of detect trypsin inhibitors and protease inhibitors. Use of AAS for detection of lead, chromium, mercury, arsenic, iron, detection of tannin and phytic acid. Visit to toxicology lab and public health laboratory. Visit to Quality Testing Laboratory, food processing industry/ government laboratory.

Suggested Readings

1. Bagchi D and Swaroop A. 2016. *Food Toxicology*. 500p. CRC Press, Boca Raton.
2. Bureau of Indian Standards. Available at: www.standardsdata.in. Accessed on 13-02-2025.
3. Centers for Disease Control and Prevention. Available at: http://www.cdc.gov/. Accessed on 13-02-2025.
4. Compendium_Food_Additives_Regulations_08_09_2020-compressed.pdf. Available at: www.fssai.gov.in. Accessed on 08-09-2020.
5. Damodaran S, Parkin K L and Fennema O R. 2007. *Fennema's Food Chemistry*. (4th Edn.). Taylor and Francis, Boca Raton.
6. Derelanko M J and Hollinger M A. 2002. *Handbook of Toxicology*. (2nd Edn.). CRC Press, Boca Raton.
7. Food Quality News. Available at: http://www.foodqualitynews.com/. Accessed on 13-02-2025.
8. Food Safety and Standards Authority of India. Available at: www.fssai.gov.in. Accessed on 13-02-2025.
9. Hodgson E. 2004. *A Textbook of Modern Toxicology*. John Wiley and Sons, New York.
10. Robertson G L. 2006. *Food Packaging Principles and Practice*. (2nd Edn.). CRC Press, London.
11. Shibamoto T and Bjeldanes L F. 2012. *Introduction to Food Toxicology*. (2nd Edn.). Academic Press, London.
12. U.S. Food and Drug Administration. 2020. *Bad Bug Book: Foodborne Pathogenic Microorganisms and Natural Toxins.* Available at: http://www.fda.gov/downloads/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathogensNaturalToxins/BadBugBook/UCM297627.pdf. Accessed on 13-02-2025.
13. U.S. Food and Drug Administration. Available at: http://www.fda.gov/. Accessed on 13-02-2025.

Food Chemistry 3 (3+0)

Objectives

i. To provide an understanding of the chemical function and properties of major food components

ii. To provide an understanding of the chemical interactions of food components and their effects on sensory and nutritional quality, functional properties, and safety of foods

Theory

Nature, scope and development of food chemistry. Properties of foods: Solubility, vapour pressure, boiling point, freezing point, osmotic pressure, viscosity, surface tension, specific gravity, oxidation and reduction. Acids, bases and buffers. Chemical bonding - Colloids - Water and moisture in foods- Hydrogen bonding, bound water, capillary water and loosely bound water; structure and properties of water molecule Water activity and effects on storage life. Carbohydrates- classification, structure and properties of carbohydrates and dietary fiber. Proteins in foods- classification, structure and properties of proteins and amino acids, Pure proteins of plant and animal origin - their functional characteristics, physical, chemical and nutritional changes in protein during processing. Chemical and enzymatic modification of protein. Lipids – introduction classification, physical and chemical characteristics. Chemistry of fats and oils– processing aspects Changes of lipids / fats during processing and storage. Role and use of lipids /fat, physiological effects of lipids - physiochemical aspects of fatty acids in natural foods, crystallization and intersification. Vitamins and minerals - Properties of Vitamins and minerals, enrichment, restorations, fortifications, Losses of vitamins and minerals. Structure and properties of chlorophyll, anthocyanin, flavonoid, tannin, betalin, quinone, carotenoid, myoglobin and hemoglobin. Pigments used in food industry. Flavor compounds - terpenoids, flavonoids, Sulphur compounds and volatile flavor compounds. Enzymes, enzyme inhibitors, enzymatic browning, enzymes in food processing. Composition of beverages- hot drinks, tea, coffee, cocoa, cold drinks, soft-drinks, fruit beverages and alcoholic drinks-beer, wine etc. Sugars and sweeteners, reaction of sugars, non-nutritive sweeteners. Food additives: Antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors, and flavor enhancers, humectants and anti-caking agents, leavening agents, nutrient supplements, preservatives, stabilizers, thickeners. Browning reactions in foods

Suggested Readings

1. Chopra H K and Panesar P S. 2010. *Food Chemistry*. Narosa Publishing House, New Delhi.
2. Food Safety and Standards Authority of India. Available at: www.fssai.gov.in. Accessed on 13-02-2025.
3. Khader V. 2001. *Textbook of Food Science and Technology*. 300p. Indian Council of Agricultural Research, New Delhi.
4. Manay N S and Shadaksharswamy M. 2001. *Food Facts and Principles*. (2nd Edn.). 500p. New Age International (P) Ltd. Publishers, New Delhi.
5. Meyer L H. 1991. *Food Chemistry*. 500p. AVI Publications, New York.
6. Meyer L H. 2004. *Food Chemistry*. 600p. CBS Publishers and Distributors Private Limited, Chennai.
7. Potter N N. 1996. *Food Science*. 500p. The AVI Publishing Company Inc., Westport, Connecticut.
8. Walstra P. 2001. *Physical Chemistry of Foods*. 400p. Marcel Dekker, Inc., New York.

Meat Processing and Technology 3 (2+1)

Objectives

i. To provide knowledge and skills for quality production of meat and meat products
ii. To develop human resource for meat industry and associated activities
iii. To train personnel for self-employment

iv. To impart knowledge and technical proficiency in:
   (a) Good slaughter practices
   (b) Handling of meat on scientific lines
   (c) Production of quality meat and meat products
   (d) Testing and quality control of meat and meat products
   (e) Managing small and medium enterprises

Theory

Animal foods – needs – availability – demand and supply of animal foods. Growth and development of Indian meat industry. Meat and poultry - pre-slaughter operations - preparation of animals and poultry birds for slaughter. Slaughtering of animals – requirements -stunning methods. External treatment of carcasses - skinning, depilation – external and internal treatment of carcasses – evisceration - slaughter lines and systems. Identification of parts of the animal - structure – composition – nutritive value of meat. Post mortem changes of meat – eating quality of meat tissues. Equipment in processing of meat - their design – usage and its application. Meat cutting – types of carcasses - indicators of quality of carcass. Meat composition – quality and spoilage. Eating quality of meat – color - chemical nature of myoglobin - discoloration of meat - texture and tenderness of meat - pre-slaughter and post slaughter factors effecting tenderness – improvement of tenderness. Spoilage of meat - sources of contamination, growth of microorganisms – identification of spoilage. Meat inspection, sanitation and preservation techniques. Principles of preservation of meat -hurdle concept. Methods of preservation of meat - chilling and freezing – heating – canning and thermal processing - curing and smoking, dehydration - Intermediate moisture foods – freeze drying, irradiation, high pressure treatment. Ohmic heating, High power ultra sound processing technology. Direct microbial inhibition – antibiotics – chemical preservation. Processed meats - formulation of meat products- enrobed meat products– fermented, canned and restructured meat products

- restructured steaks, roasts, blocks – portion and sticks. Dried meat – pickled, spiced and marinated meat
- prefabricated meat- effect of processing on quality of meat products. Equipment's used in processing of meat. Poultry - dressing - composition - nutritive value - processing and preservation methods - storage, spoilage and preventive measures of poultry meat. Standards and quality control measures adopted for meat and meat products. National and International - HACCP for meat and poultry and processed meat products. Fraudulent substitution of meat - its recognition and impact. Waste utilization of animal foods - edible and non-edible parts. New concept in meat technology: cultured meat, lab-grown meat. Plant-based meat analogues, *in-vitro* meat.

Practical

Formulation of Questionnaire and conduct of survey on the availability of animal foods in selected areas. Effect of processing on sheep meat (moisture content, color change, shrinkage and sensory quality attributes). Curing of meat using sugar, salt and nitrite. Effect of tenderizing agents on meat cookery. Quality evaluation of processed meat and chicken products - preparation of battered chicken. Pickling and canning of meat. Microbial quality of stored animal and chicken meat products. Visit to slaughter house and meat cold storage unit.

Suggested Readings

1. Boziaris I S. 2013. *Seafood Processing Technology: Quality and Safety*. Wiley and Blackwell Ltd.
2. Government of India (GOI). *Annual Report. Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying*. Government of India. Latest issue. Available at: https://gfi.org/science/the-science-of-cultivated-meat/. Accessed on 13-02-2025.
3. Kerry J, Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., Cambridge, England.
4. Kyriakopoulou K, Dekkers B and Van Der Goot A J. 2019. *Plant-based Meat Analogues. In: Sustainable Meat Production and Processing*. Academic Press.
5. Lawrie R A and Ledward D A. 2006. *Meat Science*. Woodhead Publishing Limited.
6. Nanda V. 2014. *Meat, Egg and Poultry Science and Technology*. I.K. International Publishing House Pvt. Ltd., New Delhi.
7. NIIR Board of Consultants and Engineers. 2005. *Preservation of Meat and Poultry*. Asia Pacific Business Press, Inc., Delhi.
8. Sharma B D and Sharma K. 2011. *Outlines of Meat Science and Technology*. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
9. Stephens N, Di Silvio L, Dunsford I, Ellis M, Glencross A and Sexton A. 2018. *Bringing Cultured Meat to Market: Technical, Socio-Political, and Regulatory Challenges in Cellular Agriculture. Trends in Food Science and Technology*. 78: 155–166. Available at: https://doi.org/10.1016/j.tifs.2018.04.010. Accessed on 13-02-2025.
10. Toldra F, Hui Y H, Astiasaran I, Nip W K, Sebranek J G, Expedito-Tadeu F, Silveira S, Stahnke L H and Talon R. 2007. *Handbook of Fermented Meat and Poultry*. Blackwell Publishing Professional, Ames, Iowa, USA.
11. Tziva M, Negro S O, Kalfagianni A and Hekkert M P. 2020. *Understanding the Protein Transition: The Rise of Plant-Based Meat Substitutes. Environmental Innovation and Societal Transitions*. **35**: 217-231.

Pulses and oilseeds: Processing and Technology 3 (2+1)

Objectives

i. To impart knowledge to the students on legume and oil seed processing

ii. To make students able to develop good expertise on the technical aspects of dhal milling, oil milling and various legumes and oil seeds-based product preparations

Theory

Food uses of major pulses- Bengal gram, green gram, black gram, red gram, lentils etc. Primary processing of pulses- Cleaning, drying, storage, control of storage pests. Secondary processing methods-Dehulling, small scale processing, large scale processing. Traditional dal mills and modern dal mills, nutrient losses during processing. Processing methods of pulses like soaking, germination, cooking, fermentation etc. Major oilseeds produced in India and their utility groundnut, rapeseed/mustard, soybean, sesame seed, sunflower, safflower, cottonseed, linseed, caster. Pre-treatments and oil extraction from different oilseeds. Refining, bleaching, deodorization, hydrogenation processes of edible oils Anti-nutritional factors and toxic constituents of pulses and oilseeds. Technology of

production of oilseed meals/flours, protein concentrates and isolates of pulses and oilseeds and their utilization. By product utilization of pulses and oilseeds.

Practical

Market survey of pulse and oilseed-based snack foods, Preparation of pulses and oilseed-based snack foods. Demonstrations on soaking, dehulling, germination, fermentation methods Analysis of antinutrients- Phytic acid, saponins, trypsin inhibitors etc. Preparation of snacks based on pulses and oilseeds. Preparation of recipes based on germinated and fermented pulses. Visit to traditional dal mills, modern dal mills, oil mills to expose students to dal milling operations and oil extraction operations.

Suggested Readings

1. Chakraverty A. 1995. *Post-harvest Technology of Cereals, Pulses and Oilseeds*. (3rd Edn.). Oxford and IBH Publishing Co., Pvt. Ltd, India.
2. eCourses Online, Indian Agricultural Statistics Research Institute (IASRI). Available at: http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=5933 (Accessed on DD-MM-YYYY).
3. Food and Agriculture Organization (FAO). Available at: http://www.fao.org (Accessed on 11-02-2025).
4. Government of India (GOI). 2021. *Agricultural Statistics at a Glance, 2021*. Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare, Directorate of Economics and Statistics.
5. Kalia M and Sood S. 2010. *Food Preservation and Processing*. Revised Edition, Kalyani Publishers, New Delhi.
6. Khader V. 2001. *Textbook of Food Science and Technology*. Indian Council of Agricultural Research, New Delhi.
7. Raghuvanshi R S and Bisht K. 2010. Uses of soybean: Products and preparation. In: *Soybean: Botany, Production and Uses*. pp 220-245. Singh G (Ed.). CAB International, UK.
8. Tamil Nadu Agricultural University (TNAU) - Postharvest Processing of Pulses. Available at: https://agritech.tnau.ac.in/postharvest/pht_pulses_processing.html (Accessed on 11-02-2025).

Sensory Evaluation of Foods 2 (1+1)

Objectives

i. To introduce the methodology used in sensory evaluation of food product
ii. To expose students to the ability of humans to use their senses to evaluate the quality attributes of food product using sensory evaluation methods such as analytical and effective methods
iii. To cover the use of relevant statistics in analyzing sensorial evaluation data

Theory

Sensory quality evaluation - introduction, method, sensory panel; physiological and psychological foundations of sensory evaluation; Principles of good practice: the sensory testing environment, test protocol considerations, Factors influencing sensory measurements, Basic principles: Senses and sensory perception, Physiology of sensory organs, Sensory and instrumental

analysis in quality control. Sensory attributes of foods and beverages and their perceptions, appearance, flavor, taste, aroma, texture/mouthfeel, trigeminal sensations, Sensory evaluation methodology, threshold measurements, difference tests, scaling procedures, descriptive analytical methods, consumer tests, Instrumental measurements, color texture, flavor, Correlation of sensory and instrumental measures, Applications of sensory tests for quality assurance product development product optimization marketing. Objective methods of evaluation. Relationship between objective and subjective methods.

Practical

Determination of threshold value for basic tastes and odor; Odor recognition, difference (PC, Duo trio, triangle); Selection of judging panel; Training of judges, for recognition of certain common flavor and texture defects using different types of sensory tests; Descriptive analysis methodology; Texture profile methodology; Sensory evaluation of various food products using different scales, score cards and tests; Estimation of color; Designing a sensory laboratory.

Suggested Readings

1. Amerine M A, Pangborn R M and Rossles E B. 1965. *Principles of Sensory Evaluation of Food*. Academic Press, London.
2. Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic, London.
3. Lawless H T and Heymann H. 2010. *Sensory Evaluation of Food: Principles and Practices*. (2nd Edn.). Springer, New York, Dordrecht, Heidelberg, London.
4. Lawless H T and Klein B P. 1991. *Sensory Science: Theory and Applications in Foods*. Publisher Name, Location.
5. Macrae R, Rolonson Roles and Sadlu M J. 1994. *Encyclopedia of Food Science and Technology and Nutrition*. Vol. XI. Academic Press.
6. Maslowitz H. 2000. *Applied Sensory Analysis of Foods*. Vols. I, II. CRC Press, Boca Raton, FL, USA.
7. Rai S C and Bhatia V K. 1988. *Sensory Evaluation of Agricultural Products*. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.

Institutional Food Service Management 3 (0+3)

Objectives

i. To cover designing the kitchen and work space, selection of equipment and maintenance, personal and finance management, food management, hygiene and sanitation, menu planning and food composition and nutritional values

ii. To help those who are interested in establishing a food service industry in making available hygienically prepared, wholesome and nutritious food to the consumers

Practical

Introduction to quantity food production, familiarization to equipment for quantity food production, Weight, measures and conversion, Recipe conversion standardization of recipes – procedure. Practical exercise on standardization of recipe, multiplication of standard recipe,

portioning and cost calculation. Standardization of recipes suitable for different catering services i.e., cafeterias /canteens, snack bars, industrial canteens, residential hostels. Costing of recipes planned and fixing the price. Exercise on quantity food production for different type of food service establishments. Visit to residential hostel, hospital canteen, industrial canteen, star hotel and fast-food centre to observe the organization, management and administration. Making a detailed project report for establishing a food service unit including making purchase documents for equipment purchase and tenders etc. Organizing and planning menu for college canteen as a catering enterprise, setting up of a canteen, management of college canteen - procurement of materials. Practical exercise on food preparation, pricing and sale. Preparation and presentation of report on management of canteen. Catering for Birthday party/Mocktail Party/ Convention/ Seminar / Conference.

Suggested Readings

1. Fuller J. 1966. *Chefs Manual and a Kitchen Management*. B.T. Batsford Ltd., London.
2. Raske L. 2017. *Foodservice Management Fundamentals*. Scitus Academics, Germany.
3. Ratti M. 2000. *Food Service Management*. Neha Publishers and Distributors, India.
4. Sethi M and Malhan S. 1997. *Catering Management - An Integral Approach*. New Age International, New Delhi.
5. Treat N and Richards. 1997. *Quantity Cookery*. Little Brown and Co, Boston, Massachusetts.
6. West B B, Wood L, Harger V F and Shugart G S. 1977. *Food Service in Institutions*. John Wiley and Sons, India.

Event Management 3 (0+3)

Objectives

i. To be aware of event management as a profession
ii. To gain basic knowledge about establishing and managing an event
iii. To understand and develop soft skills that would help in event management

Practical

Identifying practical situations for event management, conceptualizing goal and objectives, Overall show management. Exhibit sales and promotion. Festivals (diwali, religious ceremonies). Social gathering. Food fair/Conference/ workshop/seminar/congress programming. SWOT analysis of event. Portfolio preparation; presentation and projection for work. Project report on visit to different types of organizational settings like hotel, guest house, hostel, small offices, clubs, fast food centres for management and organization of events. Project planning. program planning and execution. Project development. Event accountancy. Event communication and sponsorship. Event marketing and advertising. Live event management. Visit to different organizations/hotels etc. Project preparation and report presentation.

Suggested Readings

1. Narayna S. 2001. *International Institute of Event Management*. SNDT Women's University, Juhu Campus, Juhu Tara Road, Santacruz (W), Mumbai - 400049.
2. Potions K and Bhuson H P. 1998. *Festival and Special Event Management*. IBM Cooperation, 60 Renfrew Drive, Suite 105, Markham, Ontario, Canada L3R0E1.

3. Sharma A and Arora S. 2018. *Event Management and Marketing: Theory, Practical Approaches and Planning*. English, Paperback.
4. Suvarna A. 2003. *Event Management Development Institute*. I.E.S. Management College, 4th Floor, 791, S.K. Marg, Opp. Lilavati Hospital, Bandra (W), Mumbai - 400050.

Food Processing and Packaging 4 (3+1)

Objectives

i. To impart knowledge of various areas related to food processing and packaging
ii. To enable the students to understand food composition and its physic chemical, nutritional, microbiological and sensory aspects

Theory

Food processing and preservation techniques for cereals, milk, fruits and vegetables, oil seeds, meat, fish and poultry and their impact on physical and chemical characteristics. Physico-chemical characteristics, nutritional quality and shelf-life studies. Factors effecting quality of processed foods. Food packaging, package functions, requirement and packaging materials. Principles in the development of protective packaging. Laws related to packaging. Shelf-life of packed food, special problems in packaging of foodstuffs.

Practical

Market survey for packaged processed food stuffs. Cereal cookery. Preparations showing dextrinization and gelatinization, gluten formation and influence factors. Vegetable cookery: effect of heat and alkali on pigment, preparation of soups, salads and beverages. Use of milk and milk products and egg in various preparations Estimation of shelf- life of packaged food stuffs.

Suggested Readings

1. Frank A and Paine H Y. 2003. *A Handbook of Food Packaging*. Springer Science and Business Media, U.K.
2. Kalia M and Sood S. 2010. *Food Preservation and Processing*, Revised Edition. Kalyani Publishers, New Delhi.
3. Potter N N. 1996. *Food Science*. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Srilakshmi B. 2010. *Food Science*. (5th Edn.). New Age International Pvt. Limited Pub., New Delhi.

Ergonomics in Food Service 2 (2+0)

Objectives

i. To identify the current problems related to ergonomic in food production process
ii. To understand and analyze the actual production data by using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA)
iii. To recommend the ergonomic workplace environment based on the condition of the study

Theory

Introduction to Ergonomics, principles, domains, significance and applications, Functional design, Facility design, Work zones, Work flow and travel distance, Work triangle, Managing central kitchens, kitchen layout, kitchen storage, kitchen planning, kitchen forms, Equipment selection and cart selection and maintenance, Material selection and placement, Managing human resource issues, Operational issues, food safety and hygiene and service ware., Ergonomics for Waiter staff, Cooks, food preparation workers, dishwashers, Musculoskeletal disorders – meaning, causative factors. Common MSD in food industry- Awkward posture, repetition, force. Ergonomic injury signs, symptoms and reporting. Ergonomic Risk Factors and safety Trends in accidents, Task Specific Ergonomics. Safety Responsibilities, Safety Responsibilities of Employers, Employees and Health Care Providers, Ergonomics Solutions and Stress- Engineering Improvements, Administrative Improvements and Personal Protective Equipment.

Suggested Readings

1. Brudger R S. 2003. *Introduction to Ergonomics*. Taylor and Francis, London.
2. California Department of Industrial Relations. 2003. *Ergonomics in Action: A Guide to Best Practices for the Food-Processing Industry*. OSHA.
3. Grandjean E. 2000. *Fitting the Task to the Man*. Taylor and Francis, London.
4. Macleod D. 2006. *The Ergonomics Kit*. (2nd Edn.). Taylor and Francis, London.

Food Standards and Quality Control 3 (2+1)

Objectives

i. To develop qualified and competent human resource in the field of the food standards and quality management for regulators, industry, academic/research institutions, certifying and accreditation bodies, food trade, food testing and training
ii. To delve in depth on various aspects of food standards and quality management i.e. food standards, harmonization with global benchmarks, quality management systems, food analysis, instrumentation, risk analysis /management, traceability and auditing to transform the food ecosystem
iii. To nurture a positive and disciplined food standard and quality culture among the professionals
iv. To conduct research studies on emerging food standard issues and formulation of science based regulatory framework

Theory

Importance of food quality control and assurance. Food Standards and Regulations in India: FSSAI, Prevention of Food Adulteration Act, Fruit Product Order, AGMARK, Essential Commodity Act, Consumer Protection Act, Bureau of Indian Standards, Codex Standards, Food and Drug Administration (FDA). Food additives, preservatives, coloring agents, antioxidants, emulsifying agents, leavening agents and stabilizing agents Sensory Evaluation of Food Quality – Introduction -Panel Screening-Selection of Panel members. Objective/Instrumental analysis of Quality Control.Statistical Quality Control of Foods Determination of Sensory thresholds and taste Interactions. Fundamentals of Food regulations-pertaining to Additives and Contaminants. Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws

Food packaging, packaging material. Adulteration, heavy metals. Quality criteria of foods – food grains, fruits, vegetables and animal foods. Quality criteria of processed foods. Physical, chemical and microbial contamination of foods. Food adulteration – common adulterants – health hazards. Tests to detect adulterants in food. Pesticides-Mechanisms of Toxicity-Residues in Food, Acceptable daily limits.

Practical

Sensory and nutritional evaluation of some finished products. Detection of adulterants and preservatives in products. Identification of food logos. Study of food labelling. Identification of critical control points in a product line. Sensory evaluation of different food samples. Visit to quality control laboratory/food processing industries and note the procedures and parameters used for quality assessment. Estimation of quality parameters- cereals, pulses, fruits and veg. Market survey and quality analysis of street foods. Estimation of quality parameters – cereals, pulses, fruits and vegetables - Evaluation of food quality – objective and subjective methods - Market survey and quality analysis of street foods -

Suggested Readings

1. *Food Safety and Standards* (Food Products Standards and Food Additives) Regulation, 2011.
2. Jellinek G. 1985. *Sensory Evaluation of Foods: Theory and Practice.* Ellis Honwood Ltd., Chichester, England.
3. Kalia M and Sood S. 2010. *Food Preservation and Processing.* (Revised Edn.). Kalyani Publishers, New Delhi.
4. *Manual of Food Standards and Quality Control.* 2014. Dept. of Foods and Nutrition, CCS HAU, Hisar. Detect Adulteration with Rapid Test (DART) Booklet, FSSAI (Accessed on 13-01-2025).
5. Patricia and Cuuring A. *An Operational Textbook: Guide to Food Laws and Regulations.*
6. Potter N N. 1996. Food Science. The AVI Publishing Company Inc., Westport, Connecticut.
7. Radonit and Lassztity. 2008. *Food Quality and Standards.* Encyclopedia of Life Effort Systems, USA.

Food Toxicology and Quality Testing 3 (2+1)

Objectives

i. To give an introduction to possible toxic effects of food additives and naturally occurring environmental toxins in food.

ii. To make students able to define toxicology

iii. To make student able to define the most important contaminants in food, the toxicology of various additives and environmental toxins, as well as their sources

iv. To explain what food safety is and which substances are of relevance for food safety

v. To explain to students what risk analysis, assessment and management in relation to food safety is, and know which organizations are involved in this type of work nationally and internationally

Theory

Food toxicology – definition, introduction and significance. Classification of toxic constituents. Food poisoning –types, causative factors, signs and symptoms, preventive measures. Natural food toxins – pulses, oil seeds, sea foods, processed animal foods. Anti-nutritional factors, other food toxins, their harmful effects and methods of removal. General characteristics, occurrence, properties and inactivation of protease inhibitors, trypsin inhibitors, haemagglutinins, goitrogens, gossypol. General characteristics, occurrence, properties and inactivation of saponins, lathyrogens, avidin and other antimetabolites. Microbial toxins – classification, source of contamination, effect on health, preventive measures, methods of inactivation / destruction. General characteristics, occurrence and properties of mycotoxins, aflatoxin, ochratoxin and patulin. Methods to detect and prevention of mycotoxins. Chemical toxins – Pesticides - Pesticide and insecticide residual toxicity – sources and health hazards, insecticides, metallic and others. Mineral toxicity – Chlorine and Fluorine, Heavy metals toxicity – Lead and Chromium, Mercury, Arsenic and Iron, residual effects, preventive measures, methods of removal. Food additives – classification, toxicity and effects. Toxins developed during processing. Food packaging material – Potential contaminants from food packaging material. Antibacterial drugs, hormones and growth promoters of animal origin. Detection of toxins in food chain.

Practical

Methods of detect aflatoxin and gossypol**.** Methods of detect trypsin inhibitors and protease inhibitors. Use of AAS for detection of lead, chromium, mercury, arsenic, iron, detection of tannin and phytic acid. Visit to toxicology lab and public health laboratory. Visit to Quality Testing Laboratory, food processing industry/ government laboratory.

Suggested Readings

1. Bjeldanes. 2016. Food Toxicology. CRC Press, Boca Raton.
2. Compendium of Food Additives Regulations. 2020. FSSAI.
3. Damodaran S, Parkin K L and Fennema O R. 2007. Fennema's Food Chemistry. (4th Edn.). Taylor and Francis.
4. Derelanko M J and Hollinger M A. 2002. Handbook of Toxicology. (2nd Edn.). CRC Press, Boca Raton.
5. Hodgson E. 2004. A Textbook of Modern Toxicology. John Wiley and Sons, Inc.
6. http://www.cdc.gov/ (Accessed on: DD-MM-YYYY).
7. http://www.fda.gov/ (Accessed on: 12-01-2025).
8. http://www.fda.gov/downloads/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathogensNaturalToxins/BadBugBook/UCM297627.pdf (Accessed on: 12-01-2025).
9. http://www.foodqualitynews.com/ (Accessed on: 12-01-2025).
10. Robertson G L. 2006. Food Packaging: Principles and Practice. 2nd edn. CRC Press, London.
11. Shibamoto T and Leonard F. 2012. Introduction to Food Toxicology. Academic Press, India.
12. www.fssai.gov.in (Accessed on: 12-01-2025).
13. www.standardsdata.in (Accessed on: 12-01-2025).

Print and Electronic Journalism 3 (0+3)

Objectives

i. To develop the learner into competent and efficient in the field of reporting news, processing and program production in the field of media

ii. The Subject is designed to make the students learn about script, interviews techniques, phone-ins, panel discussion, voice over, live shows and field reporting

Practical

Visit to print and electronic stations for familiarization with equipment's, Interaction with personnel of print and electronic media. Report writing on observations and presentation. Planning a press note/ press release for print media, Screening of radio news programs. Screening of TV news programs. Exercises on writing different types of reports for radio. Exercises on writing different types of reports - television formats, Hands-on experience with editing. Planning a press note/ press release for electronic media, Writing and presentation of radio and television news, Orientation to photography/videography and its equipment. Hands on training with different types of professional cameras, Writing captions for photographs. Writing and editing photo features for selected photographs and presentation. Familiarization with different online articles. Content creation for online journal. Creating a blog, awareness videos. Using social media channels such as Facebook/ Instagram/ LinkedIn/ Twitter/ WhatsApp, to create nutrition related post.

Suggested Readings

1. Bhatnagar R. 2001. *Print Media and Broadcast Journalism.* Indian Publisher Distributors, Delhi.
2. Bhatt S C. 1993. *Broadcast Journalism: Basic Principles.* Har Anand Publications, Delhi.
3. Fernández-Celemín L and Jung A. 2006. What should be the role of the media in nutrition communication? *British Journal of Nutrition* **96(S1)**: S86-S88. doi:10.1079/BJN20061707.
4. http://hosbeg.com.printmedia.an (Accessed on: 12-01-2025).
5. https://www.nyfaedu.print.journal (Accessed on: 12-01-2025).
6. https://www.vskills.in/certification (Accessed on: 12-01-2025).
7. Katyal V P. 2007. *Fundamentals of Media Ethics.* Cyber Tech Publishers, New Delhi.
8. Kumar A. 1999. *The Electronic Media.* Anmol Publications, New Delhi.

Tourism and Hospitality Management 3 (1+2)

Objectives

i. To learn skills associated with problem solving, creative and critical thinking; related to tourism industry

ii. To applying the concepts and skills necessary to achieve guest satisfaction

iii. To demonstrate knowledge of multi - cultural perspectives to meet the needs of the guests and employees

iv. To lead with the knowledge that the foundation of tourism and hospitality is based on the respect for the host culture with the responsibility to perpetuate unique values, traditions, and practices of that place

v. To demonstrate ability to perform basic and supervisory level job functions in hotel and restaurant careers

Theory

Tourism Management Introduction to Tourism, Growth and development of modern tourism, Tourism in India, Heritage/ Cultural, Pilgrimage Tourism, Medical, Hot Spots and Culinary Tourism -Business and Cruise Tourism - Eco-tourism/ Rural tourism - Emergence of Eco-tourism / Rural tourism - Concept and definitions - Growth and development issues in eco-tourism - Travel Agency and Tour Operation and logistics (Airlines operation and ticketing. Ships cruise services) business in India, Emerging trends of tourism, Impacts of Tourism, Ethics issues in tourism - Introduction to Hospitality Management. Basic Management Principles: planning, organizing, staffing, leading, controlling with specific reference to hospitality. Hotel hierarchy: GM, departmental heads, supervisors, operational employees Soft Skills in Hospitality; personal development, motivation. Communication techniques and skills, Hostess training Services offered to guests such as food and accommodation services and personal services Front Office management. Maintenance of front office records - housekeeping services - cleaning and linen services, bed making Accommodation Operations - Role of accommodation operations in hospitality. Public areas – maintenance and decoration

Practical

Study of all the activities of a tourism office and report Planning for a tour - Heritage, Eco, Wildlife, Pilgrimage, medical etc. - Planning for Accommodation operations - Preparation of a tour package - Visit to different tourist spots - Planning layouts of front office of different institutions - Mock sessions on front office handling - Mock sessions on Communication Techniques and Skill - Mock sessions on Handling Complaints and Emergencies - Mock sessions on Handling various types of clients - Practical sessions on Hostess training - Services offered - Practical sessions on housekeeping services - Report writing.

Suggested Readings

1. Dharmarajan S and Seth R. 1994. *Tourism in India - Trends and Issues.* (1st Edn.). Har Anand Publications Pvt. Ltd., New Delhi.
2. Gupta S. 2006. *World Tourism in New Millennium.* (1st Edn.). ABD Publishers, Jaipur.
3. Kamra K K and Chand M. 2006. *Basics of Tourism - Theory, Operation and Practice.* (1st Edn.). Kanishka Publishers, New Delhi.
4. Maken D. 2004. *Strategies and Planning in Tourism and Industry.* (1st Edn.). Adhyayan Publishers and Distributors, Delhi.
5. Puri M and Chand G. 2006. *Tourism Management.* (1st Edn.). Pragun Publications, New Delhi.
6. Roday S, Biwal A and Joshi V. 2009. *Tourism Operations and Management.* (1st Edn.). Oxford University Press, New Delhi.
7. Sharma R B. *World Tourism in 21st Century*. (1st Edn.). Alfa Publications, New Delhi.

SKILL ENHANCEMENT COURSES (SEC modules)

Broad course syllabi for SEC, Institutions may modify, add more courses as per the expertise and need of the area; the courses may be conducted by the institution or in partnership with any organization

Indicative list* of SEC Modules

S. No.	Course Title	Credit Hours
1.	Jam Jelly Preparation	2 (0+2)
2.	Cake Making	2 (0+2)
3.	Indian Traditional Sweets	2 (0+2)
4.	Cake Decoration and Icing	2 (0+2)
5.	Pickle Preparation	2 (0+2)
6.	Candy Making	2 (0+2)
7.	Savory Snack Preparation	2 (0+2)
8.	Ready to Eat Snacks	2 (0+2)
9.	Hygiene Management in Food Service Units	2 (0+2)
10.	Quality Control in Food Processing Units	2 (0+2)
11.	Web Designing and Multimedia Production	2 (0+2)
12.	Development of Nutritional Educational Material	2 (0+2)
13.	Development of Audio-Visual Aid	2 (0+2)
14.	Sugar Processing and Confectionary	2 (0+2)
15.	Assessment of Clinical Signs and Symptoms	2 (0+2)
16.	Development of Project Proposals	2 (0+2)
17.	Laboratory Analysis	2 (0+2)
18.	Practical Skills in Writing And Speaking	2 (0+2)

*University/HEI may offer courses in any area as identified by it, based on institutional expertise/ capabilities/resources. In addition, SEC list as suggested by UGC is given in item IV listed under 3.1.12 are also suggested.

Jam Jelly Preparation 2 (0+2)

Practical

Nutritional aspect of Fruits; Basic characteristics of jams, jellies, marmalades, fruit preserves, glazed and crystallized fruits; Role of sugar and other ingredients in fruit preservation; Introduction to various food additives used in jams, jellies and other fruit preserves; Basic tools and equipment used in the preparation of jams, jellies and crystallized fruits such as pulper, sealers, juice extracting machines, autoclaves, steam jacketed kettle, etc.; Introduction to different types of packaging materials used.

Identification of different types of spoilage occurring in fruits; Selection and grading of raw and ripe fruits for preservation; Preparation of Jam, jelly and marmalades - ripe mango, green mango, pineapple, apple, guava, orange, mixed fruits, etc.; Preparation of glazed and crystallized fruit preserves- ginger, orange, apple, etc.; Analysis of the raw material and finished product -

Pectin grade, Acidity of fruit juice and pickle, Total Solid content, Brix measurement, Moisture content, Ash content, reducing and non-reducing sugar content. Study on the shelf life of the finished product.; Basics of labeling, packaging and presentation of sweets; Waste Management and up keeping of work place.

Cake Making 2 (0+2)

Practical

Ingredient used in Cake Making Types and Varieties: Flour, Sugar, Shortening – Fats and oil, Egg, Moistening agent, Leavening Agents; Cake Making Methods: Sugar butter process, Flour butter process, Genoise method, Blending and rubbing method; Characteristic of Cakes: External characteristics, Internal Characteristics; Balancing cake formula; Cake Faults and remedies; Basic Cake Making: Plain Sponge, Madeira Cake, Rock Cake, Fruit Cake, Fatless Sponge, Swiss Rolls, Genoise Sponge; Market survey for cake and confectionary food stuffs; Project writing of small-scale bakery and confectionery unit.

Indian Traditional Sweets 2 (0+2)

Practical

Basic ingredients and their role in preparation different types of traditional sweets; Basic tools and equipment used in the preparation sweets; Stages of Sugar cookery; Preparation of Bengali sweets like- Rasogolla, Rajbhog, Rasbhari, Chamcham, Rasomalai, Sandesh Raskadam, Mohanbhog, Kheer Mohan and Channa Toast; Preparation of milk and khoya based sweets like- khoa Burfi, chocolate burfi, khoa peda, kesar peda, pista burfi, badaam pista burfi , kesar khoa burfi, kalakand, milk cake, khoa roll, kheer kadam, coconut burfi, meva bati etc.; Preparation of ghee based sweets -Patisa, Gulab Jamun, Soan Papdi, Gujia, Imarti, Motipak, Balushahi, Laddu; Preparation of khaju and dry fruits based sweets like-Kaju Burfi, Kaju Roll,Kaju Laddu, Badam Burfi, Pista Lauj and Anjeer Burfi etc.; Basics of labeling, packaging and presentation of sweets; Waste Management and up keeping of work place.

Cake Decoration and Icing 2 (0+2)

Practical

Techniques of Icing –ingredients used in icing and their role; Tools of icing, preparing, and applying various types of icing; Icings and Toppings; Fondant; American frosting; Butter cream icing; Royal icing; Gum paste, marzipan; Marshmallow; Lemon meringue; Fudge, almond paste; Glace icing.

Pickle Preparation 2 (0+2)

Practical

Nutritional aspect of fruits and vegetables; Basic characteristics of pickles; Role of various ingredients used in fruit and vegetable preservation; Introduction to various food additives used in pickle making- Spices and other constituents, condiments and other additives and ingredients, and flavouring, colouring agent and preservative; Basic tools and equipment used in the preparation of pickle making such as boilers, choppers, mechanized peelers, sealers, autoclaves, steam jacketed

kettle, pickle mixer, etc.; Introduction to different types of packaging materials used; Identification of different types of spoilage occurring in fruits; Selection and grading of raw and ripe fruits and vegetables for preservation; Preparations of different types of pickles from fruits and vegetables- (i) Preparation of salty and oily pickle (green mango, green chili, lemon, ginger, mixed type), (ii) Preparation of sweet pickle (mango, plum, papaya, date, mango lather, mixed type etc.); Examination of processed products- Examination of processed products- Detection of benzoic acid, sulphur dioxide and KMS in fruits and vegetable products. Cleaning and maintenance of the equipment; Study of containers like Glass, Tin, packaging materials, such as plastic pouches, glass containers, plastic bottle and cartons; Information to be mentioned on label and pack; Waste Management and up keeping of work place.

Candy Making 2 (0+2)

Practical

Introduction to candy making; Basic ingredients and their role in preparation different types of candies; Basic tools and equipment used in the preparation of candies; Stages of Sugar cookery, caramelization of sugar, crystallization of sugar, invert sugar, corn syrup; Preparation of: Ganache- Ganache techniques and uses, -Various types of ganache, How to work with ganache, Piped and Filled Truffles- Making various recipes of ganache used for piped truffles and filled truffles; Tempering chocolate, Slab Ganache, Finishing truffles - Tempering white, milk and dark chocolate; Molded Truffles- Producing chocolates using shell molds and slabbing with metal bars, Learn how to prepare and decoratively color molds before filling, Cut ganache slabs with use of guitar, proper dipping and finishing technique with tempered chocolate, including use of transfer sheets; Finish all Truffles- How to store and freeze finished Truffles; Candy Bars- Discussion of different characteristics of a candy bar, History and popularity of the Candy bar, How to Assemble a candy bar; Jellies and Pate de Fruit- Learn the differences between the use of gelatin and pectin in gummy candies, Preparation of jellies and Pate de fruit; Crystalline Confections- Learn how the crystallization of sugar creates candy, Preparation of different Fondants and Fudges; Preparation of Chocolate Eggs; Basics of labelling and packaging , Waste Management and up keeping of work place.

Suggested Reading

1. Greweling. 2013. *Chocolates and Confections: Formula, Theory, and Technique for the Artisan Confectioner*. (2nd Edn.). Wiley, ISBN: 9780470424414.

Savory Snack Preparation 2 (0+2)

Practical

Market survey for availability of different types of savory snacks; Preparation of snacks with some shelf life: Types of Namkeen; Preparation of Chiwda; Chakli preparation and its variations; Preparation of mathri in different flavours; Gathiya preparation; Preparation of snacks eaten when prepared: Khaman and Dhokla with chutnies; Preparation of Dahi Vada and its chutnies; Making types of bhelpuri; Making Corn bhel/Chat; Preparations of Sago: Sago Vada and Sago Khichadi; Frying skills by preparing types of fritters and potato twisters; Cutlet preparation with various variations; Preparing Sprout Chat and Masala Peanut; Preparation of Garlic bread, Focaccia and Bruschetta; Project writing of small scale savory snack production unit.

Suggested Readings

1. Brown A. 2018. *Understanding Food: Principles and Preparation.* Wadsworth Publishing Co. Inc., Davis Drive, Belmont, CA.
2. Martland R E and Welsby D A. 1980. *Textbook of Basic Cookery: Fundamental Recipes and Variations.*
3. Pant P. 2007. *Cuisines – Incredible India.* Wisdom Tree, India.
4. Sethi M. 2007. *Catering Management – An Integrated Approach.* New Age International (P) Limited Publishers, New Delhi.

Ready to Eat snacks 2 (0+2)

Practical

Introduction to convenience foods based on various food groups; Selection of raw materials, Overview of various food additives used for snacks; Preparation of Grain/pulse based snacks: whole grains –roasted, toasted, puffed, popped and flakes Coated grains-salted, spiced and sweetened Flour based snack–batter and dough based products; savoury and farsans; formulated chips and wafers, papads; Preparation of fruit and vegetable based snacks: chips, wafers, papads etc. , ready to eat fruits and vegetable based food products like, sauces, fruit bars, glazed candy etc., ready to eat canned value added fruits/vegetables and mixes and ready to serve beverages etc.; Preparation of Dairy based convenience foods; Preparation of ready-to-eat baked food products, drying, toasting roasting and flaking, coating, chipping. Preparation of coated nuts –salted, spiced and sweetened products-chikkis, Singh bhujia; Extruded snack foods: Formulation of cold and hot extruded snacks, assessment of quality; Food packaging material for snack foods, Food labels; Visit to snack making plant.

Hygiene Management in food service units 2 (0+2)

Practical

Introduction, importance and need of food hygiene and sanitation if food service establishments; Identification of microorganism, preparation of slides, preparation of media; Collection of water samples, Testing of water for: (i) Physical quality, (ii) Bacteriological quality, (iii) water hardness; Food-Borne Diseases- Define Food-Borne illness – Food Infections – Food Poisoning- Bacterial infections -Types of Food Inspections; Sanitary Procedures in Catering Industry- Sanitary Procedures for purchasing foods - categories of commodities – Storage areas Temperature Zones- Thawing, Blanching, maceration, Blast, Freezing, Pasteurization; Introduction to Daily Cleaning Procedures in Commercial Kitchen; Visit to food service establishments; Survey of food service establishments, data collection, tabulation, report writing and presentation.

Quality Control in Food Processing Units 2 (0+2)

Practical

Concept of quality control and quality assurance in food processing industry; Food and nutrition labelling on foods as per FSSAI regulations and international standards; Food safety management systems- GMP/GHP, HACCP, GLP, GAP, The Kosher and Halal Food Laws Food packaging, packaging material; Evaluation of food quality – Assessment of quality of some finished

foods through objective and subjective methods; Market survey and quality analysis of street foods; Visit to food processing Units to understand the quality control methods used while processing food; Simple physical and chemical tests to determine quality and detect adulterants in Oil and Fats, Spices and Condiments (any five), Food Grains, Pulses and Oilseeds, Flours – Wheat, Canned foods – Drained wt., Sugar and Honey, Milk and Milk products, Tea, Coffee; Report writing.

Web Designing and Multimedia Production 2 (0+2)

Practical

Study of creating Webpages using HTML elements like <html>, <head>, <title>, <body>, <u>, <b>, <i>, <p>, <marquee>,
, <ol>, <ul> with all its attributes. Familiarization with different types of websites, Hands-on-experience with Adobe photoshop for designing of website, Hands-on-experience with HTML

4.01 writing for construction of website, Hands-on-experience with Dreamweaver for construction of website. Hands-on-experience with flash for animations of website, Familiarization with cascading sheet styles. Familiarization with web analytics, Practical orientation to Multimedia application. Exposure to multimedia hardware and maintenance-parts and connection, peripheral. Handling multimedia-parts, connections and peripheral. Scanning, retrieval, capturing and navigating skills. Planning and Production of multimedia package, Multimedia authoring tools - CD and DVD writing techniques, Presentation of the prepared Multimedia kit by using LCD Projector.

Suggested Readings

1. Frain and Ben. Responsive Web Design with HTML5.
2. Jennifer Niederst Robbins. Developing web design latest edition.

Development of Nutritional Educational Material 2 (0+2)

Practical

Objectives, principles and importance of nutrition education in a community; Deficiency diseases and public health problems-Vit. A, iron and iodine deficiencies, other micronutrient deficiencies; Identification of nutritional problems and target groups (Survey); Communication techniques: Process, its components. Mass, group and individual Communication; advantages and disadvantages; Classification and use of audio-visual aids (Electronic aid, non-projected and three dimensional); Preparation of instructional material (Chart, Poster, Flipbook, Pamphlet, Calendar); Practicing and use of nutrition education material on vulnerable groups in the community, rural and urban; Planning and organizing nutritional education program for community; Evaluation of nutrition education program.

Development of Audio-Visual Aid 2 (0+2)

Practical

Introduction, need, importance of audio-visual aids; Classification of AV aids, characteristics, advantages and disadvantages of different types of AV aids; Principles to be followed for the effective use of AV aids; Development of various types of AV aids (digital/ non digital) like flash cards, posters, charts, puppets, video spots, podcasts, role plays, cultural programs like folk songs etc.; Field testing of the developed AV aids.

Sugar Processing and Confectionary 2 (0+2)

Practical

Introduction to Sugars: Composition and nutritional Composition; Types, properties and functions of Sugars; Identification and description of different stages of Sugar; Demonstration of 1 thread, 1.5 thread 2 thread consistency of sugar and Caramelization; Preparation of sweets using 1 thread sugar syrup (Gulab jamun, Makhanvada, Jalebi, Besan chakki, Ghewar etc.); Preparation of sweets using 1.5 thread and 2 thread sugar syrup (Kaju Katali, Shakkarpare, Mava petha, Gujia etc.); Preparation of Fondant and Fudge (Cake, Chocolate fudge etc.); Preparation of Toffee (Milk toffee, Chocolates, Stick jaws, liquor Chocolates etc.); Basics of labeling, packaging and presentation of sweets and confectionary products; Storage and preservation of sweets and confectionary products

Assessment of Clinical Signs and Symptoms 2 (0+2)

Practical

Preparation of list of signs and symptoms of PEM; Preparation of poster on signs and symptoms of vitamin deficiency; Preparation of folder on mineral deficiencies; Visit to Aanganwadi to assess signs of PEM deficiency in children; Visit to hospital to assess the deficiency signs and symptoms in pregnant women; Survey of adolescent boys and girls to assess micronutrient deficiency; Assessment of clinical signs and symptoms of malnutrition in school age children; Nutrition education to target groups on micro nutrient deficiency; Visit to local health centre to identify clinical signs and symptoms of nutritional problems; Community survey for nutritional deficiency disorders – data collection ,tabulation analysis, interpretation, report writing; Presentation of reports and group discussion; Comparison of data on status of various deficiency diseases in India (NFHS 3, NFHS 4, NFHS 5) in vulnerable groups; Development of tools for assessing signs and symptoms of micronutrient deficiency in vulnerable groups; Collection of data on locally available common foods and their cost and unavailability of certain foods leading to the deficiencies in particular region; Surveillance of national nutrition programs; Data analysis and Report writing.

Suggested Readings

1. Bamji M S, Prahlad R N and Vinodini R. 2003. *Textbook of Human Nutrition*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Das S. 2022. *Textbook of Community Nutrition*. Academic Publishers.
3. Mason J B, Habicht J, Tabatabai H and Valverde V. 1984. *National Surveillance*. WHO.
4. Sehgal S and Raghuvanshi R. 2007. *Textbook of Community Nutrition*. ICAR Publication.

Development of Project Proposals 2 (0+2)

Practical

It will be a group activity of 3-5 students in each group –

The students will do the background research on the project, will present an oral report, write and submit a formal project proposal on related aspects of food processing, dietetics, community nutrition, nutrition education, etc. The students are expected to: Identify an appropriate and manageable topic. A concise statement of objectives and what you intend to design and build will

be one of the outcomes of the course. Conduct a background history of the topic and a current literature search of the topic. Students are expected to search in journals, magazines and Internet. This background report will be submitted with the project proposal. Budget development. Project work plan and timeframe (including GANTT charts). Monitoring and evaluation plan. Management Plan and Institutional Capability. Prepare the proposal appropriate to the objectives of the project with budgetary details, and submit a complete written proposal.

Laboratory Aanalysis 2 (0+2)

Practical

Unit-1: General introduction to laboratory glass wares. General introduction to the laboratory instruments. Preparation of samples and buffer solutions. Qualitative and quantitative analysis of carbohydrates. Qualitative analysis of amino acids. Qualitative analysis of protein. Qualitative analysis of fat. Determination of milk quality by MBRT test; Unit-2: Estimation of bulky density of food stuffs. Estimation of color by spectroscopy. Physical analysis- specific gravity. Determination of food quality by standard plate count method. Estimation of reducing and non-reducing sugar. Estimation of starch digestibility. Estimation of minerals by UV spectrophotometer. Determination of acid values; Unit-3: Quantitative estimation of proximate principles- Estimation of moisture in food stuffs. ash minerals, Estimation of nitrogen by khjeldal method. Estimation of fat by soxhlet method. Estimation of carbohydrate by difference; Unit-4: Saponification and iodine number. Preparation of culture media. Isolation and enrichment of microorganisms. Isolation of mould from different food samples. Microbial examination of – milk products, Cereal and pulses, vegetables and fruits.

Suggested Readings

1. Pomeranz Y and Molean C E. 1977. *Food Analysis: Theory and Practical*. AVI Publication, New Delhi.
2. Sawhney S K and Singh R. 2000. *Introduction to Practical Biochemistry*. Noroda.

Practical skills in Writing and Speaking 2 (0+2)

Practical

Reading and Comprehension: Unseen Passage and Unseen Poems; Assessment of basic grammar: Worksheets on Articles, Verbs, Punctuations, Prepositions and conjunction; Worksheets on Tenses: Present tense; Simple present tense, Present Continuous Tense, Present perfect tense, Present Perfect Continuous Tense; Worksheets on Past Tense- Simple past tense, Past Continuous Tense, Past perfect tense, Past Perfect Continuous Tense; Worksheets on Future Tense- Simple future tense, Future Continuous Tense, Future perfect tense, Future Perfect Continuous Tense; Writing of letters – Informal letters, Formal letters, Emails; Notice writing / Advertisement; Essay writing; Story writing; Dairy Entry / CV writing; Writing of Blogs and technical articles; Oral Presentation skills; Extempore; Note taking and Summarizing; Individual presentations / Radio talks; Group presentations and Discussions.

Suggested Readings

1. Kumar S and Pushpa L. 2011. *Communication Skills*. Oxford University Press, India.
2. Seely J. 2005. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press, India.
3. Thomson A and Martinet A V. 1977. *A Practical English Grammar*. Oxford University Press, India.

ONLINE COURSES

In addition, students will have to opt for minimum 10 credits onlione courses(as per UGC guidelines for online courses) as a partial requirement for the B.Sc(Hons.) Food Nutrition & Dietetics

Suggestive list of on-line courses SWAYAM Portal

1. Food chemistry
2. Food fortification
3. Food microbiology
4. Food microbiology and Food safety
5. Food preservation Technology
6. Food and Nutrition
7. Food Laws and standards
8. Functional foods and Nutraceuticals
9. Fundamentals of food process engineering
10. Thermal processing of Foods
11. Dairy and Food process and product technology
12. Adolescent nutrition
13. Basics of nutrition
14. Mother health and Nutrition

PG Pathshala

1. Food safety and quality control
2. Food preservation
3. Principles of food processing
4. Innovation in food packaging
5. Food biotechnology
6. Food science
7. Macronutrients
8. Micronutrients
9. Human physiology
10. Nutritional biochemistry
11. Functional foods and nutraceuticals
12. Nutrition through life span

13. Nutrition wellness and fitness
14. Therapeutic nutrition
15. Research method in nutrition

Courses on Nutrition (Available on mooc.org (edx))

1. Nutrition and cancer- Wageningen X
2. Nutrition, Heart Disease and Diabetes- Wageningen X
3. Plant Based diet: Food of a sustainable future- Wageningen X
4. Nutrition and Health: Human Micro biome- Wageningen X
5. Nutrition and Health- Food Safety- Wageningen X
6. Nutrition and Health: Micronutrient and Malnutrition- Wageningen X
7. Nutrition and Health: Macronutrient and Over Nutrition- Wageningen X
8. Nutrition Exercise and Sports- Wageningen X
9. Feeding a hungry planet: Agriculture, nutrition and sustainability- SDG Academy X
10. Introduction to Food and Health- Stanford online
11. Mental health and nutrition- UCX
12. Sustainable food security: food Access- Wageningen X
13. Staying fit- Stanford online
14. Lifestyle management treatment of chronic disease- Part1- Doane X
15. Lifestyle management treatment of chronic disease- Part2- Doane X
16. The health effect of clinic change- Harvard X
17. Global Public Health- SDG Academy X
18. Sustainable food system: A Mediterranean perspective- SDG Academy X
19. Early childhood development: global strategies for implementation- Harvard X
20. Beer- the science of brewing- KULeuvenX
21. Fitness corporative
22. Sustainable global food systems

Courses on Nutrition (Available on IGNOU portal)

1. Diploma in nutrition and Health education
2. Certificate in nutrition and childcare
3. Certificate in Foods and Nutrition

Suggested Institutions / areas for Internship in Nutrition

1. Sports Authority of India (SAI)
2. Agricultural and Processed Food Products Export Development Authority (APEDA)
3. Food Safety and Standards Authority of India (FSSAI)

4. Centre For Health Research and Development, Society For Applied Studies
5. Defense Institute of Physiology and Allied Sciences (DIPAS)
6. Public Health Foundation of India (PHFI)
7. WHO, Internship program (WHO)
8. Hospitals- AIIMS, Apollo, Max, Fortis, Medanta, Etc.
9. Food Industries- Britannia, Perfetti, Pepsico India, Coca Cola, Haldirams, Bikaner
10. World Bank- Young Professional program (WBG)

Minimum Standards for Establishing a College of Food Nutrition and Dietetics

- **Degree Nomenclature:** B. Sc. (Hons.) Food Nutrition and Dietetics

B.Sc. (Hons.) Food Nutrition and Dietetics, being a relatively new programme may be started with College of Community Science, or as an independent degree programme of College of Food Nutrition and Dietetics or in a college where Food Science and Technology degree is provided or with the College of Veterinary Sciences.

1. Minimum intake (per year): 60

2. Faculty:

A. Core faculty: 23

FoodScience (0+2+4), Food Policy and Public Health (0+2+4), Nutrition and Dietetics (0+2+4), Sports Science & Nutrition (0+2+3).

B. Allied faculty:

Faculty for Computer Science, Statistics, Veterinary Physiology/Zoology/Human Physiology, Economics, Sociology, Psychology, English, Food Science and Technology, Microbiology, Basic Science, Journalism, Management, Environment Science Family Resource Management & Consumer Science, Extension Education and Communication Management and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. Land requirement (ha): 5

4. Essential Instructional units:,

- Laboratories and instructional facilities as per V Deans' Committee report.
- This land is required for establishment of College, Academic block including Laboratories.
- ELP units to be established under skill development or Entrepreneurial mode- 0.5 ha.

5. Divisons/Departments/Sections:

- Section of Food Science
- Section of Food Policy and Public Health Nutrition
- Section of Nutrition and Dietetics
- Section of Sports Science & Nutrition

6. Non-Teaching Staff: Office space for Dean's office, Dean's committee room, account section, students record section, ministerial staff room, computer cell, academics and controller of exam cell, toilets and conveniences, visitors room and information room shall be required.

S. No.	Divisions/Sections/Sections	Assistant/ Steno	Clerk	Lab Asstt./ Technician/ Assistant / Dietician	Attendant/ Messenger	Total
1.	Section of Food Science and Nutrition	1	1	4	1	7
2.	Section of Food Policy and Public Health Nutrition	1	1	4	1	7

S. No.	Divisions/Sections/Sections	Assistant/ Steno	Clerk	Lab Asstt./ Technician/ Assistant / Dietician	Attendant/ Messenger	Total
3.	Section of Nutrition and Dietetics	1	1	4	1	**7**
4.	Section of Sports Science & Nutrition	1	1	4	1	**7**
	TOTAL	**4**	**4**	**16**	**4**	**28**

7. Manpower Requirement of Dean s Office and other common facilities

S. No.	Name of the Post	No. of Posts
1.	Dean	01
A. Establishment (In case of independent faculty)		
1.	Assistant Administrative officer	**01**
2.	P.A./P.S. to Dean	01
3.	Senior Assistants (Academic, budget and establishment)	03
4	Clerks (one each for Academic, budget and establishment and 15.	04
5.	Messengers	03
6.	Asstt. Librarian	01
7.	Shelve Assistants	02
8.	Assistant Professor Physical Education & Sports	01
9.	Steno	02
10.	Computer assistant	01
11.	Driver (one each for light and heavy vehicle)	02
12.	Store Keeper	01
13.	Electrician	01
14.	Medical Officer	01
15.	Compounder	01
16.	Nurse	01
17.	Vehicles:	
18.	Office car	1
19.	Staff car/Jeep	3
20.	Bus	1
21.	Pick-up van	1
22.	Generator Shed	1
23.	Hostel Warden **(In case of independent faculty)**	Charge with faculty
18.	Assistant Warden	02
19.	Cook	01
20.	Assistant Cook	01
21.	Mess Helpers/ waiters (service)	06
23.	Attendants for Deans Office, library, sports, Medical Hospital	08

8. Floor Space (Department wise):

S. No.	Details	Number	Dimensions (ft)
1.	Head of the Department's Chamber	4	10 × 15 each
2.	Office Room	3	15 × 20 each
3.	Professors/Associate Professors' Rooms	13	10 × 10 each
4.	Faculty Rooms (with individual workstations)	6	20 × 30 each
5.	Laboratories	06	20 × 30 each
College Building			
1.	Class Rooms	4	Seating capacity of 65 each
2.	Multipurpose Room/Examination Hall	2	Seating capacity of 100
3.	Toilets	9	2 ladies' and 1 gents'/floor
Other Infrastructure			
1.	Auditorium Seating capacity of 500 persons	1	
2.	Dispensary	1	As per requirement
3.	Sports Complex	1each	Outdoor & Indoor
4.	Multi Gym	1	As per requirement
5.	Faculty Room for sports complex	1	10 × 15
6.	Store Room for sports complex	1	10 × 20
7.	Toilets for sports complex	1 each	For ladies and gents
5.	Hostel	1	To accommodate 250 students and with provision of 3 guest rooms.
6.	Parking facility	As per the requirement	
7.	Library	1	As per the Requirement
8.	Production cum Training Centre	1	As per the requirement

9. Laboratory Equipment:

Analytical Laboratory

S. No.	Details	S. No.	Details
1.	HPLC	7.	Vacuum cleaner
2.	UV vis Spectrophotometer	8.	Ultrasonic cleaner
3.	Kjel plus with auto titrator	9.	Muffle furnace
4.	Refrigerated centrifuge	10.	Autoclave
5.	Deep freezer	11.	Flash evaporator
6.	Moisture analyzer	12.	Laminar flow

S. No.	Details	S. No.	Details
13.	Hot air oven	29.	Sieve shaker
14.	Colony counter	30.	Pipette washer
15.	Incubator	31.	Cyclo mixer
16.	Magnetic stirrer with hotplate	32.	Spectrophotometer
17.	Viscometer	33.	Colony counter
18.	Soxplus	34.	Homogenizer
19.	Fibreplus	35.	Wiley Mill
20.	Viscometer	36.	Cabinet refrigerator
21.	Metabolic shaker	37.	Hot plates
22.	Water bath shaker	38.	Microwave digestor
23.	Photo fluorometer	39.	ICP-MS (Mass spectrometry with Inductively coupled plasma)
24.	Distillation apparatus	40.	Digital Refractometer
25.	Ion meter	41.	Rheometer
26.	Centrifuge	42.	Water activity meter
27.	pH meter	43.	Texture analyzer
28.	BOD incubator	44.	Rotavapour

Clinical Investigation Laboratory

S. No.	Details	S. No.	Details
1.	Glucometer	7.	Skinfold caliper
2.	B. P. Instrument	8.	Weighing balance
3.	Pedometer	9.	Vernier caliper
4.	Haemoglobin meter	10.	Body composition analyzer
5.	Anthropometric rod	11.	Heart Rate Monitor
6.	Infantometer	12.	Blood Analyser

Processing Lab and Product Development Laboratory

S. No.	Details	S. No.	Details
1.	Popping machine	10.	Microwave
2.	Modular Utensil storage rack/ shelves	11.	Hand held digital refractometer
3.	Potato bin	12.	Flour mill
4.	OTG	13.	Commercial Baking ovens
5.	Fryer	14.	Bottle capping machine
6.	Counter refrigerator	15.	Lyophilizer
7.	Masala grinder	16.	Vegetable cutter

S. No.	Details	S. No.	Details
8.	Wet grinder	17.	Dough kneader
9.	Vegetable peeling machine	18.	Multimill
19.	Working table	39.	Ginger peeler machine
20.	Vacuum oven	40.	Edible Food Printer
21.	Tray dryer	41.	Silicon Molds for Chocolate
22.	Grinding mill	42.	Glass Utensils for Microwave
23.	Canning equipment	43.	Shrink wrap packaging machine
24.	Vacuum sealing cum Gas flushing and sealing machine	44.	Form fill and sealing machine
25.	Hand held printer	45.	Vacuum packaging machine
26.	Bottling equipment	46.	Heat sealing machine
27.	Pouch filling machine	47.	Amylograph
28.	Coffeemaker	48.	Extension graph
29.	Tea maker	49.	Fruit Crusher/Pulper
30.	Electronic kitchen balance	50.	Juice Extractor
31.	Refrigerator	51.	Dough Divider
32.	Deep freezer	52.	Bread Slicer
33.	Heavy duty Mixer, Juicer, Grinder	53.	Table Sheeter
34.	HotTwin screw Extruder	54.	Muncell Colour Chart
35.	Cold Extruder/Pasta machine	55.	Farinograph
36.	Electric Pulper	56.	Ice cream machine
37.	Stone separator	57.	Khoa making machine
38.	Onion and Garlic peeler machine		

Catering Laboratory

S. No.	Details	S. No.	Details
1.	Microwave ovens	12.	Fryer
2.	Hot case cabinet	13.	Dough kneader (Heavy duty)
3.	Flycatchers	14.	Sugar grinder
4.	Air curtain	15.	Tandoor (Electric)
5.	Food processor	16.	Grill
6.	Water purifier	17.	Sandwich maker
7.	Dosa griddle plate	18.	Utensils for cooking and serving

S. No.	Details	S. No.	Details
8.	Refrigerator	19.	Pressure cookers (different sizes)
9.	Cooking range/Gas Burner	20.	Bain Marie Counter
10	Electric Juicer	21.	Idli maker
11.	Washing machine fully automatic	22.	Sprout maker

Nutrition Counselling Centre **Sports Nutrition Lab**

S. No.	Details	S. No.	Details
1.	Computers	1.	Diet Calculation Software
2.	Scanners	2.	Bioscan/ Body composition analyzer
3.	Video-editing workstation	3.	Digital weighing scale
4.	Smart Boards	4.	Antrhopometric rod/Stadiometer
5.	Laptop	5.	Indirect caloriemeter
6.	Printers cum scanner	6.	Heart rate monitor
7.	Photocopiers	7.	Pulse oximeter
8.	LED screen Television	8.	Windmill spirometer
9.	DSLR Camera	9.	Blood pressure equipment (Automated and manual
10	Measuring equipment	10	Skinfold calipers
11.	Anthropometric kit	11.	Mobile privacy screens
12.	Body Composition Analyser	12.	Accelerometers (ActiTrainer)
13.	Display units	13.	Treadmill
14.	Video Conferencing set up		

Office Requirements

1. Computers/ Laptops with accessories
2. Printer cum scanner
3. Photocopier

List of Furniture

1. Students chairs
2. Students stools
3. Book Racks
4. Storage cabinets
5. Filing cabinets
6. Office Almirahs
7. Display units

Additional Essential Requirements (common to all disciplines/Colleges)

- The requirement shall be enhanced proportionate to intake of students.
- At least 50% land should be devoted to Instructional farm. The land should be registered in the name of sponsoring trust/society/university.
- The aerial distance between academic block and the entry point of the instructional farm should not exceed 7 Km.
- If a college is offering multiple Under Graduate Programmes, the instructional farm facility should be additional.
- The students and staff amenities including hostels, sports complex, residences etc. should be treated as a common facility for the all colleges and accordingly land requirement shall be adjusted.
- For Post Graduate Programmes, land requirement should be additional to Under Graduate Programmes as per Deans Committee/ BSMA Committee guidelines. If a college is running only UG programme, the Departments and its faculty must be ensured. All departments should have at least two faculty members. If the Department is running PG/Ph.D. programmes, there should be at least 7 faculties (1 Professor, 2 Associate Professors and 4 Assistant Professors) for an intake of 10 in M.Sc. and 5 in Ph. D programme.
- Colleges should maintain records of contractual teaching/non-teaching staff including appoint files, qualifications, minimum salary/packages prescribed by UGC/ICAR (as per updated notification), disbursement of salary (yearly filed ITR with Form 16 (TRACES) clearly mentioning name of host institute, time table for each semester mentioning name of faculty, HRD records for both teaching/non-teaching staff.
- In any case batches of theory and practical should be made as per Dean's Committee recommendation. Semester-wise Academic Calender, Course Schedule and Time Table should be prepared for all Batches in theory and practical.
- Common facilities may be considered for all colleges in the University.

FOOD TECHNOLOGY

Course Curricula for Undergraduate Programs in Food Technology: UG-Certificate (Food Technology); UG-Diploma (Food Technology); B. Tech. (Food Technology)

INTRODUCTION

In an era marked by rapid population growth, changing dietary patterns, and environmental concerns, the significance of food technology cannot be overstated. Food Technology course is designed to address the multifaceted challenges facing the food industry today. It recognizes the need for a holistic approach to food technology education that encompasses theoretical knowledge, practical skills, and ethical considerations. At its core, the course aims to produce graduates who are well-equipped to address issues such as food security, safety, new product development, sustainability, and innovation.

The National Education Policy–2020 (NEP–2020) serves as a guiding framework aimed at revolutionizing education in this critical field. This comprehensive policy not only emphasizes theoretical knowledge but also underscores the importance of practical application, interdisciplinary learning, innovation, and critical thinking.

In view of these, the restructuring of undergraduate programs in Food Technology have been carried out. More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has also been made for advanced skill development through project work or experiential learning/ incubation, etc. These activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and analytical thinking. Besides, as per NEP 2020, provision for multiple exit and entry options have also been included.

One of the fundamental pillars of the program on Food Technology course is the emphasis on practical application. Recognizing the importance of hands-on learning experiences, laboratory work, and internships, the course has been designed to provide students with real-world exposure to the complexities of food processing, preservation, and quality assurance. By integrating practical training into the curriculum, students can develop essential skills that are crucial for success in the food industry. Two exit options, one after first year as a UG-Certificate and the other after the second year as UG-Diploma in Food

Technology, have been provided, so that the students can look for employment at any point of their career.

The course on Food Technology advocates for an interdisciplinary approach to education. It recognizes that food technology is inherently multidisciplinary, drawing upon principles from fields such as biology, chemistry, microbiology, engineering, and nutrition. By incorporating elements from these diverse disciplines, students gain a comprehensive understanding of food science and are better equipped to tackle complex challenges in the field.

This modified Food Technology course has far reaching implications for the future of food. By equipping students with comprehensive knowledge, practical skills, and ethical principles, the syllabus lays the foundation for a sustainable, resilient, and equitable food system. Graduates of the program are poised to make meaningful contributions to the food industry, driving innovation, promoting food security, and ensuring the safety and integrity of the global food supply.

Entrepreneurship in food technology is an aspect that is characterized by a spirit of innovation and disruption. Entrepreneurs in this field leverage cutting-edge technologies, scientific advancements, and creative thinking to develop novel solutions that revolutionize the way we produce, process, and consume food. These entrepreneurs are driving forward-thinking initiatives that have the potential to reshape the future of food.

The details of the course structure for the Undergraduate courses in Food Technology (UG-Certificate, UG-Diploma and B. Tech.) have been prepared after having multistage in-depth deliberations and discussions with the Deans' and faculty members of the Food Technology discipline of different SAUs, stakeholders from related industries and alumni. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP 2020.

This course on Food Technology represents a landmark initiative aimed at transforming education in this critical field. By emphasizing practical application, interdisciplinary learning, innovation, and food safety, the program seeks to empower students with the knowledge and skills needed to address the complex challenges facing the food industry. As we look towards the future, the course curricula on Food Technology holds immense promise for shaping a more sustainable, resilient, and equitable food system for generations to come.

HIGHLIGHTS

- The B. Tech. (Food technology) Program will be of 4 years, covering 181 credits, which has 171credits (exclusive of four credits of two non-gradial courses i.e (Deeksharambh (Induction-cum-Foundation course): 2 credits and Study tour: 2 credits), offered by the parent institute. Additionally, 6 credits of online courses are to be taken by the student as per his/ her choice.
- More weightage has been given to skill enhancement courses in first two years, semesters 1 to 4. Students have been given flexibility and choice in selection of skill enhancement courses from a basket of multiple skill enhancement modules offered in all the four semesters of first two years.
- The UG Certificate is being offered in three domains viz., Food Plant Operations, Food Manufacturing and Food Quality Testing for which a basket of courses has been offered to enhance their skill in the particular domain.
- Students will be given 4 credits of skill-based courses each in first, second, and 2 each in third and fourth semesters so that they will acquire enough knowledge and skill through hands-on training in related domain.
- The students will have flexibility and choice in selection of skill areas from a basket of skill enhancement modules to be offered/ listed by the parent institute. After common orientation on different skill enhancement modules, students will take up either one or more modules as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the HAEI can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.
- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/ companies/ NGO progressive entrepreneurs for running the Skill Enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.
- In first year, after completing the course requirement of 45 credits of both the semesters, there is provision of extra 10 credits Internship of two months period for Industry placement/ Industry exposure/ Hands-on training with local food processors/equipment manufacturers, etc. in related domain of skill to get first-hand experience to become eligible for the award of UG-Certificate on exit.
- The second year has been designed with the basic engineering courses as well as fundamental courses in food technology with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of Food Technology. After satisfactory completion of the courses of 2nd year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Food Technology on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given in proper amalgamation of theory and practical to provide them hard core knowledge of the B. Tech. (Food Technology) discipline. In third year, the student will be taught intensive core courses of Food Technology.

- Six credits of online courses are at the discretion of students. Students have the choice of taking online courses to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these online courses of 6 credits any time preferably during the 3rd and 4th years. These courses are to be completed with satisfactory grade the students have to get prior approval from university HEA's for their registration.
- On successfully completing the four years degree requirement, the student will be given undergraduate degree of B. Tech. (Food Technology).

Entry and Exit Options

The entry and exit options for the UG-B. Tech. Food Technology programme in are shown in the figure 1 below:

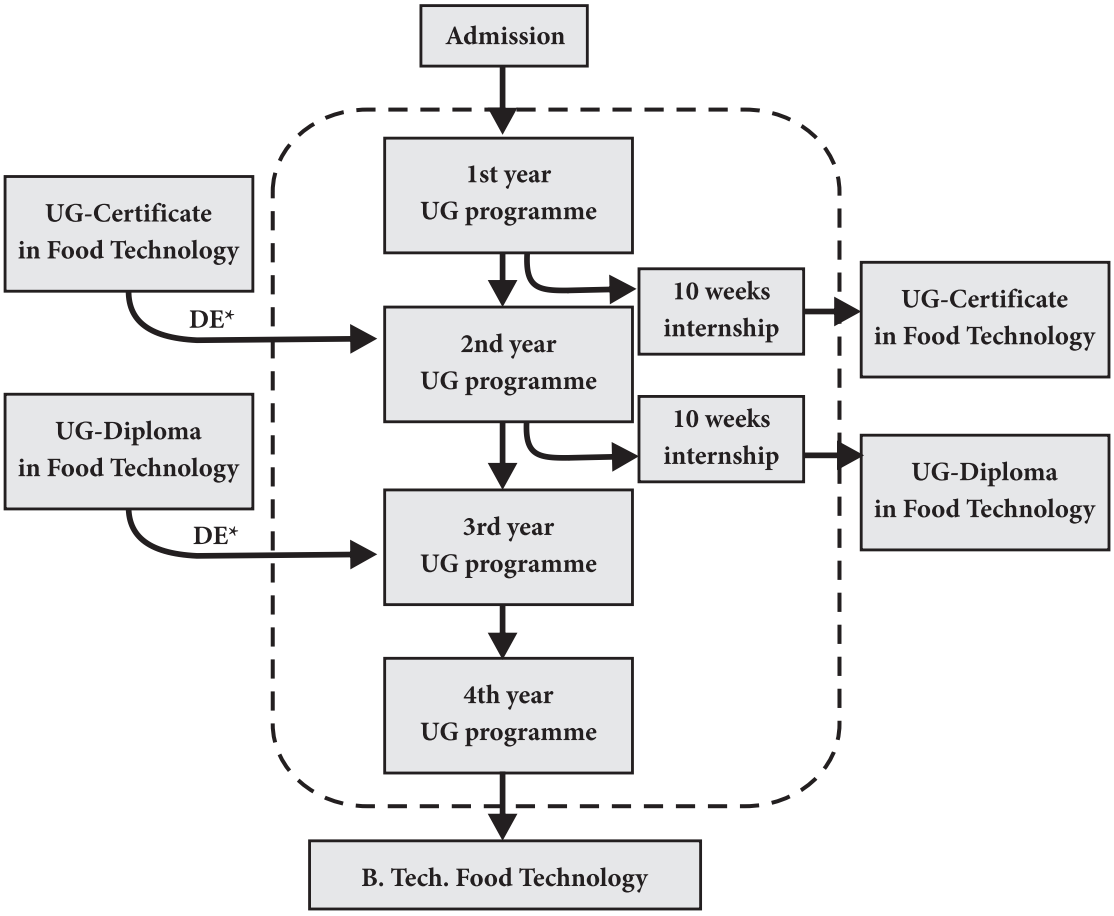


Fig.1 Entry and Exit options for the UG programs in Food Technology

***Direct Entry in the Respective Year**

Exit and entry options:

- **UG-Certificate in Food Technology** (exit after first year and completion of 10 weeks' internship) with following specialization e.g. UG certificate in Food technology (Food Plant Operations)

a. Food Plant Operations

b. Food Manufacturing

c. Food Quality Testing

- **UG-Diploma in Food Technology** (exit after second year and completion of 10 weeks' internship) as per the specialization given in 03 areas as above.

- **B.Tech. (Food Technology)** (on successful completion of four-year degree requirements)

The Universities may consider allowing lateral entry for the candidates having Diploma in Food Technology (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having Diploma in Food Technology (with minimum 3 years course program after 10th or equivalent as approved by UGC/ICAR as per the provisions to be notified by the respective AU from time to time.

Admission Eligibility for Entry into 1st year UG program: 10+2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU/HAEI.

ACADEMIC PROGRAM

Semester Wise Course Distribution

S. No.	Course Title	Credit hours	Total Credit hours
	First Year		
	Semester-I		
1.	*Deeksharambh* (Induction-cum-Foundation Course of 2 weeks)	2 (0+2) Non-Gradial	22 (10+12) +2 (Non-Gradial)
2.	Fundamentals of Food Processing	3 (2+1)	
3.	Workshop Technology	3 (1+2)	
4.	Basic Electrical Engineering	3 (2+1)	
5.	General Microbiology	3 (2+1)	
6.	Farming Based Livelihood System	3 (2+1)	
7.	Communication Skills	2 (1+1)	
8.	NCC-I/ NSS-I	1 (0+1)	
9.	Skill Enhancement Course- I***	2 (0+2)	
10.	Skill Enhancement Course - II***	2 (0+2)	
	Semester-II		
1.	Post-Harvest Engineering	3 (2+1)	23 (11+12)
2.	Food Chemistry I	3 (2+1)	
3.	Unit Operations in Food Processing	3 (2+1)	
4.	Food Thermodynamics	3 (2+1)	
5.	Engineering Drawing and Graphics	3 (1+2)	

S. No.	Course Title	Credit hours	Total Credit hours
6.	Environmental Studies and Disaster Management	3 (2+1)	
7.	NCC-II/NSS-II	1 (0+1)	
8.	Skill Enhancement Course - III***	2 (0+2)	
9.	Skill Enhancement Course - IV***	2 (0+2)	

Discipline/ Department		Course Title	Credit hours
Food Technology	1	Introduction to Drying Technology and Dryers	2 (0+2)
	2	Introduction to Processing of Extruded Foods	2 (0+2)
	3	Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)
Food Quality	1	Introduction to Food Safety and Sanitation	2 (0+2)
	2	Introduction to Good Laboratory Practices	2 (0+2)
	3	Basic Food Analysis Laboratory Techniques	2 (0+2)
Food Engineering	1	Introduction to Electrical and Control Systems in Food Industry	2 (0+2)
	2	Introduction to Mechanical Systems in Food Industry	2 (0+2)
	3	Introduction to AutoCAD	2 (0+2)
Food Plant Operations	1	Maintenance of Food Processing Equipment	2 (0+2)
	2	Introduction to Bottling and Canning Line	2 (0+2)
	3	Introduction to Manufacturing of Bakery Products	2 (0+2)

From Basket of Skill enhancement course modules, only one course from each discipline is to be selected per semester as per the selected specialization of certificate. However, at least one course of other specialization viz. Food Technology, Food Engineering and Food Quality is to be taken for the Diploma course.

Student taking various SKILL ENHANCEMENT COURSES will be eligible to get a Certificate with Nomenclature as follows provided the student has selected courses as mentioned against the nomenclature of the UG-Certificate.

Nomenclature of Certificate	Skill Enhancement Courses to be selected from the respective disciplines	
	Semester-I	Semester-II
UG-Certificate in Food Technology (Food Plant Operations)	Food Engineering	Food Plant Operations
UG-Certificate in Food Technology (Food Manufacturing)	Food Technology	Food Plant Operations
UG-Certificate in Food Technology (Food Quality Testing)	Food Quality Assurance	Food Plant operations

Post- II Semester

Course Title	Credit hours
Internship (only for exit option for award of UG-Certificate) 10 weeks	**10 (0+10)***

Second Year			
Semester-III			
1.	Food Chemistry II	3 (2+1)	**23 (13+10)**
2.	Fluid Mechanics	3 (2+1)	
3.	Heat and Mass Transfer in Food Processing	3 (2+1)	
4.	Basic Electronic Engineering	2 (1+1)	
5.	Food Microbiology	3 (2+1)	
6.	Engineering Mathematics- I	2 (2+0)	
7.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
9.	Skill Enhancement Course-V***	2 (0+2)	
Semester-IV			
1.	Fundamentals of Food Engineering	3 (2+1)	**20 (13+7)**
2.	Food Plant Sanitation	3 (2+1)	
3.	Food Quality, Safety Standards and Certification	2 (2+0)	
4.	Engineering Mathematics- II	2 (2+0)	
5.	Food Plant Utilities and Services	3 (2+1)	
6.	Entrepreneurship Development and Business Management	3 (2+1)	
7.	Personality Development	2 (1+1)	
8.	Skill Enhancement Course-VI***	2 (0+2)	
Student taking various SKILL ENHANCEMENT COURSES can exit here to get a UG-Diploma in Food Technology			

Post- IV Semester

Course Title	Credit hours
Internship (only for exit option for award of UG- Diploma)	**10 (0+10)***

Third Year			
Semester-V			
1.	Food Biochemistry and Nutrition	3 (2+1)	**22 (14+8) +2** (Non-Gradial)
2.	Processing Technology of Cereals	3 (2+1)	
3.	Processing Technology of Fruits and Vegetables	3 (2+1)	
4.	Food Packaging Technology and Equipment	2 (1+1)	
5.	Processing of Spices and Plantation Crops	3 (2+1)	
6.	Food Storage Engineering	3 (2+1)	
7.	Project Preparation and Management	2 (1+1)	
8.	Agriculture Marketing and Trade	3 (2+1)	
9.	Study tour (10-14 days during the semester)	2 (0+2) NG	

Semester-VI			
1.	Food Additives and Preservatives	2 (1+1)	**21 (13+8)**
2.	Sensory Evaluation of Food Products	2 (1+1)	
3.	Processing Technology of Legumes and Oilseeds	3 (2+1)	
4.	Food Refrigeration and Cold Chain	3 (2+1)	
5.	Processing of Meat, Fish and Poultry Products	3 (2+1)	
6.	Processing Technology of Beverages	3 (2+1)	
7.	Bakery, Confectionary and Snack Products	3 (2+ 1)	
8.	Processing Technology of Liquid Milk	2 (1+1)	
Fourth Year			
Semester-VII			
1.	Food Process Equipment Design	3 (2+1)	**20 (5+5)**
2.	Processing Technology of Dairy Products	3 (2+1)	
3.	ICT Applications in Food Industry	3 (1+2)	
4.	Seminar	1 (0+1)	
5.	Elective Courses	10	

Student has to complete 20 credits in this semester. Courses 1-4 (10 credits) are compulsory. (Minimum 10 credit hours from this Suggestive list of courses should be opted as Elective Courses) as given below:

ELECTIVE COURSES

S. No.	Course Title	Credit hours	
1.	Design and Formulation of Foods	3 (2+1)	
2.	Industrial Microbiology	3 (2+1)	
3.	Introduction to Food Biotechnology	3 (2+1)	
4.	Business Management and Economics	2 (2+0)	
5.	Statistical Methods and Numerical Analysis	2 (1+1)	
6.	Instrumentation and Process Control in Food Industry	3 (1+2)	
7.	Instrumental Techniques in Food Analysis	2 (1+1)	
8.	Traditional Indian Dairy Products	2 (1+1)	
9.	Ice-cream and Frozen Desserts	3 (2+1)	
10.	Energy Conservation and Management	2 (1+1)	
11.	Applications of Renewable Energy in Food Processing	2 (1+1)	
12.	Food Plant Design and Layout	3 (2+1)	
13.	Waste and By-Products Utilization	3 (2+1)	

Semester-VIII			
1	Student READY: (Internship/In plant training/Hands-on-training/ Experiential learning/Student project etc.) (20 weeks)	20 (0+20)	**20 (0+20)**

#CNC-Compulsory non-gradial course

*** From the available basket of skill enhancement modules

Department wise course distribution

S. No.	Course Title	Credit hours
Department of Food Technology		
1	Fundamentals of Food Processing	3 (2+1)
2	Processing Technology of Fruits and Vegetables	3 (2+1)
3	Processing Technology of Liquid Milk	2 (1+1)
4	Food Packaging Technology and Equipment	2 (1+1)
5	Processing Technology of Cereals	3 (2+1)
6	Processing Technology of Legumes and Oilseed	3 (2+1)
7	Processing Technology of Dairy Products	3 (2+1)
8	Processing of Meat, Fish and Poultry Products	3 (2+1)
9	Bakery, Confectionary and Snack Products	3 (2+ 1)
10	Processing of Spices and Plantation Crops	3 (2+1)
11	Sensory evaluation of Food Products	2 (1+1)
12	Processing Technology of Beverages	3 (2+1)
13	Internship (at Industry/ Research Institutes, etc.) (20 weeks)	20 (0+20)
Skill Enhancement Courses		
1	Introduction to Drying Technology and Dryers	2 (0+2)
2	Introduction to Processing of Extruded Foods	2 (0+2)
3	Introduction to Milling (Rice, Dal, Spices, etc.)	2 (0+2)
Department of Food Engineering		
1	Workshop Technology	3 (1+2)
2	Engineering Drawing and Graphics	3 (1+2)
3	Basic Electrical Engineering	3 (2+1)
4	Food Thermodynamics	3 (2+1)
5	Post-Harvest Engineering	3 (2+1)
6	Fluid Mechanics	3 (2+1)
7	Heat and Mass Transfer in Food Processing	3 (2+1)
8	Basic Electronic Engineering	2 (1+1)
9	Unit Operations in Food Processing	3 (2+1)
10	Fundamentals of Food Engineering	3 (2+1)
11	Food Refrigeration and Cold Chain	3 (2+1)
12	Food Storage Engineering	3 (2+1)
13	Food Process Equipment Design	3 (2+1)
14	Instrumentation and Process Control in Food Industry	3 (1+2)
Skill Enhancement Courses		
1	Introduction to Electrical and Control Systems in Food Industry	2 (0+2)
2	Introduction to Mechanical Systems in Food Industry	2 (0+2)
3	Introduction to AutoCAD	2 (0+2)

S. No.	Course Title	Credit hours
Department of Food Quality Assurance		
1	Food Chemistry I	3 (2+1)
2	Food Chemistry II	3 (2+1)
3	General Microbiology	3 (2+1)
4	Food Microbiology	3 (2+1)
5	Industrial Microbiology	3 (2+1)
6	Food Biochemistry and Nutrition	3 (2+1)
7	Food Plant Sanitation	3 (2+1)
8	Introduction to Food Biotechnology	3 (2+1)
9	Instrumental Techniques in Food Analysis	2 (1+1)
10	Food Additives and Preservatives	3 (2+1)
11	Food Quality, Safety Standards and Certification	2 (2+0)
Skill Enhancement Courses		
1	Introduction to Food Safety and Sanitation	2 (0+2)
2	Introduction to Good Laboratory Practices	2 (0+2)
3	Basic Food Analysis Laboratory Techniques	2 (0+2)
Department of Food Business Management		
1	Business Management and Economics	2 (2+0)
2	Engineering Mathematics- I	2 (2+0)
3	Engineering Mathematics- II	2 (2+0)
4	Statistical Methods and Numerical Analysis	2 (1+1)
5	ICT Applications in Food Industry (Informatics)	3 (1+2)
6	Project Preparation and Management	2 (1+1)
	Common Courses	
1	Induction-cum Foundation Course (2 weeks)	2 (0+2) Non-Gradial
2	Farming Based Livelihood System	3 (2+1)
3	Communication Skills	2 (1+1)
4	Personality Development	2 (1+1)
5	Environmental Science and Disaster Management	3 (2+1)
6	Entrepreneurship Development and Business Management	3 (2+1)
7	Agriculture Marketing and Trade	3 (2+1)
8	Agricultural Informatics & Artificial Intelligence	3 (2+1)
Department of Food Plant Operations		
Skill Enhancement Courses		
1	Food Plant Utilities and Services	3 (2+1)
1	Maintenance of Food Processing Equipment	2 (0+2)
2	Introduction to Bottling and Canning Line	2 (0+2)

S. No.	Course Title	Credit hours
3	Introduction to Manufacturing of Bakery Products	2 (0+2)
4	Internship (only for exit option for award of UG-Certificate) 10 weeks	**10 (0+10)**
5	Internship (only for exit option for award of UG- Diploma) 10 weeks	**10 (0+10)**

Table 1 Credits Allocation Scheme of UG programs B. Tech (Food Technology) (Credit Hours)

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)		
II	15	---	3(6)	1(3)	4	-	23	-	10(12)	
III	16	----	3 (10)	2(8)	2	-	23			
IV	13	3(5)		2(7)	2	-	20	-	10(13)	**6**
V	19	3(9)	-	-	-	-	22	2(11)		
VI	21	-	-	-	-	-	21	-		
VII	20	-	-	-	-	-	20	-		
VIII		-	-	-	-	20	20	-		
Total	**116**	**9**	**6**	**8**	**12**	**20**	**171**	**4**		**6**

Note: The credit hours mentioned in the table includes both theory and practical.

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Meditation
(9) Agriculture Marketing and Trade
(10) Agricultural Informatics and artificial intelligence
(11) Study tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

Summary of Credit Distributions

Categories of Courses	Credit Hours
Core Courses (Major and Minor)	116
Common Courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Internship	20
**MOOCs/Online Courses (Non-gradial)	6**
Grand Total	**171+6****

**Massive open online courses

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Course)- Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Helpings in for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in University
3. Instilling life and social skills
4. Social awareness, ethics and values, team work, leadership, creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Fundamentals of Food Processing 3 (2+1)

Objectives

i. To gain an understanding of the perishability of food and causes for food spoilage

ii. To have an idea of the basic methods of preservation of food

iii. To know about non thermal processing of food

Theory

Food: Definition and Functions, Classification of foods, sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation.

Food processing: Introduction, levels and techniques; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality.

Preservation by heat treatment: Principle, process and equipment for blanching, canning, pasteurization, sterilization. Preservation by use of low temperature: Principle, methods, equipment.

Preservation by drying, dehydration and concentration: Principle, methods, equipment; Preservation by irradiation: Principle, methods, equipment; Preservation by chemicals- antioxidants, mould inhibitors, antibodies, acidulants, Hurdle technology etc; Preservation by fermentation: Principles, methods, equipment.

Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc. Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze-drying process; Demonstration of preserving foods under cold vs. freezing process; Processing of foods using fermentation technique, i.e. preparation of sauerkraut; Study on effect of high pressure on microbe; Study on effect of pulse electric field on food.

Suggested Readings

1. Brennan J G. 2006. *Food Processing Handbook*. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Desrosier N W and Desrosier J N. 1977. *The Technology of Food Preservation*. (4th Edn.) AVI Publishing Co., Connecticut, USA.
3. Fellows P. 2000. *Food Processing Technology: Principles and Practice*. (2nd Edn.) CRC Press, Boca Raton, FL, USA.
4. Karel M and Lund D B. 2003. *Physical Principles of Food Preservation*. (2nd Edn.) Marcel Dekker, Inc., NY, USA.
5. Lal G, Siddappa G S and Tandon G L. 1959. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
6. Potter N N and Hotchkiss J H. 1995. *Food Science*. (5th Edn.) Chapman and Hall, NY, USA.
7. Rahman, M.S. 2007. Handbook of Food Preservation. (2nd Edn.) CRC Press, Boca Raton, FL, USA.
8. Stavros Y. 2008. *Solving Problems in Food Engineering*. Springer Science + Business Media, NY, USA.
9. Tewari G and Juneja V K. 2007. *Advances in Thermal and Non-Thermal Food Preservation*. Blackwell Publishing, Ames, Iowa, USA.
10. Zeuthen P and Bùgh-Sùrensen L. 2003. *Food Preservation Techniques*. CRC Press LLC, Boca Raton, FL, USA.

Workshop Technology 3 (1+2)

Objectives

i. To gain an understanding about different type of material and their measurement
ii. To have an idea of the basic methods involved in repair and maintenance of equipment
iii. To know about skills related to welding, blacksmith, carpentry, sheet metal, machining etc.

Theory

Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications; Safety measures in workshop; Indian Factory Acts on safety; Measuring and Gauging: Basic measuring instruments and gauges; Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.

Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipment; Gas welding and cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost. Smithy and forging: Introduction to different tools and their uses, different forging operations.

Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.

Machinery: Introduction to various workshop machines (1) Lathe, (2) power hacksaw, (3) Shaper and planner, (4) Drilling, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for shaping, slotting and planning operations, work holding and tool holding devices.

Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.

Practical

Identification of different materials of manufacture; Demonstration of different measuring instruments and measurement technique; Identification of various hand tools; Demonstration of various power tools and machine tools; Simple exercises in filing, fitting, chipping, hack sawing, chiseling, tapping, etc.; Introduction to welding machine, processes, tools, their use and precautions; Simple exercises on arc welding; Simple exercises in gas welding; Demonstration of various casting processes and equipment, tools and their use; Exercises on mould making using one piece pattern and two piece pattern; Demonstration of mould making using sweep pattern and match plate pattern; Simple exercises on turning: Step turning, taper turning, drilling and threading; Introduction to shaper and planner machine and preparations of various jobs on them; Introduction to drilling machines and preparation of a related jobs; Demonstration of other important operations and preparation of additional jobs.

Suggested Readings

1. Chapman W A J. 1989. *Workshop Technology*. Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi.
2. Hazra Choudari S K and Bose S K. 1982. *Elements of Workshop Technology*. (Vols. I and II.) Media Promoters and Publishers Pvt. Ltd., Mumbai.
3. Raghuwansi B S. 1996. *A Course in Workshop Technology*. (Vol. I and II.) Dhanpet Rai and Sons, New Delhi.

Basic Electrical Engineering 3 (2+1)

Objectives

i. To differentiate between single and three phase connection
ii. To have an idea of the basic measuring electrical current and its quality
iii. To know about application of wiring and connections

Theory

AC Fundamentals: Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, Magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents, phase relations and vector representation, AC through resistance, inductance and capacitance, AC series and parallel circuits, Simple R-L, R-C and R-L-C circuits; Engineering Circuit Analysis: Current, Voltage, Power, Circuit elements, Ohm's law.

Phase Systems: Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement.

Transformer: Principle of working, construction of single-phase transformer, core type, shell type transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test.

Single phase induction motor: Double field revolving theory, characteristics, phase split, shaded pole motors.

Poly phase induction motor: Construction, operation, equivalent circuit, production of rotating field, effect of rotor resistance, torque equation, starting and speed control methods.

Alternators: Principle of operation, types of rotors, EMF equation.

D.C. Machine (generator and motor): Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics. D.C. Motors, their starting, speed controls and characteristics.

Electric Power Economics: Maximum demand charge, Load factor, Power factor and power factor improvement.

Measuring Equipment's: Classification, Characteristics of different electrical measuring systems and equipments.

Electrical Wiring: system of wiring, domestic wiring installation, industrial electrification.

Protection devices: Earthing, Circuit protection devices, fuses, ELCB and relays.

Practical

Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation. (b) Delta connection study of voltage and current relation. Measurement of Power in 3 phase circuit by wattmeter and energy meter: (a) for balanced loads, (b) for unbalanced loads. Polarity test, no-load test, efficiency and regulation test of single-phase transformer, starting of induction motors by; (a) D.O.L. (b) Manual star delta (c) Automatic star delta starts. Starting of slip ring induction motors by normal and automatic rotor resistance starters. Test on 3 phase induction motor- determination of efficiency, line current, speed slip and power factor at various outputs. Determination of relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristics of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Problems on Industrial Electrification. Study of various circuit protection devices. Study of various measuring instruments.

Suggested Readings

1. Theraja B L and Theraja A K. 2005. *A Textbook of Electrical Technology*. Vol. II. S. Chand and Company Ltd., New Delhi.
2. Toro V D. 2000. *Electrical Engineering Fundamentals*. Prentice-Hall India Private Ltd., New Delhi.

General Microbiology 3 (2+1)

Objectives

i. To identify the micro-organisms, their structure and growth characteristics
ii. To aquaint with techniques for cultivation and preservation and control

Theory

Scope and history of microbiology: (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.), Place of Microorganisms in living world; Groups of microorganisms; Applied area of microbiology, Classification and identification of micro- organism; Major Characteristics of Microorganisms, Methods of classification of bacteria.

Microscopy: Introduction to microscope; Component of microscope; Types of microscope and Microscopic techniques.

Microbial Ultra Structure and Functions: Morphological features; Structures external to cell wall, Cell wall; Structures internal to cell wall.

Cultivation and preservation of micro-organisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for micro-organisms.

Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: growth curve, continuous culture, synchronous culture; Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections; Control of microorganisms: Physical and Chemical agents; Bacterial genetics; Structure and functions of DNA and RNA; Overview of replication and regulation.

Practical

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (monochrome staining, gram staining, negative staining, capsule- staining, flagella staining and endospore staining); Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); Growth characteristics of fungi: Determination of microbial numbers, direct plate count, generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

Suggested Readings

1. Pelczar Jr. M J, Chan E C S and Krieg N R. 1998. *Microbiology*. (5th Edn.) Tata McGraw-Hill Education, New Delhi.
2. Tortora G J, Funke B R and Case C L. 2014. *Microbiology: An Introduction*. (12th Edn.) Prentice-Hall, NY, USA.
3. Willey J M, Sherwood L M and Woolverton C J. 2013. *Prescott's Microbiology*. (9th Edn.). McGraw-Hill Higher Education, NY, USA.

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry, duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities.

Role of farming- based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. *Towards Green Villages: A strategy for Environmentally Sound and Participatory Rural Development*. Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience*. Department for International Development: London, UK.
3. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa*. Consultation Document, FAO, Rome, Italy.
4. Dixon J and Gulliver A with Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO and World Bank, Rome, Italy and Washington, DC, USA.
5. Evenson R E. 2000. *Agricultural Productivity and Production in Developing Countries. In: FAO, The State of Food and Agriculture*, FAO, Rome, Italy
6. Bhatt B P, Kumar Abhay, Thakur P K, Dey Amitava, Kumar Ujjwal, Kumar Sanjeev, Jha B K, Kumar Lokendra, Pathak K N, Hassan A, Singh S K, Singh K K and Singh K M. 2014. *Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar*. ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar A S, Ravisankar N, Prusty A K, Shamim M, Singh Raghuveer, Bhaskar S, Malik S K, Tomar R K, Arunachalam A and Alagusundaram K. 2020. *Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment*. Indian Council of Agricultural Research, New Delhi.
8. Reddy S R. 2016. *Farming System and Sustainable Agriculture*. Kalyani Publishers, New Delhi.
9. Singh J P, Ravisankar Natesan Prusty, A K, Sikka Alok, Gangwar B, Pramanick Mahadev, Chatterjee Soumitra, Ray Manabendra, Mukhopadhyay Swapan. 2015. *Region Specific Integrated Farming System Models*. ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Barbara Pease and Allan Pease. 2006. *Definitive Book of Body Language*-RHUS.
2. Carnegie Dale. 2018. *The Quick and Easy Way to Effective Speaking*. Fingerprint Publishing.
3. Francis Peter S J. 2012. *Soft Skills and Professional Communication*. Tata McGraw Hill, New Delhi.
4. Kumar S and Pushpa Lata. 2011. *Communication Skills*. Oxford University Press.
5. Mark Goulston. 2015. *Just Listen*. Amacom (Reprint Edn.) HarperCollins.
6. Napoleon Hill. 2014. *Think and Grow Rich*-Fingerprint.
7. Neuliep James W. 2003. *Intercultural Communication: A Contextual Approach*. Houghton Mifflin Co Boston.
8. Raman M and Singh P. 2000. *Business Communication*. Oxford University Press.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press.

National Cadet Corps (NCC-I) **1 (0+1)**

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.
- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) **1 (0+1)**

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

All the activities related to the National Service Scheme are distributed under four different courses viz., National Service Scheme I, National Service Scheme II, National Service Scheme III and National Service Scheme IV each having one credit load. The entire four courses should be offered continuously for two years.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

Introduction and Basic Components of NSS:

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS.
- organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

- NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Post-Harvest Engineering 3 (2+1)

Objectives

i. To understand the basic post-harvest operations
ii. To gain an understanding of various engineering properties
iii. To differentiate between different types of material handling systems

Theory

Overview of Post-Harvest Technology. Concept and science, Introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses, reasons for losses, importance of loss reduction, Post-Harvest Handling operations. Water Activity; Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture. Engineering Properties of Food Materials; physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement.

Cleaning; Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling. Sorting, grading, methods of grading; Grading-Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance Magnetic separator, destoners, electrostatic separators, pneumatic separator. Decorticating and Shelling; Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.

Milling, polishing, grinding, milling equipment, de-huskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement.

Materials Handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices.

Study of different Material Handling systems; Classification, principles of operation, conveyor system selection/design; Belt conveyor: Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain; Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors; Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement; Pneumatic conveying system: types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Suggested Readings

1. Brennan J G. 2006. *Food Processing Handbook*. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Chakraverty A. 2008. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. (3rd Edn.) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Chakraverty A and Singh R P. 2014. *Post Harvest Technology and Food Process Engineering*. CRC Press, Boca Raton, FL, USA.
4. Dash S K, Bebartta J P and Kar A. 2012. *Rice Processing and Allied Activities*. Kalyani Publishers.
5. Earle R L. 1983. *Unit operations in Food Processing*. Pergamon Press, New York, USA.
6. Green D W and Perry R H. 2008. *Perry's Chemical Engineers' Handbook*. McGraw-Hill Co., Inc., NY, USA.
7. Hall C W and Davis D C. 1979. *Processing Equipment for Agricultural Products*. The AVI Publishing Company, Inc., Connecticut, MA, USA.
8. Henderson S M and Perry R L. 1966. *Agricultural Process Engineering*. (2nd Edn.) The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. Mohsenin N N. 1980. *Thermal Properties of Foods and Agricultural Materials*. Gordon and Breach Science Publishers, New York.

10. Mohsenin N N. 1984. *Electromagnetic Radiation Properties of Foods and Agricultural Products*. Gordon and Breach Science Publishers, New York.
11. Mohsenin N N. 1986. *Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties*. (2nd Edn.) Gordon and Breach Science Publishers, NY.
12. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. New Delhi: CBS Publisher and Distributors Pvt Ltd.
13. Sahay K M and Singh K K. 2001. *Unit Operations of Agricultural Processing*. Vikas Publishing House Pvt. Ltd., Noida, UP.

Food Chemistry I — 3 (2+1)

Objectives

i. To learn the chemical aspects of food and bio- materials and its importance in food processing
ii. To gain an understanding of various water and macro- molecules
iii. To have an idea of about the effect of processing on these biomolecules

Theory

Water; Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems.

Carbohydrates; Monosaccharaides, disaccharides and polysaccharides, modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates.

Proteins in foods: Proteins: Classification, structure and properties, Proteins and nutrition, Functional properties of proteins, Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein.

Lipids in foods: Classification, structure and properties of lipids; Role and use of lipids/ fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, use of oils and fats in food formulation.

Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques, chemical aspects of lipids, antioxidants.

Practical

Determination of moisture content of foods using different methods; Studies of sorption isotherms of different foods; Swelling and solubility characteristics of starches; Rheological properties of food systems; Determination of crude proteins by micro-Kjeldhal method; Determination of essential amino acids i.e. lysine, tryptophan, methionine, etc.; Isolation of egg and milk protein;

Preparation of protein isolate and concentrate of proteins; Determination of acid value, saponification value and iodine number of fat/oil; Assay of amylases, papain and lipases.

Suggested Readings

1. Brady J W. 2013. *Introductory Food Chemistry*. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.
2. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.) Springer-Verlag Berlin Heidelberg.
3. Fennema O R. 1996. *Food Chemistry*. (3rd Edn.) Marcel Dekker, Inc., New York, USA.
4. Meyer L H. 1974. *Food Chemistry*. The AVI Publishing Co Inc., Connecticut, MA, USA.

Unit Operations in Food Processing 3 (2+1)

Objectives

i. To familiarize with Commonly involved unit operations in food processing
ii. To differentiate between blanching, pasteurization and sterilization
iii. To apply of these unit operations in food product development

Theory

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation.

Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices.

Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, Freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.

Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations.

Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization.

Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation, distillation of wines and spirits. Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment. Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment. Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger.

Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package.

Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification.

Practical

Study of working principle open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar.

Study of freezers/ Design problems on freezers; To study freezing of foods by different methods IQF freezing; Determination of freezing time of a food material; To study simple distillation process and determine the rate of distillation; To study the process of roasting/ To study the effect of time-temperature combination on roasting; Determination of oil uptake by the food product during frying.

To determine the efficacy of a blanching process; time-temperature combination for a blanching process; efficacy of a sterilization process; Determination of F value for a product in can/ retortable pouch; Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators.

Suggested Readings

1. Earle R L. 2004. *Unit Operations in Food Processing*. The New Zealand Institute of Food Science and Technology, New Zealand.
2. Fellows P. 2000. *Food Processing Technology: Principles and Practice*. (2nd Edn.). CRC Press, Boca Raton, FL, USA.
3. Geankoplis C G. 2003. *Transport Processes and Separation Process Principles (Includes Unit Operations)* (4th Edn.). Prentice-Hall, NY, USA.
4. Ibarz A and Barbosa-Cánovas G V. 2003. *Unit Operations in Food Engineering*. CRC Press, Boca Raton, FL, USA.

5. McCabe W L, Smith J and Harriott P. 2004. *Unit Operations of Chemical Engineering*. (7th Edn.) .McGraw-Hill, Inc., NY, USA.

6. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. CBS Publisher and Distributors Pvt Ltd. New Delhi.

7. Richardson J F, Harker J H and Backhurst J R. 2002. *Coulson and Richardson's Chemical Engineering (Vol. 2) – Particle Technology and Separation Processes*. (5th Edn.). Butterworth–Heinemann, Oxford, UK.

8. Saravacos G D and Kostaropoulos A E. 2002. *Handbook of Food Processing Equipment*. Springer Science andBusiness Media, New York, USA.

9. Singh R P and Heldman D R. 2014. *Introduction to Food Engineering*. (5th Edn.). Elsevier, Amsterdam, The Netherlands.

10. Sinnott R K. 1999. *Chemical Engineering (Vol. 6) – Chemical Engineering Design*. (3rd Edn.) Butterworth-Heinemann, Oxford, UK.

11. Treybal R E. 1980. *Mass Transfer Operations*. (3rd Edn.). McGraw-Hill Book Company, Auckland, USA.

12. Valentas K J, Rotstein E and Singh R P. 1997. *Handbook of Food Engineering Practice*. CRC Press, Boca Raton, FL, USA.

Food Thermodynamics 3 (2+1)

Objectives

i. To have an idea about basic concepts of energy and laws of thermodynamics

ii. To know about thermodynamic cycles and their application

iii. To know about psychrometric properties of air and its application in drying and other food applications

Theory

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat.

First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis. Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, entropy, availability and irreversibility. Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule. Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle. Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms.

Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity. Boilers and steam generation: fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Practical

Demonstration and application of zeroth law of thermodynamics; first law of thermodynamics; and second law of thermodynamics. Study of different types of boilers; boiler mounting and accessories; various types of burners and fuels; Determination of calorific values of different fuels. Study of vapour compression refrigeration test rig; heat pump; properties of wet, dry, saturated and superheated steam; Use of steam tables and Moiler charts; dryness fraction of steam; use of psychometric chart for humidification, dehumidification, heating and drying; Determination of thermodynamic properties on psychrometric charts; study of steam trap and steam line layouts; Visit to food plant with steam utilization.

Suggested Readings

1. Brooker D B, Bakker-Arkema F W and Hall C W. 1976. *Drying Cereal Grains*. The AVI Publishing Company, Inc., Connecticut, MA, USA.
2. Geankoplis C J. 2003. *Transport Processes and Separation Process Principles (Includes Unit Operations)*. (4th Edn.) Prentice-Hall, NY, USA.
3. McCabe W L, Julian Smith and Peter Harriott. 2004. *Unit Operations of Chemical Engineering*. (7th Edn.) McGraw-Hill, Inc., NY, USA.
4. Nag P K. 2005. *Engineering Thermodynamics*. (3rd Edn.) Tata-McGraw-Hill Education, New Delhi.
5. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. New Delhi: CBS Publisher and Distributors Pvt Ltd. New Delhi.
6. Rajput R K. 2007. *Engineering Thermodynamics*. (3rd Edn.) Laxmi Publications (P) Ltd., Bangalore.
7. Smith J M, Van Ness H C and Abbott M M. 2005. *Introduction to Chemical Engineering Thermodynamics*. (7th Edn.) McGraw-Hill, Inc., NY, USA.

Engineering Drawing and Graphics 3 (1+2)

Objectives

i. To gain an understanding about drawing as per engineering requirement
ii. To have an idea of the isometric, orthographic views and projection
iii. To know about Computer Aided Design

Theory

Definition of projection, Principle of projection, Methods of projections, Orthographic projection, plane of projection, First and third angle of projection.

Different methods of dimensioning; Isometric scale, Isometric axes, Isometric projection, Preparation of working drawing from models and isometric views.

Concept of sectioning; Revolved and oblique section; Sectional drawing of simple machine parts; Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints.

Nomenclature, thread profiles, multi-start threads, left and right-hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts; Drawing of missing views. Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.

Practical

Introduction of drawing scales; Principles of orthographic projections; References planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids: Change of position method, alteration of ground lines; Section of solids and interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids; Preparation of manual drawings with dimensions from models and isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Sectional drawings of engineering machines; Computer graphics for food engineering applications; Interpretation of sectional views of food equipment and components; Practice in the use of basic and drawing commands on AutoCAD; Generating simple 2-D drawings with dimensioning using AutoCAD; Small Projects using CAD/CAM.

Suggested Readings

1. Bhat N D and Panchal V M. 1995. *Machine Drawing*. Charotar Publishing House, Anand.
2. Bhat N D. 1995. *Elementary Engineering Drawing*. Charotar Publishing House, Anand.
3. Lee K. 1999. *Principles of CAD/CAM/CAE Systems*. Prentice-Hall, USA.
4. Zeid I. 2004. *Mastering CAD/CAM*. McGraw-Hill Book Co., NY, USA.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth

- Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.

Environmental Pollution: Definition, cause, effects and control measures of: (i) Air pollution. (ii) Water pollution. (iii) Soil pollution. (vi) Marine pollution. (v) Noise pollution. (vi) Thermal pollution h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/ forest/ grassland /hill /mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De A K. 2010. *Environmental chemistry*. Published by New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5. 384p.
2. Dhar Chakrabarti P G. 2011. *Disaster Management - India's Risk Management Policy Frameworks and Key Challenges*. 36p. Published by Centre for Social Markets (India), Bangalore.

3. Bharucha Erach. 2004. *Textbook for Environmental studies*. University Grants Commission, New Delhi.
4. Parthiban K T, Vennila S, Prasanthrajan M and Umesh Kanna S. 2023. *Forest, Environment, Biodiversity and Sustainable Development*. Narendra Publishing House, New Delhi.
5. Prasanthrajan M and Mahendran P P. 2008. *A Textbook on Ecology and Environmental Science*. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur
6. Prasanthrajan M. 2018. *Objective environmental studies and disaster management*. 146p. ISBN 9789387893825. Scientific publishers, Jodhpur.
7. Sharma P D. 2009. *Ecology and Environment*. Rastogi Publications, Meerut, India
8. Tyler Miller and Scot Spoolman. 2009. *Living in the Environment (Concepts, Connections, and Solutions)*. Brooks/cole, Cengage learning publication, Belmont, USA.

National Cadet Corps (NCC-II) 1 (0+1)

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defence obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1 (0+1)

- Importance and role of youth leadership.
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies.
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs.
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations.

- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-Semester II (Only for exit option for award of UG-Certificate in Food Technology)

S. No.	Course Title	Credit Hours
SCE 121	Internship (10 weeks)	10 (0+10)

Semester III

Food Chemistry II 3 (2+1)

Objectives

i. To study chemical aspects of food and bio- materials and their importance in food processing

ii. To gain an understanding of chemicals responsible for flavour, pigments and colorants

iii. To have an idea of about the effect of processing on these biomolecules

iv. To gain the knowledge about role of enzymes in food processing

Theory

Philosophy and definitions of flavour, Chemistry of food flavour; flavourmatics/ flavouring compounds, sensory assessment of flavour, technology for flavour retention.

Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs.

Popular colors used in food and their fictional properties; Regulatory use of regulatory dyes; Colour losses during thermal processing. Vitamin functions in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins, optimization and retention of vitamins. Important minerals and their function in body and deficiency conditions, Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals. Various anti-nutritional factors their mode of action and inactivation.

Enzymes in Food Processing: Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid, enzyme specificity, Michaelis-Menten equation, regulation mechanism.

Practical

Preparation of mineral solution by using ash and tri-acid method (dry and wet oxidations); Estimation of calcium; Determination of phosphorus; Determination of iron; Estimation of magnesium; Estimation of tannins and phytic acid from food; Determination of vitamin A (Total carotenoids), C, E; Determination of ascorbic acid by dye method; Determination of thiamin and riboflavin; Determination of food colors; Assessment of hydrocolloids as food additives; Assessment of various pectinases from fruits and vegetables.

Suggested Readings

1. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.) Springer-Verlag Berlin Heidelberg.
2. Fennema O R. 1996. *Food Chemistry*. (3rd Edn.) Marcel Dekker, Inc., New York, USA.

Fluid Mechanics 3 (2+1)

Objectives

i. To get idea about types of fluids and their properties
ii. To gain knowledge about the flow behaviour of the fluids
iii. To differentiate about various types of pumps and their use in food processing

Theory

Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces, Flow behavior of viscous fluids; Compressible and non-compressible fluids; Surface tension, capillarity, Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer; Floating bodies: Archimedes principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height; Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications; Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries; Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude; Pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps.

Practical

Study of different tools and fittings; Study on flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge co-efficient for venturi, orifice, V-notch; Verification of emptying time formula for a tank; Determination of critical Reynold's number by Reynold apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of rotameter; Study of different types of valves; Study of pumps for viscous fluid; Floating bodies, liquid flow, venturimeter, orifice, weir, flow through pipes; Study and operation of centrifugal and other pumps used in dairy and food processing plants.

Suggested Readings

1. Bird R B, Stewart W E and Lightfoot E N. 2002. *Transport Phenomena*. (2nd Edn.) John Wiley and Sons, Inc., New York, USA.
2. Çengel Y A and Cimbala J M. 2006. *Fluid Mechanics: Fundamentals and Applications*. McGraw-Hill, Inc., New York, USA.
3. Finnemore E J and Franzini J B. 2002. *Fluid Mechanics with Engineering Applications*. (10th Edn). McGraw-Hill, Inc., New York, USA.
4. Munson B R, Young D R and Okiishi T H. 2002. *Fundamentals of Fluid Mechanics*. (4th Edn.) John Wiley and Sons, Inc., New York, USA.
5. Nevers N D. 1991. *Fluid Mechanics for Chemical Engineers*. McGraw-Hill, Inc., New York, USA.
6. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in Food Process Engineering*. New Delhi: CBS Publisher and Distributors Pvt Ltd. New Delhi.
7. Streeter V L. 1962. *Fluid Mechanics*. (3rd Edn.) McGraw-Hill Book Co., Inc., Boston, USA.
8. White F M. 2010. *Fluid Mechanics*. (7th Edn.) McGraw-Hill Book Co., Inc., Boston, USA.

Heat and Mass Transfer in Food Processing 3 (2+1)

Objectives

i. To have knowledge about the mechanism of heat and mass transfer
ii. To get knowledge of dimensionless numbers involved in heat and mass transfer
iii. To differentiate between different types of heat exchangers

Theory

Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer, food properties measurements and errors; One-dimensional steady state conduction: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines; One-dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions; Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins; Introduction to unsteady state heat conduction: System with negligible internal resistance and in various geometries; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer; Dimensionless numbers: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heisler charts and calculations; Heat transfer to flowing fluids; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Efficiency and NTU analysis;

Application of different types of heat exchangers in dairy and food industry; Mass transfer: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.

Practical

Heat transfer analysis during conduction and convection; Study on various types of heat exchangers used in food industry; Preparation and calibration of thermocouples; Determination of thermal conductivity of different food products; Study of working principle and constructional details of plate heat exchanger; Study of working principle and constructional details of shell and tube heat exchanger. Determination of overall heat transfer coefficient of shell and tube, plate heat exchangers, jacketed kettle used in food industry; Studies on heat transfer through extended surfaces; Studies on temperature distribution and heat transfer in HTST pasteurizer; mass transfer coefficient in foods; glass transition temperature of food sample; mass transfer during leaching process.

Suggested Readings

1. Cao E. 2010. *Heat Transfer in Process Engineering*. The McGraw-Hill Companies, Inc., New York, USA.
2. Green Don W and Perry Robert H. 2008. *Perry's Chemical Engineers' Handbook*. McGraw-Hill Co., Inc., NY, USA.
3. Geankoplis C J. 2003. *Transport Processes and Separation Process Principles (Includes Unit Operations)*. (4th Edn.) Prentice-Hall, NY, USA.
4. Holman J P. 2010. *Heat Transfer*. (10th Edn.) McGraw-Hill Book Co., Boston, USA.
5. Lienhard IV, J H and Lienhard V, J H. 2008. *A Heat Transfer Textbook*. Phlogiston Press, Cambrige, MA, USA.
6. McCabe W L, Smith Julian, Harriott Peter. 2004. *Unit Operations of Chemical Engineering*. (7th Edn.) McGraw-Hill, Inc., NY, USA.
7. Özişik M N. 1993. *Heat Conduction*. (2nd Edn.) John Wiley and Sons, NY, USA.
8. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. CBS Publisher and Distributors Pvt Ltd, New Delhi.
9. Rajput R K. 2008. *Heat and Mass Transfer*. S. Chand and Co., New Delhi
10. Richardson J F, Harker J H and Backhurst J R. 1999. *Coulson and Richardson's Chemical Engineering (Vol. 1: Fluid Flow, Heat Transfer and Mass Transfer*). (6th Edn.) Butterworth–Heinemann, Oxford, UK.
11. Treybal R E. 1980. *Mass Transfer Operations*. (3rd Edn.) McGraw-Hill Book Company, Auckland, USA.

Basic Electronics Engineering 2 (1+1)

Objectives

i. To study basic concepts of electronics and their relevance in food industry

ii. To get idea about various electronic components

iii. To Know about electronic device and their concept in measurement

Theory

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); voltage multiplier, filter circuits; Bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiters, OP-AMP voltage regulators; Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits binary ladder D/A converter and A/D converter; Transducers: Classification, selection criteria, characteristics, sensors and actuators construction, working principles, applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges, capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers, variable parameter type, digital, actuating and controlling devices.

Practical

Study of diode characteristics; Study of triode characteristics; Study of Zener diode; Study of V-I characteristics of P-n junction diode; Study of RC coupled amplifier; Study of RC phase shift oscillator; Study of full wave rectifier; Verification of logic gates; Determination of energy gap in a junction diode; Study of transistor characteristics in CE configuration; Study of OP-Amp IC 741 as differential amplifier; Study of half wave rectifier; Study of OP-AMP IC 741 as an active rectifier; Study of transistor characteristics; Study of temperature characteristics of resistor; Study of diode as clipper and clamper.

Suggested Readings

1. Kumar Anand. 2014. *Fundamentals of Digital Circuits*. PHI Pvt. Ltd., New Delhi.
2. Gupta S. 2002. *Electronic Devices and Circuits*. Dhanpat Rai Publications (P) Limited, New Delhi.
3. Mehta V K and Mehta R. 2008. *Principles of Electronics*. S. Chand and Co., New Delhi.
4. Roy D C. 2003. *Linear Integrated Circuits.* John Wiley International, New York.
5. Sawhney A K. 2010. *Course in Electrical and Electronics Measurements and Instrumentation*. Dhanpat Rai Publications (P) Limited, New Delhi.

Food Microbiology 3 (2+1)

Objectives

i. Microbiology of different foods

ii. Food borne toxins

iii. Understand spoilage of food

Theory

Importance and significance of microbes in food science; Sources of microorganisms in foods and their effective control; Factors affecting growth and survival of microorganisms in foods; Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc. Normal Microbiological quality of Foods and its significance: milk and milk products, fruits and vegetables, cereals and cereal products, meat and meat products, fish and other sea foods, poultry and eggs; sugar and sugar products, slats and spices and canned foods; Chemical changes caused by microorganisms: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances; Shelf life: Calculation of shelf life, Shelf-life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products; Microbial toxins; Bacterial toxins, fungal toxins, algal toxins and mushroom toxins; Food borne intoxications and infections: types of food involved, toxicity and symptoms, chemical properties, environmental conditions; Food borne viruses: types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms.

Practical

Isolation of bacteria and molds from foods; Microbial examination of cereal and cereal products: Identification, isolation and confirmation; Microbial examination of vegetable and fruits: Identification, isolation and confirmation; Microbial examination of meat and meat products: Identification, isolation and confirmation; Microbial examination of fish and other sea foods: Identification, isolation and confirmation; Microbial examination of eggs and poultry: Identification, isolation and confirmation; Microbial examination of milk and milk products: Identification, isolation and confirmation; Microbial examination of sugar, salts and spices: Microbial examination of canned products: Identification, isolation and confirmation; Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/ Enterococcus); Thermal death time determination; Detection of Salmonella from food sample; Detection of coliforms from water by MPN method; Detection of *Staphylococcus aureus* from food sample.

Suggested Readings

1. Adams M R and Moss M O. 2008. *Food Microbiology*. (3rd Edn.). The Royal Society of Chemistry, Cambridge, UK.
2. Banwart G J. 1989. *Basic Food Microbiology*. (2nd Edn.). Chapman and Hall, New York, USA.
3. Frazier W C and Westfoff D C. 1987. *Food Microbiology*. (4th Edn.). Tata McGraw-Hill Education, New Delhi.
4. Jay J M. 2000. *Modern Food Microbiology*. (6th Edn.). Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
5. Ray B and Bhunia A. 2008. *Fundamental Food Microbiology*. (4th Edn.). CRC press, Taylor and Francis Group, USA.

Engineering Mathematics-I **2 (2+0)**

Objectives

i. To gain knowledge about curves and their expression in mathematical form

ii. To develop equations for a process and its integration

Theory

Taylor's and Maclaurin's expansions, indeterminate form: Curvature, asymptotes, tracing of curves function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima; Reduction formulae, Gamma and Beta functions: Rectification of standard curves, volumes and surfaces of revolution of curves Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume; Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation; Differential equations of higher orders, methods of finding complementary functions and particular integrals, Method of variation of parameters simultaneous linear differential equations with constant coefficients, Cauchy's and Legendre's linear equations, Bessel's and Legendre's differential equations series solution techniques; Differentiation of vectors, scalar and vector point functions, vector differential operator Del: Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, Identities involving Del, second order differential operator Line, Surface and volume integrals, Stoke's, divergence and Green's theorems.

Suggested Readings

1. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers Delhi.
2. Narayan S. 2004. *Differential Calculus*. S. Chand and Co. Ltd., New Delhi.
3. Narayan S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan S. 2004. *A Textbook of Vector Calculus*. S. Chand and Co. Ltd. New Delhi

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii. To provide basic knowledge of computer with applications in agriculture
iii. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in

Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific document, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/ Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Sethi Dhabal and Manoranjan. 2020. *Concepts and Techniques of Programming in C*. Wiley India.
2. Rajaraman V and Adabala Neeharika. 2015. *Fundamentals of Computer*. (6th Edn.) PHI Learning Pvt. Ltd.
3. ITL Education Solutions Limited. 2005. *Introduction to Information Technology*. Pearson.
4. Date C J. 2000. *Introduction to Database System*. Addison-Wesley.
5. Mahapatra Subrat Kumar, Mishra Prasannajit and Pradhan Jayashankar. 2022. *Introductory Agri Informatics*. Jain Brothers Publication.

Physical Education, First Aid,Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices

ii. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems andits Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yoga, Types of Yoga, Introduction to Yoga.

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra.
- Role of yoga in sports.
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester IV

Fundamentals of Food Engineering 3 (2+1)

Objectives

i. To understand basic concepts of engineering principals applied to food
ii. To differentiate between drying and dehydration and different types of dryers
iii. To know about basic operations like size reduction, mixing, separation

Theory

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foam-mat dryers. Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping). Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids. Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine. Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids. Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

Practical

Determination of fineness modulus and uniformity index; Determination of mixing index of a feed mixer; Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law. Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of centrifugal separator; Study of freeze dryer and freeze-drying process; Study on osmosis in fruits; Determination of solid gain and moisture loss during osmosis; Study of reverse osmosis process; Study of ultra-filtration/membrane separation process.

Suggested Readings

1. Geankoplis C J. 2003. *Transport Processes and Separation Process Principles (Includes Unit Operations)*. (4th Edn.) Prentice-Hall, NY, USA.
2. McCabe W L, Smith Julian and Harriott Peter. 2004. *Unit Operations of Chemical Engineering*. (7th Edn.) McGraw-Hill, Inc., NY, USA.
3. Mohsenin N N. 1986. *Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties*. (2nd Edn.) Gordon and Breach Science Publishers, New York.
4. Mohsenin N N. 1984. *Electromagnetic Radiation Properties of Foods and Agricultural Products*. Gordon and Breach Science Publishers, New York.
5. Mohsenin N N. 1980. *Thermal Properties of Foods and Agricultural Materials*. Gordon and Breach Science Publishers, New York.
6. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. New Delhi: CBS Publisher and Distributors Pvt. Ltd, New Delhi.
7. Richardson. J F, Harker J H and Backhurst J R. 2002. *Coulson and Richardson's Chemical Engineering (Vol. 2) – Particle Technology and Separation Processes*. (5th Edn.) Butterworth–Heinemann, Oxford, UK.
8. Saravacos G D and Kostaropoulos A E. 2002. *Handbook of Food Processing Equipment*. Springer Science and Business Media, New York, USA.

Food Plant Sanitation 3 (2+1)

Objectives

i. To know importance of sanitation and hygiene and its application to food

ii. To gain knowledge of Hazard Analysis and Critical Control Point

iii. To learn good manufacturing practices

Theory

Sanitation and food industry: Sanitation, sanitation laws, regulations, and guidelines, establishment of sanitary Practices. Foodborne bioterrorism: Potential risks and protection measures for bioterrorism. The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures. The Relationship of allergens to sanitation: Food allergens and its control measures. Food contamination sources: Sources of contamination, contamination of foods, protection against contamination. Personal hygiene and sanitary food handling: Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility. Cleaning compounds and sanitizers: Classification, selection of cleaning compounds and sanitizers, CIP and COP, handling and storage, precautions. Pest and Rodent Control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management. Sanitary design and construction for food processing: Site selection, site preparation, building construction considerations, processing and design considerations, pest control design. Waste product handling: solid waste and liquid waste management. Role of HACCP in sanitation: Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices.

Practical

Estimation of BOD (Biological Oxygen Demand); Estimation of COD (Chemical Oxygen Demand); Determination of hardness of water; Good Manufacturing Practices (GMPs) and personal hygiene; Sewage treatment: Primary, secondary, tertiary and quaternary; Aerobic and anaerobic sludge treatment; Lab demonstration on state of water; Study of CIP plant; Isolation and identification of Actinomycetes; Enrichment and isolation of cellulose degrading bacteria; Biodegradation of phenol compounds; Bacteriological examination of water: Coliform MPN test; Sampling of airborne microorganisms; Sampling of surfaces - equipment and physical plant; Aerosol sampling and measurement guidelines.

Suggested Readings

1. Cramer M M. 2013. *Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices*. CRC Press, Boca Raton, FL, USA.
2. Hui Y H, Bruinsma B L, Gorham J R, Nip W K, Tong P S, and Ventresca P. 2003. *Food Plant Sanitation*. Marcel Dekker, Inc., NY, USA.
3. Mitchell R and Gu J D. 2010. *Environmental Microbiology*. (2nd Edn.) John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
4. Marriott N G and Gravani R B. 2006. *Principles of Food Sanitation*. (5th Edn.) Springer Science and Business Media, Inc., NY, USA.
5. Pepper I L and Gerba C P. 2005. *Environmental Microbiology: Laboratory Manual*. (2nd Edn.) Elsevier Academic Press, Amsterdam.

Food Quality, Safety Standards and Certification 2 (2+0)

Objectives

i. To familiarize the students with quality and safety of food and the standards and certification available
ii. To understand quality and its assessment
iii. To learn different food laws and FSMS 22000

Theory

Introduction: Definition, its role in food industry, Quality attributes; Quality Defects: Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects. Measurement of defects by different techniques; Quality Assessment; Quality assessment of food materials on the basis of sensory evaluation, Physical, chemical microbiological methods; Quality of products during processing and after processing; Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Role of QC and QA Quality: Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries; Quality Improvement Total Quality management: Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality.

Food Laws; Food Laws and Standards: National and International food laws. Mandatory and voluntary food laws. Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities. AGMARK, BIS, FPO, Weights and Measures Act, CODEX; Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO –standards and certification process Weights and Measures Act and Packaged commodity rules; Role of CODEX in food safety and standards, Food safety issues and risk analysis; FSMS 22000, Food Safety Management Systems, ISO 22000 – 2005 and other Global Food safety management systems. Principles, implementation; documentation, types of records; Auditing, certification procedures, certifying bodies, accrediting bodies.

Suggested Readings

1. Alli I. 2004. *Food Quality Assurance: Principles and Practices*. CRC Press, Boca Raton, FL, USA.
2. Hester R E and Harrison R M. 2001. *Food Safety and Food Quality*. Royal Society of Chemistry, Cambridge, UK
3. Schmidt R H and Rodrick G E. 2003. *Food Safety Handbook*. John Wiley and Sons, Inc., Hoboken. New Jersey, USA.

Engineering Mathematics-II 2 (2+0)

Objectives

i. To familiarize the students with basic concept of mathematics
ii. To gain knowledge about matrix and their transformation
iii. To develop partial differential equations and their applications

Theory

Elementary transformation and rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix; Consistency and solution of linear equations; Eigen value and vectors, Cayley-Hamilton theorem; Linear and orthogonal transformations; Diagonalization of matrices, Bilinear, Quadratic forms; Limit, continuity, derivative of function of complex variable; Analytical function, C-R equations, conjugate function, harmonic functions; Fourier series: Infinite series and its convergence, periodic function, Euler's formulae for calculating Fourier coefficients, Dirichlet's conditions; Fourier series of functions with arbitrary period; Fourier series of odd and even functions; Half range sine and cosine series, Harmonic analysis; Formation of partial differential equations; Lagrange's linear equation; Higher order linear partial differential equation with constant coefficients; Solution of non-linear partial differential equation (Charpit's method); Application of partial differential equations: One dimensional wave e.g., one dimensional heat equation, two dimensional steady state heat equation i.e. Laplace equation.

Suggested Readings

1. Ramana B V. 2008. *Engineering Mathematics*. Tata McGraw-Hill Book Co., New Delhi.
2. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers, Delhi.
3. Narayan S. 2004. *A Textbook of Matrices*. S. Chand and Co. Ltd., New Delhi.

Food Plant Utilities and Services 3 (2+1)

Objectives

i. To gain knowledge of various Utilities and services required in a food processing plant
ii. To understand working of different services
iii. To understand cleaning, maintenance and trouble shooting

Theory

Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing; Electrical System- Introduction to electric power supply systems, electrical billing, electrical load management and maximum demand control, power factor improvement and benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system. Electrical motors- Types, losses in Introduction motor, motor efficiency, factors affecting motor performers, performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Compressed air system - Requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and efficiency. HVAC and Refrigeration system - Requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and saving opportunities. Vapor absorption refrigeration system: Working principle, types and comparison with VCR system, saving potential; Fans and blowers - Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, Pumps and pumping systems- Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. DG set system- Requirement, introduction, factors affecting selection; Fuels and combustion - Introduction to fuels; properties of fuel oil, coal and gas; storage; handling and preparation of fuels; principles of combustion, combustion of oil, coal and gas; draft system. Boilers- Boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities; Steam system - Properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings; Waste heat recovery - Classification, advantages and application, commercially viable waste heat recovery devices, saving potential; Other utilities and services - Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system.

Practical

Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities.; electrical power supply system, billing and load estimation; Motors and variable speed drives specification, selection, performance terms and definitions; compressed air system components and performance terms and definitions; refrigeration and HVAC system components, performance terms and definitions and load estimation of a plant; fans and blowers, types, specification, performance terms and definitions. Pumps types, specification, selection, performance terms and definitions; plant lighting system and their components; DG system their specification and selection; combustion of oil, gas and coal; boiler performance terms and assessment. Study on cost of steam; waste heat recovery devices. Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger

(Shell and tube, PHE, run around coil exchanger, direct contact HX), Waste heat recovery boilers, Heat pumps and Thermo compressor. ClP system components; water treatment plant; effluent treatment plant; fire control operations and use of fire extinguishers.

Suggested Readings

1. Lijun Wang. 2008. *Energy Efficiency and Management in Food Processing Facilities*. CRC Press.
2. Casper M E. 1977. *Energy-saving Techniques for the Food Industry*. Published by Noyes Data Corp.
3. 1979. *Chilton's Food Engineering*. Chilton Company.
4. Whitman W E and Holdsworth S D. *A Survey of Water Use in the Food Industry*. British Food Manufacturing Industries Research Association.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide student an insight into the concept and scope of entrepreneurship.
ii. To expose the student to various aspects of establishment and management of a small business unit.
iii. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises*. Pearson Publications, New Delhi.
2. Desai Vasant. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House
3. Desai V. 2015. *Entrepreneurship: Development and Management*. Himalaya Publishing House.
4. Grover Indu. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Publishing Academy.
5. Gupta C B. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
6. Khanka S S. 1999. *Entrepreneurial Development*. S. Chand and Co.
7. Mehra P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
8. Pandey M. and Tewari D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
9. Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
10. Singhal R K. 2013. *Entrepreneurship Development and Management*. Katson Books.
11. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill.

Personality Development 2 (1+1)

Objectives

i. To make students realize their potential strengths

ii. To cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Andrews Sudhir. 2008. *How to Succeed at Interviews*. (21st Rep.). Tata McGraw-Hill.
2. Heller Robert. 2002. *Effective Leadership*. Essential Manager series. DK Publishing.
3. Hindle Tim. 2009. *Reducing Stress*. Essential Manager series. DK Publishing.
4. Kumar Pravesh. 2005. *All about Self- Motivation*. Goodwill Publishing House, New Delhi.
5. George Matthew Adams. 2020. *You Can*. Fingerprint! Publishing
6. Mile D J. 2004. *Power of Positive Thinking*. Delhi. Rohan Book Company.
7. Smith B. 2004. *Body Language*. Delhi: Rohan Book Company.
8. Shaffer D R. 2009. *Social and Personality Development*. (6th Edn.). Belmont, CA: Wadsworth.

Post-Semester IV* (Only For exit option for UG-Diploma in Food Technology)

S. No.	Course Title	Credit Hours
SDE 221	Internship (10 weeks)	10 (0+10)

*Mandatory requirement for UG-Diploma.

Semester V

Food Biochemistry and Nutrition 3 (2+1)

Objectives

i. Gain an understanding of nutrition and diets

ii. Understand and learn metabolic pathways for different biomolecules in human body

Theory

Concepts of Food and Nutrition; Functions of food; Basic food groups; nutrients supplied by food; Water and energy balance, water intake and losses, basal metabolism; Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Mechanism of Enzyme action; Introduction to enzyme and characteristics, coenzymes, kinetics and mechanism of enzyme action; Derivation of Michaelis- Menten Equation, Enzyme inhibition by pH, allosteric enzymes; Nucleic acids, structures of various components of DNA and RNA.

Nutrients; Functions, sources, digestion, absorption, assimilation, transport of carbohydrates; Functions, sources, digestion, absorption, assimilation, transport of proteins; Functions, sources, digestion, absorption, assimilation, transport of fats; Metabolism of carbohydrates.

Introduction to carbohydrates metabolism, glycolysis, TCA cycle; Electron transport chain, oxidative and substrate level phosphorylation; Metabolism of Lipids; Introduction to lipid metabolism, β-oxidation of long chain fatty acids, Ketosis, breakdown of phospholipids; Biosynthesis of fatty acids, triglycerides and phospholipids; Introduction to protein metabolism, transamination; Deamination and decarboxylation; Fixation of Nitrogen, Urea Cycle; Functions, sources, absorption, deficiency of macrominerals, microminerals and trace minerals; Functions, sources, absorption,

deficiency of Vitamins A &D, Vitamins E and K and water-soluble vitamins Information about hormones and relation between vitamins and hormones.

Practical

Preparation of various solutions and buffers; Qualitative and quantitative determination of carbohydrates; Qualitative and quantitative determination of amino acids; Qualitative and quantitative determination of proteins; Qualitative and quantitative determination of lipids; Qualitative and quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pka of acid; Determination of pI for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of β-carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.

Suggested Readings

1. Berdanier C D, Feldman E B and Dwyer J. 2008. *Handbook of Nutrition and Food*. (2nd Edn.). CRC Press, Boca Raton, FL, USA.
2. Berg J M, Tymoczko, J L, Stryer L and Gatto Jr. G J. 2002. *Biochemistry*. (7th Edn.). W.H. Freeman and Company, NY, USA.
3. Buchanan, B B, Gruissem W and Jones R L. 2002. *Biochemistry and Molecular Biology of Plants*. John Wiley and Sons, Inc., NY, USA.
4. Moe G, Kelley D, Berning J and Byrd-Bredbenner C. 2013. *Wardlaw's Perspectives in Nutrition: A Functional Approach*. McGraw-Hill, Inc., NY, USA.
5. Nelson D L and Cox M M. 2012. *Lehninger Principles of Biochemistry*. (6th Edn.). Macmillan Learning, NY, USA.
6. Voet D and Voet J G. 2011. *Biochemistry*. (4th Edn.). John Wiley and Sons, Inc., New York, USA.

Processing Technology of Cereals 3 (2+1)

Objectives

i. To learn milling technology of rice, wheat, corn and barley
ii. To get knowledge about breakfast cereals and their processing

Theory

Present status and future prospects of cereals and millets; Morphology, physico-chemical properties of cereals, major and minor millets Chemical composition and nutritive value; Paddy processing and rice milling: Conventional milling, modern milling; Milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Ageing of rice; Enrichment of rice – methods of enrichment; Rice fortification; Wheat milling: Break system, purification system and reduction system; extraction

rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking; Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches; Barley: Malting and milling; Oat/Rye: Processing, milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, finger millets): Processing of millets for food uses; Secondary and tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded.

Practical

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and milling of wheat; Production of sorghum flakes; Production of popcorns, flaked rice, puffed rice, noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value added products from millets; Visit to Cereal processing unit.

Suggested Readings

1. Araullo E V, De Padua D B and Graham M. 1976. *Rice Post Harvest Technology*. IDRC, Canada.
2. Chakraverty A and Singh R P. 2014. *Post Harvest Technology and Food Process Engineering.* CRC Press, Boca Raton, FL, USA.
3. Chakraverty A, Mujumdar A S, Vijaya Raghavan G S and Ramaswamy H S. 2003. *Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices.* Marcel Dekker, Inc., NY, USA.
4. Champagne E T. 2004. *Rice: Chemistry and Technology*. (3rd Edn.). AACC International, Inc., St. Paul, MN, USA.
5. David A V, Dendy and Dobraszczyk B J. 2001. *Cereal and Cereal Products: Technology and Chemistry*. Springer-Verlag, US.
6. Kent N L and Evers A D. 1994. *Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture*. (4th Edn.). Elsevier Science Ltd., Oxford, UK.
7. Khan K and Shewry P R. 2009. *Wheat: Chemistry and Technology*. (4th Edn.). AACC International, Inc., St. Paul, MN, USA.
8. Matz S A. 1991. *The Chemistry and Technology of Cereals as Food and Feed.* (2nd Edn.). Springer Science + Business Media, NY, USA.
9. Wrigley C. 2004. *Encyclopedia of Grain Science*. Academic Press, London, UK.
10. White P J, Johnson L and Lawrence A. 2003. *Corn: Chemistry and Technology*. (2nd Edn.). AACC International, Inc., St. Paul, MN, USA.

Processing Technology of Fruits and Vegetables 3 (2+1)

Objectives

i. To understand methods of preservation of fruits and vegetables

ii. To get knowledge of FSSAI specifications of fruits and vegetables products

Theory

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables; Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching- operations and equipment; Canning: Definition, processing steps, and equipment.

Cans and containers, quality assurance and defects in canned products; FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products; FSSAI specifications of crystallized fruits and preserves, jam, jelly and marmalades, candies; Preparation, preservation and machines for manufacture of above products; Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, leather, dehydrated, wafers and papads, soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products; By-products of fruit and vegetable processing industry.

Practical

Primary processing of selected fruits and vegetables; Canning of Mango/Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of fruit marmalade; Preparation of RTS; Preparation of squash; Preparation of syrup; Preparation of raisins, dried fig and dried banana; Preparation of anardana; Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, canning plant, vegetable dehydration plant.

Suggested Readings

1. Chavan U D and Patil J V. 2013. *Industrial Processing of Fruits and Vegetables*. Astral International Pvt. Ltd., New Delhi.
2. Chakraverty A, Mujumdar A S, Vijaya Raghavan G S and Ramaswamy Hosahalli S. 2003. *Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. Marcel Dekker, Inc., NY, USA.
3. Cruess W V. 2004. *Commercial Fruit and Vegetable Products*. Agrobios India, Jodhpur.
4. Dauthy M E. 1995. *Fruit and Vegetable Processing*. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome.
5. EIRI Board of Consultants and Engineers. 2008. *Manufacture of Snacks, Namkeen, Papads and Potato Products*. EIRI, New Delhi.
6. Hui Y H. 2006. *Handbook of Fruits and Fruit Processing*. Blackwell Publishing Ltd., Oxford, UK.
7. Hui Y H, Chazala S, Graham D M, Murrell K D and Wai-Kit Nip. 2004. *Handbook of Vegetable Preservation and Processing*. Marcel Dekker, Inc., NY, USA.

8. Lal G, Siddappa G S and Tandon G L. 1959. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.

9. Pandey P H. 1997. *Post Harvest Technology of Fruits and Vegetables*. Saroj Prakashan, Allahabad.

10. Rajarathnam S and Ramteke R S. 2011. *Advances in Preservation and Processing Technologies of Fruits and Vegetables*. New India Publishing Agency, New Delhi.

11. Srivastava R P and Kumar S. 2002. *Fruit and Vegetable Preservation: Principles and Practices*. (3rd Edn.). International Book Distribution Co., Delhi.

12. Thompson A K. 2003. *Fruit and Vegetables: Harvest, Handling and Storage*. (2nd edn.) Blackwell Publishing Ltd., Oxford, UK.

Food Packaging Technology and Equipment 2 (1+1)

Objectives

i. To understand concept of packaging, its type and properties of packaging materials

ii. To gain knowledge about intelligent, smart and active packaging

iii. To learn labelling requirement and regulations

Theory

Packaging situations in World and India; Need of packaging; Package requirements, package functions; Properties of different packaging materials; Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.; Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminum/ tin/ SS) as package material-manufacture, advantages, disadvantages, Plastic as package material, classification of polymers, properties of each plastics, uses of each plastics; Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging; Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging; Edible packaging- Types and sources; Microwavable packaging - Types and applications. Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package. Packaging practices followed for fruits and vegetables and their products, packaging machines, Filling machines, vacuum packaging machines. Bottle fillers, fillers for dry mixers, ice-cream fillers, Form fill and seal (FFS) machines, vacuum packaging machine, shrink wrap packaging machine, Aseptic tetra pack system; Labelling requirements, methods of coding and regulation and standards of labelling of food packages.

Practical

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, paper boards; Measurement of bursting strength of paper, paper boards; Measurement of tear resistance of papers;

Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of laquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, ink adhesion; packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machines, bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

Suggested Readings

1. Ahvennainen R. 2003. *Novel Food Packaging Techniques*. CRC-Woodhead Publishing Ltd., Cambridge, England.
2. Coles R, McDowell B and Kirwan M J. 2003. *Food Packaging Technology*. Blackwell Publishing Ltd., Oxford, UK
3. Han J H. 2007. *Packaging for Nonthermal Processing of Food*. Blackwell Publishing Ltd., Oxford, UK.
4. Han J H. 2005. *Innovations in Food Packaging*. Elsevier Science and Technology Books, UK.
5. Lee D S. 2008. *Food Packaging Science and Technology*. CRC Press, Boca Raton FL, USA.
6. Robertson G L. 2014. *Food Packaging: Principles and Practice*. (3rd Edn.). CRC Press, Boca Raton, FL, USA.
7. Robertson G L. 2010. *Food Packaging and Shelf Life – A Practical Guide*. CRC Press, Boca Raton, FL, USA.

Processing of Spices and Plantation Crops 3 (2+1)

Objectives

i. To learn processing technology of different spices
ii. To understand post-harvest technology of tea, coffee, cocoa etc.

Theory

Production and processing scenario of spice, flavour and plantation crops and its scope; Major spices: Post harvest technology, composition; Processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom. Equipment for cryogenic grinding; Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram; Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves; Post-harvest technology for Tea, coffee, cocoa, Vanilla and annatto processing; Post-harvest technology and processing of areca nut, cashew nut, oil palm, coconut. Flavours of minor spices; Flavour of major spices. Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices. Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization. Functional packaging of spices and spice products; By-products of plantation crops and spices.

Practical

Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, ginger, pepper, clove; Peperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, valuable oil, specific gravity, refractive index, acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to spice industry.

Suggested Readings

1. Gupta S. 2007. *Handbook of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.
2. Hirasa K and Takemasa M. 1998. *Spice Science and Technology*. Marcel Dekker, NY, USA.
3. Panda H. 2010. *Handbook on Spices and Condiments (Cultivation, Processing and Extraction)*. Asia Pacific Business Press Inc., New Delhi.
4. Pruthi J S. 2001. *Spices and Condiments – Major Spices of India*. National Book Trust, New Delhi.
5. Purseglave J W, Brown E G, Green C L and Robbins S R J. 1981. *Spices (Vol. I and II)*. SRJ Academic Press, New Delhi.
6. Shanmugavelu K G, Kumar N and Peter KV. 2022. *Spices and Plantation Crops*. Oxford and IBH Publishing Co., New Delhi.

Food Storage Engineering 3 (2+1)

Objectives

i. To understand storage structure for grains and other perishables
ii. To learn the design of storage structure

Theory

Introduction: Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis.

Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control.

Storage structures: Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos.

Storage of grains: Respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation.

Aeration and stored grain management: Purposes of aeration, aeration theory, aeration system design, aeration system operation.

Storage pests and control: Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control.

Storage of perishables: Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage.

Design of storage structures: Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.

Practical

Visits to traditional storage structures; Layout design, sizing, capacity and drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

Suggested Readings

1. Boumans G. 1985. *Grain Handling and Storage*. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brooker D B, Bakker-Arkema F W and Hall C W. 1976. *Drying Cereal Grains*. The AVI Publishing Company, Inc., Connecticut, MA, USA.
3. Hall C W. 1980. *Drying and Storage of Agricultural Crops*. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
4. Jayas D S, White N D G and Muir W E. 1994. *Stored Grain Ecosystems*. Marcel Dekker, New York.
5. Kutz M. 2007. *Handbook of Farm, Dairy, and Food Machinery*. William Andrew, Inc., Norwich, NY, USA.
6. Michael A M and Ojha T P. 2004. *Principal of Food Technology (Vol. I)*. Jain Brothers, New Delhi.
7. Newbaver L W and Walker H B. 2003. *Farm Buildings Design*. Prentice-Hall Inc., New Jersey, USA.
8. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. CBS Publisher and Distributors Pvt Ltd, New Delhi.
9. Pandey P H. 1997. *Post Harvest Technology of Fruits and Vegetables*. Saroj Prakashan, Allahabad.

Project Preparation and Management 2 (1+1)

Objectives

i. To understand concepts of project management
ii. To develop knowledge to develop a project plan and its analysis

Theory

Project and project Management, Evolution of project management, Forms and environment of project management; Project life cycle; Project Identification, Screening, Project Appraisal,

Project Selection, Project Proposal and Project Scope; Project Planning; Work break down structure and Network Scheduling; Critical Path Method; Program Evaluation and Review Technique; Time-cost relationship in project; Resource Considerations in Projects, Resource Profiles and levelling, limited Resource Allocation; Project Implementation, Monitoring and Control: Project management Process and role of project manager, team building, Leadership in Projects, Organizational and behavioural issues in Project Management; Project Monitoring and Control; Project Completion and Review; Project Management - Recent trends and Future Directions. Computers in Project Management.

Practical

Brainstorming exercise to identify a set of projects and their evaluation; work break down structure for different projects; Network Scheduling and Drawing network charts for different projects; Formulation of CPM scheduling for a specific project; Formulation of PERT scheduling for a specific project; Reduction of Project Duration: Time/cost trade off; Resource Profiles and levelling; PERT/Cost Method, Earned value analysis.

Suggested Readings

1. Chandra P. 1980. *Projects- Preparation, Appraisal, Budgeting and Implementation*. Tata McGraw-Hill Publication, New Delhi.
2. Chandra P. 2014. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review*. Tata McGraw-Hill Publishing Company Ltd, New Delhi.
3. Gopalakrishnan P and Rama Moorthy V E. 2014. *Textbook of Project Management*. Laxmi Publications Pvt. Limited, New Delhi.
4. Kerzner H. 2006. *Project Management – A System Approach to Planning, Scheduling, and Controlling*. CBS Publishers and Distributors, New Delhi.
5. Nicholas J M. 2005. *Project Management for Business and Technology – Principles and Practices*. Pearson Prentice Hall.
6. Panneerselvam R. 2004. *Operations Research*. (2nd Edn.) International Book House, Mumbai.

Agriculture Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost

based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Publisher, New Delhi.
3. Salvatore Dominick. 2009. *Microeconomics: Theory and Applications*. Oxford University Press, England.
4. Kohls Richard L and Uhl Josheph N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2005. *Principles of Marketing*. Pearson Prentice-Hall.
6. Lekhi R K and Singh Joginder. 2006. *Agricultural Economics*. Kalyani Publishers, Delhi.
7. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi.

8. Pandey Mukesh and Tewari Deepali. 2004. *Rural and Agricultural Marketing*. International Book Distributing Co. Ltd, New Delhi.
9. Sharma R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

Study tour- Non-gradial 2 (0+2)

The study tour will be of 10-14 days duration within the 5th semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organisations/ industries (related to the profession), they will also be exposed to the geographical, social, socio-economic and cultural diversity of different places/ states. After the visit, the students will submit a report/ make a presentation.

Semester VI

Food Additives and Preservatives 2 (1+1)

Objectives

i. To understand types of food additives and their mechanism
ii. To differentiate between natural and synthetic additives

Theory

Introduction to Food additives; Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; flavours, emulsifiers, sweeteners; Food preservatives and their chemical action; Role and mode of action of Class I and Class II preservatives; chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

Practical

Evaluation of GRAS aspect of food additives; Estimation of chemical preservatives by TLC (organic and inorganic); Identification of food colour by TLC (organic and inorganic); Quantitative estimation of added dyes; Isolation and identification of naturally occurring food pigments by paper and TLC; Role and mode of action of chelating agent in fruit juice; Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream); Role and mode of clarifying agent in fruit juices; Role and mode of antioxidant in frozen fish; Role of leaving agent in baked food product; Preservation of coconut shreds using humectants.

Suggested Readings

1. Belitz H D, Grosch W and Schieberle P. 2009. *Food Chemistry*. (4th Edn.). Springer-Verlag Berlin Heidelberg.
2. Deshpande S S. 2002. *Handbook of Food Toxicology*. Marcel and Dekker AG, Basel, Switzerland.

3. Mahindru S N. 2008. *Food Additives: Characteristics, Detection and Estimation*. APH Publishing Corporation, New Delhi.

Sensory Evaluation of Food Products 2 (1+1)

Objectives

i. To understand basic concept of sensory evaluation

ii. To gain knowledge about consumer study

Theory

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation; Principles of good practice: the sensory testing environment, test protocol considerations, Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes; Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odour testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste; Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation; Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests.

Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling; dilution procedures, descriptive sensory analysis, contour method, other procedures; Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

Practical

Determination of threshold value for basic tastes; Odour recognition, difference (PC, Duo- trio, triangle); Determination of threshold value for various odours; Selection of judging panel; Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests; Descriptive analysis methodology; Sensory evaluation of various food products using different scales, score cards and tests; Texture profile methodology; Estimation of color; Relationship between objective and subjective methods; Designing a sensory laboratory.

Suggested Readings

1. Amerine M A, Pangborn R M and Rossles E B. 1965. *Principles of Sensory Evaluation of Food*. Academic Press, London.
2. Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
3. Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood, UK.
4. Lawless H T and Klein B P. 1991. *Sensory Science Theory and Applications in Foods*. Marcel and Dekker AG, Basel, Switzerland.
5. Lawless H T and Heymann H. 2010. *Sensory Evaluation of Food: Principles and Practices*. (2nd Edn.). Springer, New York or Dordrecht Heidelberg, London.
6. Macrae R, Robinson R K and Sadler M J. 1994. *Encyclopedia of Food Science and Technology and Nutrition (Vol. XI)*. Academic Press, London.
7. Moskowitz H R. 2000. *Applied Sensory Analysis of Foods (Vols. I & II)*. CRC Press, Boca Raton, FL, USA.
8. Piggot J R. 1984. *Sensory Evaluation of Foods*. Elsevier Science and Technology, UK.
9. Potter N N and Hotchleiss J H. 1995. *Food Science*. (5th Edn.). CBS Publishers, Delhi.
10. Rai S C and Bhatia V K. 1988. *Sensory Evaluation of Agricultural Products*. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
11. Stone H and Sidel J L. 1985. *Sensory Evaluation Practices*. Academic Press, London.

Processing Technology of Legumes and Oilseeds 3 (2+1)

Objectives

i. To understand the nutritional value and composition of legumes and oil seeds

ii. To gain knowledge about milling of pulse and oil seeds

Theory

Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds; Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti- nutritional compounds; Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency; Factors affecting milling quality and quantity; Problems in dhal milling industry; Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal; Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes; Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines.

Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry; Desolventization; Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls; Hydrogenation of oils; New technologies in oilseed processing; Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates; By-products of pulse and oil milling and their value addition.

Practical

Determination of physical properties of legumes and oil seeds; Determination of proximate composition of selected pulses and oilseeds; Determination of nutritional quality of selected pulses and oilseeds; Study of mini dhal mill; Study of mini oil mill; Preconditioning of pulses before of mini oil mill; Preconditioning of pulses before milling; Preconditioning of oilseeds before milling; Removal of anti-nutritional compounds from selected pulses and oilseeds; Laboratory milling of selected pulses and its quality evaluation; Laboratory milling of selected oilseeds and its quality evaluation; Laboratory refining of selected oils; Laboratory hydrogenation of selected oils; Study of cooking quality of dhal; Processing of composite legume mix and preparation of value added products; Visit to commercial dhal mills and oil mills.

Suggested Readings

1. Chakraverty A. 2008. *Post Harvest Technology of Cereals, Pulses and Oilseeds* (3rd edn.) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chakraverty A, Mujumdar A S, Vijaya Raghavan G S and Ramaswamy H S. 2003. *Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. Marcel Dekker, Inc., NY, USA
3. Gunstone F D. 2008. *Oils and Fats in the Food Industry*. John Wiley and Sons, Ltd., West Sussex, UK.
4. Sahay K M and Singh K K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.
5. Shahidi F. 2005. *Bailey's Industrial Oil and Fat Products (Vols. 1 to 6*). (6th Edn.). John Wiley and Sons, Inc. Hoboken, New Jersey, USA.

Food Refrigeration and Cold Chain 3 (2+1)

Objectives

i. To understand the concept of refrigeration system, refrigerant and their properties
ii. To design of cold storage and air conditioning systems for food storage application

Theory

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; plug and chill type refrigeration based on chemicals. Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated

refrigerating machine; water/lithium bromide and ammonia/water absorption cooling. Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants-physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations. Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display. Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food. Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling/Refrigeration load calculations: Load sources, product cooling, conduction heat load, convection heat load, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.

Practical

Study of vapour compression refrigeration system; Determination of COP of vapour compression refrigeration system; Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems; Study of refrigerants, their properties and charts; Study of direct and indirect contact freezing equipment for foods; Study of spray freezing process for foods; Study of food cold storage; Estimation of refrigeration load for cold storage; Estimation of refrigeration load for meat and poultry products; Study of refrigeration system of dairy plant; Estimation of refrigeration load for ice-cream; Study of cooling system for bakery and estimation of refrigeration loads; Estimation of refrigeration load during chocolate enrobing process; Study of refrigerated van; Study of deep freezing and thawing of foods; Study of refrigerated display of foods and estimation of cooling load.

Suggested Readings

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). 2006. *ASHRAE Handbook 2006: Refrigeration*. ASHRAE.
2. Arora C P. 2000. *Refrigeration and Air Conditioning*. (2nd Edn.). Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. CBS Publisher and Distributors Pvt Ltd. New Delhi.
4. Stoecker W F and Jones J W. 1982. *Refrigeration and Air Conditioning*. (2nd Edn.) McGraw-Hill Book Co., New York, USA.
5. Whitman W C, Johnson W M, Tomczyk J A and Silberstein E. 2009. *Refrigeration and Air Conditioning Technology*. (6th Edn.). Delmar, Cengage Learning, NY, USA.

Processing of Meat, Fish and Poultry Products 3 (2+1)

Objectives

i. To understand types of meat and the unit operations in meat, fish and poultry processing

ii. To gain knowledge about various methods of preservation of meat, fish, poultry and their products.

Theory

Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish. Structure and composition of muscle, types, classification and composition of fish, Pre-slaughter operations and slaughtering operations for animals and poultry. Dressing and evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat. Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for- meat, poultry and fish, Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH); Meat quality parameters – color water holding capacity, palatability, marbling quantum of connective tissue, firmness and storage conditions; Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation; Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products; Problems on mass balancing of ingredients in formulation of value added meat products; Abattoir design and layout; Preservation of fresh fish, characteristic of fresh fish and fermented and value added products of fish; Spoilage indices of fish and factors affecting the spoilage of fish; Eggs: Structure, composition, quality characteristics, defects and grading of egg processing, preservation of eggs; Processing and preservation of poultry meat and chicken patties, Preparation protocols of indigenous products: Fish sauce and paste; By-products of meat, poultry, fish and eggs and their utilization; Safety standards in meat/ fish industry: HACCP/ISO/MFPO/ FSSAI/ Kosher/Halal, EU hygienic regulations and ISO 9000 standards.

Practical

Pre-slaughter operations of meat animals and poultry birds; Slaughtering and dressing of meat animals; Study of post-mortem changes; Meat cutting and handling; Preservation of meat by freezing; Preservation of meat by curing and pickling; Preservation of meat by dehydration; Evaluation of quality and grading of eggs; Preservation of shell eggs; Preparation of value added poultry meat products; Value added egg products; Visit to abattoir. Study of anatomy and dressing of fish; Study of anatomy and dressing of prawn and other marine products; Identification of different types of fish - Selection and grading; Identification of different types of prawn and other marine products; Quality evaluation of fish; Preparation of sun dried and salt cured fish, fish sauce; Chilling and freezing of fish; Preparations of fish protein concentrate; Preparation of fish meal; Preparation of marine fish oils and various fish products; Preservation of fish: Drying, pickling; Preservation of marine products using fermentation process; Preparation of value added sea products: Cutlets, bullets, wafers; Processing of fish oils; Canning methods for marine fishery products; Estimation of TVB and TMA; Determination of iodine value; Visit to fish and prawn processing industry.

Suggested Readings

1. Berkel B M V, Boogaard B V D and Heijnen C. 2004. *Preservation of Fish and Meat*. Agromisa Foundation, Wageningen, Netherlands
2. Borstorm G. 1961. *Fish as Food (Vol. I, II, III and IV*). Academic Press, New York.
3. FAO. 2003. *Code of Practices of Canned Fishery products*. FAO, UN, Rome.
4. Hall G M. 1997. *Fish Processing Technology*. (2nd Edn.). Chapman and Hall, London, UK.
5. Kerry J and Ledward D. 2005. *Meat Processing-Improving Quality*. Woodhead Publishing Ltd., Cambridge, England.
6. Lawrie R A. 1985. *Meat Science*. (4th Edn.). Pergamon Press, Oxford, UK.
7. Nanda Vikas. 2014. *Meat, Egg and Poultry Science and Technology*. I.K. International Publishing House Pvt. Ltd., New Delhi.
8. Rautenstrauss B W and Liehr T. 2002. *Fish Technology*. Springer-Verlag, US.
9. Sen D P. 2005. *Advances in Fish Processing Technology*. Allied Publishers Pvt. Ltd., Delhi.
10. Sharma B D and Sharma K. 2011. *Outlines of Meat Science and Technology*. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
11. Sharma B D. 2003. *Modern Abattoir Practices and Animal Byproducts Technology*. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
12. Stadelman W J and Cotterill O J. 1995. *Egg Science and Technology*. (4th Edn.). Food Products Press, NY, USA.
13. Swatland H J. 2004. *Meat Cuts and Muscle Foods*. (2nd Edn.). Nottingham Univ. Press, Nottingham.
14. Toldrá F, Hui Y H, Astiasarán I, Nip W K, Sebranek J G, Silveira E T F, Stahnke L H, Talon R. 2007. *Handbook of Fermented Meat and Poultry*. Blackwell Publishing Professional, Ames, Iowa, USA.
15. Varnam A H and Sutherland J P. 1995. *Meat and Meat Products: Technology, Chemistry and Microbiology*. Chapman and Hall, London.

Processing Technology of Beverages 3 (2+1)

Objectives

i. To learn different about types of beverages
ii. To aquint with various technologies involved in beverage processing
iii. To gain knowledge about FSSAI specifications of beverages
iv. To understand ingredients, manufacturing and packaging processes for beverages.

Theory

History and importance of beverages and status of beverage industry; Processing of beverages: Packaged drinking water, juice-based beverages, synthetic beverages, still, carbonated; Low-calorie and dry beverages, isotonic and sports drinks. Dairy based beverages, Alcoholic beverages, fruit beverages, specialty beverages, Tea, coffee, cocoa, spices, plant extracts, etc. FSSAI specifications for beverages. Ingredients, manufacturing and packaging processes and equipment for different beverages; Water treatment and quality of process water; Sweeteners, colorants,

acidulants, Clouding and clarifying and flavouring agents for beverages, Carbon dioxide and carbonation. Quality tests and control in beverages, Miscellaneous beverages: Coconut water, sweet toddy, Sugar cane juice, coconut milk, flavoured syrups.

Practical

Quality analysis of raw water; Determination of density and viscosity of caramel; Determination of colours in soft drinks by wool technique; Preparation of iced and flavoured tea; Preparation of carbonated and non-carbonated beverages; Determination of caffeine in beverages; Determination of brix value, gas content, pH and acidity of beverages; Quality analysis of tea and coffee; Preparation of miscellaneous beverages; Visit to carbonation unit; Visit to mineral water plant.

Suggested Readings

1. Ashurst P R. 2005. *Chemistry and Technology of Soft Drinks and Fruit Juices*. (2nd Edn.) Blackwell Publishing Ltd., Oxford, UK.
2. Chakraverty A, Mujumdar A S, Vijaya Raghavan G S and Ramaswamy H S. 2003. *Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. Marcel Dekker, Inc., NY, USA.
3. Eblinger H M. 2009. *Handbook of Brewing: Processes, Technology, Markets*. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim. Germany.
4. Hui Y H. 2007. *Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods*. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Joshi V K and Pandey A. 1999. *Biotechnology: Food Fermentation – Microbiology, Biochemistry and Technology – Vol. II*. Educational Publishers and Distributors, New Delhi.
6. Varnam A H and Sutherland J P. 1994. *Beverages: Technology, Chemistry and Microbiology*. Chapman, London, UK.

Bakery, Confectionery and Snack Products 3 (2+1)

Objectives

i. To learn the processing and packaging and storage of bakery and confectionary products
ii. To understand extrusion technology and its application in production of breakfast cereals and snacks

Theory

Bakery products- Types (leavened and unleavened), specifications, compositions and ingredients (flour, sugar, fat, shortening, leavening agent etc.); Formulations, processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), equipment, packaging, storage and quality testing of bakery products. Processing technology of bread, biscuits and cakes. Classification of biscuits and manufacturing process of crackers

Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations; Hard boiled candies, pan coating, toffees and caramels, chewing gum and sugar free

confections; Processing of chocolate – types cocoa beans and processing, other ingredients, mixing refining, conching, storage and packaging. Processing, equipment, packaging, storage and quality testing of confectionery and chocolate products. Product quality characteristics; Defects, causes and corrective measures. Extrusion technology and applications in food processing; Snack foods: Types, specifications, compositions, ingredients, Formulations, processing, equipment, packaging, storage and quality testing; Snack food seasonings. Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients; Formulations, processing, equipment for breakfast cereals, macaroni and malts; Packaging, storage and quality testing for breakfast cereals, macaroni and malts. Cooked corn products – tortilla chips; Modified starches for snack foods; Oils and industrial frying. Preservatives used in Bakery, Confectionery and snack products preservation; Quality testing of Bakery, Confectionery and snack products.

Practical

Identifications and composition of various ingredients for snacks, bakery and confectionery products; Flours, their classifications and characterization; preparation, packaging and quality evaluation of selected snack items; preparation, packaging and quality evaluation of selected bakery items; preparation, packaging and quality evaluation of selected confectionery items; preparation, packaging and quality evaluation of selected chocolates; Preparation of traditional Indian confection. Visit to bakery, confectionary and snack units (industry).

Suggested Readings

1. Amendola J and Rees N. 2003. *Understanding Baking: The Art and Science of Baking*. (3rd Edn.). John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
2. Corke H, Leyn I D, Cross N A, Nip W K and Hui Y H. 2006. *Bakery Products: Science and Technology*. Blackwell Publishing Ltd., Oxford, UK.
3. Duncan Manley. 2000. *Technology of Biscuits, Crackers and Cookies*. (3rd Edn.). Woodhead Publishing Limited, Cambridge, England.
4. Grewling P P. 2013. *Chocolates and Confections*. (2nd Edn.). John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
5. Hui Y H. 2007. *Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods*. John Wiley and Sons, Inc., Hoboken, New Jersey, USA.
6. Jackson E B. 1995. *Sugar Confectionery Manufacture*. (2nd Edn.). Springer-Verlag, US.
7. Kent N L and Evers A D. 1994. *Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture*. (4th Eedn.). Elsevier Science Ltd., Oxford, UK.
8. Kingslee J J. 2006. *A Professional Text to Bakery and Confectionery*. New Age International, New Delhi.
9. Matz S A. 1976. *Snack Food Technology*. (2nd edn.). AVI Publishing Co., Inc., Westport, Connecticut, USA.
10. Minife B W. 1989. *Chocolate, Cocoa, and Confectionary – Science and Technology*. (3rd Edn.). Chapman and Hall, Inc., New York, USA.
11. Pyler E J and Gorton L A. 2009. *Baking Science and Technology – Vol. II: Formulation and Production*. (4th Edn.). Sosland Publishing Company, Kansas City, MO, USA.

12. Pyler E J and Gorton L A. 2008. *Baking Science and Technology – Vol. I: Fundamentals and Ingredients*. (4th Edn.). Sosland Publishing Company, Kansas City, MO, USA.

Processing Technology of Liquid Milk 2 (1+1)

Objectives

i. To understand different steps of milk processing

ii. To gain knowledge about different types of milk and their process

Theory

Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavored milk. Effect of thermal treatment on milk constituents. Fermented milk, acidophilous milk, etc.; Effect of thermal treatment on milk constituents; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting these changes and effects of these changes on the quality of finished products. Cream: definition, classification, manufacture of different types of cream, processing of cream; Adulterations in milk and its detection; Quality defects in milk - causes and prevention. Liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.; Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.

Practical

Platform tests of raw milk (clot on boiling (COB) test, alcohol test); Determination of physical properties of milk; Determination of proximate composition and biochemical properties of milk; Determination of microbiological properties of milk; Detection of adulterants in milk; Identification and demonstration of liquid milk processing equipment, pipes and fittings; Preparing standardized milk as per requirement; Separation of fat from milk; Pasteurization and homogenization of milk; Packaging of liquid milk; Preparation of curd and yogurt, Visit to chilling centre and dairy plant.

Suggested Readings

1. De S. 2005. *Outlines of Dairy Technology*. Oxford University Press, New Delhi.

2. Hui Y H. 1993. *Dairy Science and Technology Handbook (Vol. I, II and III)*. Wiley-VCH, USA.

3. Kanekanian A. 2014. *Milk and Dairy Products as Functional Foods*. John Wiley and Sons, Ltd., UK.

4. Kessler H G. 1981. *Food Engineering and Dairy Technology*. Verlag A. Kessler, Fraising (F.R. Germany).

5. Tamime A Y. 2009. *Milk Processing and Quality Management*. Blackwell Publishing Ltd., UK.

6. Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology*. (2nd Edn.). CRC Press, Boca Raton, FL, USA.

Semester VII

Food Process Equipment Design 3 (2+1)

Objectives

i. To learn design consideration for storage vessels, evaporators, crystallizers, separators etc.

ii. To know safety aspects in equipment design

Theory

Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes. Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations. Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories. Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort. Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystallizer and entrainment separator. Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation. Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems. Design of freezing equipment: Design of ice-ream freezers and refrigerated display system. Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer. Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder. Design of fermenters: Design of fermenter vessel, design problems. Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.

Practical

Design of pressure vessel; Design of shell and tube heat exchangers and plate heat exchanger; Design of sterilizers and retort; Design of single and multiple effect evaporators; Design of rising film and falling film evaporator; Design of crystallizer; Design of tray dryer; Design of fluidized bed dryer; Design of spray dryer; Design of vacuum dryer; Design of microwave dryer; Design of belt and chain conveyor; Design of screw conveyor; Design of bucket elevator and pneumatic conveyor; Design of twin screw extruder; Design of fermenter.

Suggested Readings

1. Ibarz Albert and Barbosa-Cánovas Gustavo V. 2003. *Unit Operations in Food Engineering*. CRC Press, Boca Raton, FL, USA.

2. Bhattacharyya B C. 2008. *Introduction to Chemical Equipment Design- Mechanical Aspect*. CBS Publishers and Distributors, New Delhi.

3. Couper J R, Penney W R, Fair J R and Walas S M. 2012. *Chemical Process Equipment: Selection and Design*. 21. Elsevier Science and Technology Books, UK.

4. Geankoplis C J. 2003. *Transport Processes and Separation Process Principles (Includes Unit Operations)*. (4th Edn.) Prentice-Hall, NY, USA.

5. Pandey H, Sharma H K, Chauhan R C, Sarkar B C and Bera M B. 2010. *Experiments in food process engineering*. CBS Publisher and Distributors Pvt Ltd, New Delhi.

6. Richardson J F and Peacock D G. 1994. *Coulson and Richardsons's Chemical Engineering, Vol. 3, Chemical and Biochemical Reactors and Process Control*. (3rd Edn.) Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands.

7. Saravacos G D and Kostaropoulos A E. 2002. *Handbook of Food Processing Equipment*. Springer Science and Business Media, New York, USA.

8. Singh R P and Heldman D R. 2014. *Introduction to Food Engineering*. (5th Edn.) Elsevier, Amsterdam, The Netherlands.

9. Sinnott R K. 1999. *Chemical Engineering (Vol. 6: Chemical Engineering Design)*. (3rd Edn.). Butterworth-Heinemann, Oxford, UK.

10. Stanbury P F, Whitakar A and Hall S J. 1995. *Principles of Fermentation Technology*. (2nd Edn.). Elsevier Science Ltd., Burlington, MA, USA.

11. Valentas K J, Rotstein E and Singh R P. 1997. *Handbook of Food Engineering Practice*. CRC Press, Boca Raton, FL, USA.

Processing Technology of Dairy Products 3 (2+1)

Objectives

i. To learn the processing of dairy products viz. cream, butter, ghee, ice-cream etc.

ii. To gain knowledge of traditional dairy products and their processing

Theory

Cream: Basic aspect, Classification, manufacture of different types of cream, processing of cream; Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter- defects, causes and their prevention, packaging and storage; Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage. Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram, equipment, quality testing, defects causes and prevention, packaging and storage. Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk. Manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage. Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.

Practical

Preparation of butter/ table butter, Preparation of ghee, Preparation of paneer; Preparation of selected type of cheese; Preparation of ice-cream and selected frozen desserts; Preparation of condensed milk; Preparation of spray dried milk powder; Preparation of selected Indian dairy

products; Shrikhand mawa/khoa based products halwa/ kheer etc., Determination of selected quality parameters of selected dairy products; Visit to dairy plant.

Suggested Readings

1. Aneja R P, Mathur B N, Chandan R C and Banerjee A K. 2002. *Technology of Indian Milk Products: Handbook of Process Technology, Modernization for Professionals Entrepreneurs and Scientists*. Dairy India Yearbook, New Delhi
2. De S. 2005. *Outlines of Dairy Technology*. Oxford University Press, New Delhi.
3. Kanekanian A. 2014. *Milk and Dairy Products as Functional Foods*. John Wiley and Sons, Ltd., UK.
4. Kessler H G. 1981. *Food Engineering and Dairy Technology*. Verlag A. Kessler, Fraising, F.R. Germany.
5. Hui Y H. 1993. *Dairy Science and Technology Handbook – Vol. I, II and III*. Wiley-VCH, USA.
6. Walstra P, Wouters J T M and Geurts T J. 2006. *Dairy Science and Technology*. (2nd Edn.). CRC Press, Boca Raton, FL, USA.
7. Tamime A Y. 2009. *Milk Processing and Quality Management*. Blackwell Publishing Ltd., UK.

ICT Applications in Food Industry 3 (1+2)

Objectives

i. To understand the requirement of information and its computerization and SCADA systems

ii. To learn different software tools like MATLAB, GAMBIT, Fluent, LabVIEW etc.

iii To learn different techniques like Fuzzy logic, Neural network, Image processing etc.

Theory

Importance of computerization in food industry, operating environments and information systems for various types of food industries. Introduction to Supervisory control and data acquisition (SCADA): SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems. Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems. Use of add-ins, use of solver. Web hosting and webpage design; file transfer protocol (FTP), Online food process control from centralized server system in processing plant. Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system. Problem solving methodologies, numeric, cell, arrays, matrix operations; User defined functions, programming using MATLAB; debugging MATLAB programs, Applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB; Function discovery, regression, the basic fitting interface, three dimensional plots; Introduction to Toolboxes useful to Food Industry, Curve fitting toolbox, Fuzzy logic toolbox, Neural Network toolbox, Image processing toolbox, statistical toolbox. Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry; Introduction to CFD softwares, GAMBIT and Fluent

software, LabVIEW – LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/ tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW; LabVIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.

Practical

Introduction to various features in spreadsheet; Solving problems using functions in spreadsheets; Use of Add-Ins in spread sheet and statistical data analysis using Analysis Tool pack; Solution of problems on regression analysis using Analysis Tool pack in spreadsheet; Solution of problems on optimization using solver package in spreadsheet; Introduction to MATLAB; Writing code using MATLAB programming; Solution of problems using Curve Fitting Toolbox in MATLAB; Solution of problems using Fuzzy Logic Toolbox in MATLAB; Solution of problems using Neural Network Toolbox in MATLAB; Solution of problems using Image Processing Toolbox in MATLAB; Introduction to GAMBIT software; Creation of geometry for laminar flow through pipe using GAMBIT; Introduction to FLUENT software; Import of geometry and application of boundary conditions; Solution of problems on laminar flow using FLUENT; Introduction to LabVIEW and NI-DAQ.

Suggested Readings

1. Bailey D and Wright E. 2003. *Practical SCADA for Industry*. Elsevier, Burlington, MA
2. Chapman N and Chapman J. 2006. *Web Design: A Complete Introduction*. John Wiley and Sons, USA.
3. Palm III W J. 2011. *Introduction to MATLAB for Engineers*. (3rd Edn.). McGraw-Hill Companies, Inc., NY, USA.
4. Sun D W. 2007. *Computational Fluid Dynamics in Food Processing*. CRC Press, Boca Raton, FL, USA.
5. Singh R P. 2014. *Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis*. Academic Press, London.

ELECTIVE COURSES

Sr. No.	Course Title	Credit hours
1.	Design and Formulation of Foods	3 (2+1)
2.	Industrial Microbiology	3 (2+1)
3.	Introduction to Food Biotechnology	3 (2+1)
4.	Business Management and Economics	2 (2+0)
5.	Statistical Methods and Numerical Analysis	2 (1+1)
6.	Instrumentation and Process Control in Food Industry	3 (1+2)
7.	Instrumental Techniques in Food Analysis	2 (1+1)
8.	Traditional Indian Dairy Products	2 (1+1)

Sr. No.	Course Title	Credit hours
9.	Ice-cream and Frozen Desserts	3 (2+1)
10.	Energy Conservation and Management	2 (1+1)
11.	Applications of Renewable Energy in Food Processing	2 (1+1)
12.	Food Plant Design and Layout	3 (2+1)
13.	Waste and By-Products Utilization	3 (2+1)

** Sr No. 8-10 are cross-listed from Dairy Technology

Design and Formulation of Foods 3 (2+1)

Objectives

i. To understand about RDA for Indians
ii. To design and formulate new and innovative target foods
iii. To gain knowledge about various therapeutic diets

Theory

Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food; Concept of different food groups, recommended dietary allowances (RDA) for Indians; nutrition for infant, pre-school and school children, adult, pregnant and lactating women, old age people. Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition. Therapeutic diets – Principles and objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation. Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods. Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food.

Practical

To study the principles and planning menu; Develop diet plan using food exchange list and nutrient calculation for school children, adult, pregnant; Preparation and formulation of Indian Traditional Snack, Traditional Sweet; Preparation and development of food for pregnant and lactating women, foods for infants; Preparation and formulation of food and energy drinks for diabetic person (sugar free food products); sports person and osteoporosis; preparation of prebiotic and pro biotic food product; Preparation of functional food using millets; whey beverage probiotic beverage; Production of functional beverage and antioxidant determination; Visit to Food Processing Industries/ Expos.

Suggested Readings

1. Antia F P. 1974. *Clinical Dietetics and Nutrition*. Oxford Medicine Publications, New Delhi.
2. Davidson S, Passmore R and Eastwood M A. 1986. *Davidson and Passmore Human Nutrition and Dietetics*. Churchill Livingstone, London
3. Gopalan C, Ramshastri B V and Balasubramaniam S C. 1989. *Nutritive Value of Indian Foods*. National Institute of Nutrition, Hyderabad.

4. Pokorny J, Yanishlieva N and Gordon M. 2001. *Antioxidants in Food*. Woodhead Publishing Limited, Abington Hall, Abington.
5. Potter N N and Hotchkiss J H. 1995. *Food Science*. (5th Edn.). Chapman and Hall, NY, USA.
6. Mazza G.1998. *Functional Foods: Biochemical and Processing Aspects*. Technomic Publ. Co.,. Lancaster, PA.
7. Robinson C. 1975. *Basic Nutrition and Diet Therapy*. Macmillan Publisher, London.
8. Swaminathan M. 1974. *Essentials of Nutrition*. Ganesh & Co Publishers, New Delhi.
9. Steinkrauss K H. 1995. *Handbook of Indigenous Fermented Foods*. Marcel Dekker, Inc., NY, USA.

Industrial Microbiology 3 (2+1)

Objectives

i. To learn about industrially important micro-organism and their growth
ii. To understand bioreactor design and downstream processing

Theory

Overview of Industrial Microbiology; Introduction to industrial fermentations, Range of fermentation processes, Chronological development, Compartmental part of fermentation processes; Industrially Important Microorganisms. Criteria for Selection of Industrially Important Microorganisms, Overview of strain improvement of Industrially Important Microorganisms, Preservation of industrially important microorganisms. Fermentation Media; Media selection, Medium Formulation, Medium for industrial fermentation; Microbial Growth; Typical Growth Curve, Synchronous growth, Batch Fermentations, Continuous Fermentation; Fed Batch Fermentation. Bioreactor Design: Basic functions, Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories, Types of reactor; Problems related to scale up of Process; Upstream and Down Stream Processes: Upstream processes, Overview of Downstream Processing, Methods of cell destruction, Methods of purification of enzyme/product, Concentration and Packaging.

Practical

Isolation and screening of citric acid/ amylase/ protease /antibiotic producing microbes, Production of citric acid/Lactic acid/ Acetic acid, Purification of citric acid/Lactic acid/ Acetic acid and Estimation of citric acid/Lactic acid/ Acetic acid; Standardization of physical factors for higher yields of citric acid; Isolation, identification of cultures producing bio-colours; Production, purification and estimation of beer/ ethanol; Production, purification and assay of fungal amylases/ proteases/Lipase; Production and assay of nisin from lactic acid bacteria; Single cell protein production; Starter activity of Baker's yeast Mushroom production.

Suggested Readings

1. Briggs D E, Boulton C A, Brookes P A and Stevens R. 2004. *Brewing Science and Practice*. Woodhead Publishing Ltd. Cambridge, England.
2. Casida Jr. L E. 1968. *Industrial Microbiology*. New Age International Publishers, New Delhi.

3. Okafor N. 2007. *Modern Industrial Microbiology and Biotechnology*. Science Publishers, Enfield, New Hampshire, USA.
4. Reed G. 2004. *Prescott and Dunn's Industrial Microbiology*. (4th Edn.). AVI Publishers, Connecticut, USA.
5. Stanbury P F, Whitakar A and Hall S J. 1995. *Principles of Fermentation Technology*. (2nd Edn.). Elsevier Science Ltd., Burlington, MA, USA.

Introduction to Food Biotechnology 3 (2+1)

Objectives

i. To understand various biotechnological terminology
ii. To understand application of biotechnology in food systems

Theory

Introduction, History and scope of biotechnology, Review of DNA replication, transcription, and translation. Review of DNA replication, transcription, and translation continued, Natural and artificial mechanisms of DNA transfer. Introduction to vectors, Selectable markers, Cloning vectors, Expression vectors, Shuttle vectors, Creation of recombinant DNA molecules, Creation of genomic and cDNA libraries. Library screening, Ligation, Restriction endonuclease digestion and mapping, Gel electrophoresis, Northern blotting, Southern blotting. Polymerase Chain Reaction (PCR), DNA sequencing and sequence analysis, Reverse transcriptase PCR, Real time PCR Week 8 Production of monoclonal antibodies, Immunoblotting. DNA microarrays, Protein microarrays. Introduction to bioinformatics. Applications of biotechnology: Genetically engineered foods, Bioremediation, DNA fingerprinting, Molecular diagnostics, Molecular forensics Transgenic organisms, Ethical issues in biotechnology, The future of biotechnology.

Practical

Study of auxotroph; Micro-propagation through tissue culture; Strain improvement through U.V. mutation for lactose utilization; Chemical mutagenesis using chemical mutagens (Ethidium bromide); Determination of survival curves using physical and chemical mutagens; Isolation and analysis of chromosomal/genomic DNA from *E. coli* and *Bacillus cereus*; Separation of protoplast using cellulytic enzymes; Production of biomass from fruit and vegetable waste; Introduction of ELISA/Southern blot/DNA finger printing, etc.; Agarose gel electrophoresis of plasmid DNA; Pesticide degradation by *Pseudomonas* spp.

Suggested Readings

1. Brandenberg Oliver, Dhlamini Zephaniah, Sensi Alessandra, Ghosh Kakoli and Sonnino Andrea. 2011. *Introduction to Molecular Biology and Genetic Engineering*. FAO, Rome, Italy.
2. Paul Meenakshi. 2007. *Biotechnology and Food Processing Mechanics*. Gene-Tech Books, New Delhi.
3. Primrose S B and Twyman R M. 2006. *Principles of Gene Manipulation and Genomics*. (7th Edn.). Blackwell Publishing, Victoria, Australia.

4. Renneberg R and Lorch V. 2017. *Biotechnology for Beginners*. Academic Press. London.
5. Singh B D. 2014. *Biotechnology - Expanding Horizons*. Kalyani Publishers, New Delhi.
6. Smith J E. 2009. *Biotechnology*. (5th Edn.). Cambridge University Press, Cambridge, UK
7. Stahl U, Donalies U E B and Nevoigt E. 2009. *Food Biotechnology*. Springer Berlin, Heidelberg.
8. Watson James D. 2013. *Molecular Biology of the Gene*. (7th Edn.). Benjamin Cummings, San Francisco, USA.

Business Management and Economics 2 (2+0)

Objectives

i. To learn basic principles of management
ii. To learn basic financial and human resource management

Theory

Definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory. Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid. Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity; Markets: Types of markets and their characteristics. National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production; Law of variable proportions and law of returns to scale. Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Finance management: Definition, scope, objective; Different systems of accounting: Financial accounting, cost accounting, management accounting. Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

Suggested Readings

1. Dewett K K and Navalur M H. 2010. *Modern Economic Theory*. (Revised edition) S. Chand and Sons, New Delhi.
2. Jain S P and Narang K L. 2020. *Financial Accounting*. Kalyani Publications, Ludhiana.
3. Harold K, Weihrich H and Aryasri A R. 2004. *Principles of Management*. Tata McGraw-Hill Education Private Limited, New Delhi.
4. Prasad L M. 2001. *Principles and Practices of Management*. (9th Edn.). S. Chand and Sons, New Delhi.
5. Subba Rao P. 2008. *Human Resource Management*. (Revised) Himalaya Publication, New Delhi.
6. Thomas P C. 2008. *Managerial Economics*. (9th Edn.). Kalyani Publishers, New Delhi.

Statistical Methods and Numerical Analysis 2 (1+1)

Objectives

i. To learn different statistical test

ii. To understand design of experiments

Theory

Statistical inference and testing of hypothesis – Z test, t test and F test**,** Chi-square test and its uses – testing the goodness of fit and test of independence (contingency table)**,** Correlation and regression analysis**.** Basic principles of experimental design Analysis of variance (ANOVA) – one way and two-way classification. Basic designs- Layout and analysis of completely randomized design (CRD) with equal and unequal number of observations, randomized block design (RBD), Latin square design (LSD). Response surface methodology.

Practical

Problems on Z test–One and two sample test Problems on t test-One and two sample (dependent and independent) test; Problems on F test, chi square test, correlation and regression; Fitting of simple linear regressions; Fitting of multiple regression equations; ANOVA: One way/two way; 2^2; Problems on CRD, RBD, LSD, Problems on response surface methodology.

Suggested Readings

1. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers, Delhi.
2. Gupta P P and Malik C C. 1993. *Calculus of Finite Differences and Numerical Analysis*. Krishna Prakash Mandir, Meerut.
3. Kreyszig E. 2006. *Advanced Engineering Mathematics*. (9th Edn.). John Wiley and Sons, New York, USA.

Instrumentation and Process Control in Food Industry 3 (1+2)

Objectives

i. Learn different measurement and control parameters and instruments for their measurement

ii. Understand process control in food processing

Theory

Introduction, definitions, characteristics of instruments, static and dynamic characteristics, Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers; Pressure and pressure scales, manometers, pressure elements differential pressure. Liquid level measurement, different methods of liquid level measurement, flow measurement, differential pressure meters, variable area meters; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale, Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples; Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control

systems; Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware. Frequency response analysis, characteristics, Bode diagram and Nyquist plots and stability analysis; Controllers and indicators: Temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing; Introduction of 8051/8085 based system and applications in processing.

Practical

Study on instrumentation symbols; Determination of relative humidity by wet and dry bulb thermometer; Measurement of wind velocity by anemometer; Measurement of intensity of sun shine by sunshine recorders; Study of characteristics of pressure transducers, real-time study of pressure transducers characteristics with PC, characteristics of IC temperature sensor, characteristics of platinum RTD, temperature controlled alarm system; Study of water level to current conversion; Study of characteristics of capacitive transducer; 8051 based programming examples; Programmable Logic Controllers (PLC) Hardware; PLC Ladder programming; control of Multiprocess system.

Suggested Readings

1. Liptak Bela G. 2003. *Instrument Engineer's Handbook – Vol. I and II*. (4th Edn.). CRC Press, Boca Raton, FL, USA.
2. Johnson Curtis D. 2003. *Process Control Instrumentation Technology*. (7th Edn.). Prentice Hall of India Pvt. Ltd., New Delhi.
3. Green Don W and Perry Robert H. 2008. *Perry's Chemical Engineers' Handbook*. McGraw-Hill Co., Inc., NY, USA.
4. Murty D V S. 2004. *Transducers and Instrumentation*. Prentice Hall of India Pvt. Ltd. New Delhi.

Instrumental Techniques in Food Analysis 2 (1+1)

Objectives

i. To learn various instruments used for food analysis
ii. To learn the methods of various analyses
iii. To gain knowledge about various equipment and their working for those analyses

Theory

Concepts of food analysis; Rules and regulations of food analysis Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods, Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations. Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy, atomic absorption and emission, florescence mass spectroscopy. Food compositional analysis and applications in the food industry.

Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high

performance liquid chromatography; Ion chromatography and others. Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultra centrifugation, iso-electric focusing, Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors, Rapid microbiological methods: Overview, Conductance/ impedance techniques for microbial assay; chemosensors, biosensors, immunosensors.

Practical

Sampling plan; Sample collection and preparation for analysis; Sensory evaluation of products; Quality evaluation of raw materials: Fruits, vegetables, cereals, dairy products, meat, poultry products; Quality evaluation of food products for color and taste of marketed products; Analysis of heavy metals using atomic absorption spectrophotometer; Estimation of physic acid using spectrophotometer; Separation of amino acids by two-dimensional paper chromatography; Identification of sugars in fruit juice using TLC; Separation of pralines by ion-exchange chromatography; Molecular weight determination using sephadox-gel; Identification of organic acids by paper electrophoresis; Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE, GCMS; Quantitative make-up of water and fat soluble vitamins using HPLC; Fatty acid profiling using gas chromatograph; Separation of sugars by paper chromatography; Analysis of wheat flour; Analysis of foods for pesticide and drug residues; Study of colorimetry and spectrophotometry; Spectrophotometric method of total chlorophyll (A and B).

Suggested Readings

1. Nieisen S S. 2010. *Food Analysis Laboratory Manual*. (2nd Edn.). Springer, NY, USA.
2. Nieisen S S. 2003. *Food Analysis*. (3rd Edn.). Kluwer Academic, New York, USA.
3. Ötles S. 2009. *Handbook of Food Analysis Instruments*. CRC Press, Boca Raton, FL, USA.
4. Sun D W. 2008. *Modern Techniques for Food Authentication*. Elsevier Inc., Burlington, MA, USA.

**Traditional Indian Dairy Products 2 (1+1)

Objectives

i. To understand the processes involved in the manufacture of heat desiccated and acid coagulated dairy products and a wide variety of traditional Indian sweets
ii. To learn about the chemical composition and legal standards for traditional Indian sweets
iii. To acquire knowledge about packaging options available for traditional dairy products and methods for their shelf life
iv. To learn about mechanization of certain processes involved in the large-scale manufacture of traditional Indian dairy products

Theory

Status and significance of traditional Indian milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation, factors affecting yield of khoa. Mechanization in manufacture of khoa. Khoa based sweets: Burfi, Peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process

description, factors affecting yield, physico-chemical changes during manufacture. Channa: Product description, standards method of manufacture, packaging and preservation. Chhana-based sweets: Rasogolla, Sandesh, Rasomalai. Mechanization of manufacturing process, advances in preservation and packaging. Paneer: Product description, standards, method of manufacture, packaging and preservation. Mechanization of Paneer manufacturing/packaging process. Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. Misti Dahi: Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical

Preparation of Khoa from cow, buffalo and concentrated milk; Preparation of Burfi, Peda, Kalakand, Milkcake and Gulabjamun; Preparation of Paneer from cow, buffalo and mixed milk; Preparation of Chhana from cow and buffalo milk and mixed milk; Preparation of Sandesh and Rasogolla; Preparation of kheer; Preparation of Rabri, Misti Dahi, Chhana and Shrikhand; Visit to industry.

Suggested Readings

1. Aneja R P, Mathur B N, Chandan R C and Banerjee A K. 2002. *Technology of Indian Milk Products*. A Dairy India Publ., Delhi, India
2. Agarwala S P. 2006. *Equipment for paneer making, Lecture compendium on developments in traditional dairy products*. Short course organized by CAS from Dec. 10-30, 2006.
3. Dharam Pal and Narender Raju P (Eds.). 2006. *Developments in Traditional Dairy Products, Lecture Compendium of the 21st Short Course*. CAS in Dairy Technology, NDRI, Karnal.
4. Pal D. 1997. *Technology of the manufacture of rabri and basundi*. In Advances in Traditional Dairy Products. Short course, CAS in Dairy Technology, NDRl Deemed University, Karnal.

**Ice-Cream and Frozen Desserts 3 (2+1)

Objectives

i. To understand about evolution of ice cream industry, classification of ice cream, ingredients used and their role in determining quality of the final products
ii. To learn about design and working of Ice cream freezers including cleaning and sanitization
iii. To aquire knowledge about the physic-chemical properties of ice cream mix and effect of process variables on the quality of ice cream
iv. To learn about the defects that appear in ice cream, causative factors and measures to control them

Theory

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition and standards of ice cream and other frozen desserts. Stabilizers and emulsifiers-their classification, properties and role in quality of ice cream, Technological aspects of ice cream manufacture, Thermodynamics

of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant. Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention. Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management, Nutritive value of ice-cream.

Practical

Calculation of standardization of ice-cream mixes; Manufacture of plain and fruit flavoured ice-cream; Manufacture of chocolate, fruit and nut ice cream; Preparation of sherbets/ices; Preparation of soft served and filled ice-cream; Manufacture of kulfi. Study of continuous and batch type freezers; Manufacture of ice-cream by continuous process; Determination of overrun in ice cream; Visit to an Ice Cream Plant.

Suggested Readings

1. Arbuckle W S. 1991. *Ice Cream*. AVI Publ., Co. Inc., West Port, Connecticut.
2. Hall C W and Hedric T T. 1975. *Drying of Milk and Milk Products*. AVI Publ. Co. Inc., West Port, Connecticut.
3. Hui Y H. 1993. *Dairy Science and Technology Handbook 2- Product Manufacturing*. Wiley – VCH Inc., USA.
4. Ice Cream Alliance and Ice Cream Federation. 1992. *Code of Practice for the Hygienic manufacture of Ice Cream*. Ice Cream Alliance.
5. NDRI. 1998. *Advances in Ice Cream and Frozen Desserts*. Lecture compendium, Sixth short course, Dec 15, 1998- Jan 4, 1999. NDRI, Karnal.
6. Robinson R K. 1986. *Modern Dairy Technology (Vol II*). Elsevier Sci. Publ. Co., Inc., New York, USA.
7. Robinson R K. 2002. *Dairy Microbiology Handbook*. (3rd Edn.). John Willey and sons, New York, USA.
8. Sommer H H. 1951. *The Theory and Practice of Ice Cream Making*. (6th Edn.). Madison, Wisconsin.

**Energy Conservation and Management 2 (1+1)

Objective

To equip students with the knowledge and skills required to effectively manage and conserve energy resources within the context of dairy and food processing industries

Theory

Introduction: Potential and Importance of industrial energy conservation in dairy and food processing; Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE); Electricity Act 2003, Integrated energy policy; Energy management and audit: Definition, energy audit, need, types of energy audit; Energy audit approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy

balances and computation of efficiencies of equipment; Role of Energy inspectors and Auditors in energy management; Electrical load management: Demand management, energy management information systems, Energy saving controllers and cost saving techniques; Quality of power, Power factor and its improvement; Transformers, losses in transformers; Energy savings in transformers; Electric motor-selection and application, Energy efficient motors; Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy; Bureau of Energy Efficiency (BEE): Power saving guide with Star Ratings of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters; Industrial Lighting: Quality of light, types of light sources, energy efficiency, Light controls. Energy efficiency and conservation in utilities: High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities; Energy conservation in steam distribution systems, efficient piping layouts, protective and insulation coverings in utility pipes; Steam conservation opportunities; Upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in Refrigeration and AC systems (HVAC), Cooling towers, Pumps and pumping systems, Fans, Blowers, Air compressors; Maintenance and upkeep of Vacuum lines and Compressed air pipe lines; Conservation and reuse of water, water auditing; Energy conservation opportunities in Wastewater treatment. Processing equipment: Improving efficiency and energy conservation opportunities in few important food processing operations like Thermal processes, Evaporation, Drying and Freezing; Role of steam traps in energy saving; Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator. Energy conservation in buildings: Concepts of Green Buildings; Waste-heat recovery and thermal energy storage in food processing facilities; Condensate recovery and reuse; Application of recuperator to recover energy from flue gases from boiler, DG exhaust, hot air from spray dryer, FBD etc; Diesel generating sets (stand by AC Gen sets): Energy saving opportunities in DG sets, Fuel and Oil conservation; important regular maintenance aspects; Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Introduction to Solar, and Bio-mass Energy; Solar thermal and photo-voltaic energy options for food processing industries; Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Practical

Study of Energy Conservation Act 2001; Study of schemes of BEE; Study of concepts of Energy Balance in Unit Operations and System boundaries; Solving examples on energy balances; Solving problems on electrical energy use and management: Connected load, Maximum demand, Demand factor and Load curve; Determination of Load factor of an installation; Study of use of power factor meter and determination of true power and wattles power by using PF meters, Watt meter, Ammeter and Volt meter; Study of performances of a general type of induction motor and an energy efficient induction motor; Study of use of VSD; Study of various types of electrical appliances classified under different BEE Star Ratings; Drawing Energy Balance on a boiler: Collection of data, Analysis of results and determination of efficiency; Exercise on energy audit of a Dairy plant.

Suggested Readings

1. Tufail Ahmand. 2012. *Dairy Plant Engineering and Management*. Kitab Mahal Publisher, NewDelhi.
2. Klemeš Jiři, Smith Robin and Kim Jin-Kuk. 2008. *Handbook of Water and Energy Management in Food Processing, A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition*. Elsevier Science Ltd., Burlington, MA, USA..

3. Wang Lijun. 2008. Energy *Efficiency and Management in Food Processing Facilities*. RC Press, Boca Raton, FL, USA.
4. Paul O'Callaghan. 1993. *Energy Management*. McGraw- Hill Book Company Europe, Shppenhangers Road, England.

Applications of Renewable Energy in Food Processing 2 (1+1)

Objective

To equip students with the knowledge about the alternative and renewable sources of energy available for operating of a food processing industry

Theory

Introduction to energy sources; classification of renewable energy sources, utilization of these sources in food processing sector; Solar radiation, measurement of solar radiation, types of solar collectors and their uses; familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; utilization of solar thermal energy in food processing; Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry; Biomass and its characterization; briquetting of biomass. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry and biodiesel preparation; Importance of biogas technology, production mechanism, types of biogas plants, uses of biogas, handling and utilization of digested slurry. Use of food waste for biogas generation and its applications; Brief introduction to wind energy, hydroelectric energy, ocean energy.

Practical

Study of solar radiation measuring instruments; Study of solar cooker; Study of solar water heater; Study of solar dryer; Study of solar PV system; Estimation of calorific value of biomass; Estimation of moisture content of biomass; Estimation of ash content of biomass; Estimation of fixed carbon and volatile matter of biomass; Study of briquetting machine; Demonstration of up draft gasifier; Demonstration of down draft gasifier; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum type biogas plants; Demonstration of biodiesel preparation; Demonstration of wind measuring instruments.

Suggested Readings

1. Khandelwal K C and Mahdi S S. 1990. Biogas Technology- A Practical Handbook.
2. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, Delhi.
3. Rai G D. *Solar Energy Utilization*. Khanna Publishers, Delhi.
4. Rathore N S, Kurchania A K, Panwar N L. 2007. *Non-Conventional Energy Sources*. Himanshu Publications, New Dehli.
5. Rathore N S, Kurchania A K, Panwar N L. 2007. *Renewable Energy, Theory and Practice*. Himanshu Publications, New Dehli.
6. Tiwari G N and Ghoshal M K. 2005. *Renewable Energy Resources: Basic Principles and Applications*. Narosa Pub. House. Delhi.

Food Plant Design and Layout 3 (2+1)

Objective

To equip students to effectively design food processing plant incorporating the appropriate machinery, equipment, utility services, conforming to the legal standards.

Theory

Introduction Classification of food processing plants, food plant design concepts, situations giving rise to plant design problems and general design considerations (technical, economic, legal, safety and hygiene). Feasibility Study Steps involved in feasibility study, collection of the information, information flow diagrams, market analysis, technical analysis and preparation of feasibility report.

Plant Location Factors affecting plant location, their interaction with plant location, location theory models for evaluation of alternate locations. Plant Size Economic plant size, factors affecting the plant size (technical and economical), raw material availability, market demand, competition in the market, return on investment etc. Procedures for estimation of economic plant size (breakeven analysis and optimization), estimation of volume of production for each product.

Product and Process Design; Design of product, product specifications, least cost mix of raw materials, process design, process selection considering technical, economic and social aspects. Process planning and scheduling, flow sheeting, flow diagrams and process flow charts including their design and computer aided development of flow charts.

Selection of Equipment Process equipment, material handling equipment, service equipment, instruments and controls, considerations involved in equipment selection, economic analysis of equipment alternatives using optimization techniques and cash flows, economic decision on spare equipment, prediction of service life of the equipment.

Plant Layout Types of layouts, considerations involved in planning an efficient layout, preparation and development of layout, evaluation of alternate layouts, use of computers in development and evaluation of layouts, equipment symbols, flow sheet symbols, electric symbols, graphic symbols for piping systems, standards for space requirement and dimensions, distances between critical plant areas and for different plant facilities.

Planning and Design of Service Facilities and Plant Surroundings Requirements of the steam, refrigeration, water, electricity, waste disposal, lighting, ventilation, drainage, CIP system, dust removal, fire protection etc. Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe colouring. Planning of offices, laboratories, lockers and toilet facilities, canteen, parking lots and roads, loading docks, garage, repair and maintenance shop, ware houses etc.

Workers Safety and Health Aspects Falling hazards and safeguards, electric hazards, heat exposure, dust protection, noise control, protection against chemicals, fire safety, fumes, moist conditions, personnel hygiene, sanitary requirements and standards, insect, rodent and bird control.

Building and Building Materials Requirements in respect of building type, wall, ceiling and floor construction, building height and building materials.

Practical

Prepare a feasibility report, prepare a plant location report, study design and layout of milk processing plant, study design and layout of fruit processing plant, To study design and layout of beverage plant, study design and layout of meat and meat products plant, To study design and layout of bakery and confectionery plant, study design and layout of grain processing plant, study design and layout of cold storage and warehouse, Design and layout of milk processing plant, Design and layout of fruit processing plant, Design and layout of beverage plant, Design and layout of meat and meat products plant, Design and layout of bakery and confectionery plant, Design and layout of grain processing plant, Design and layout of cold storages and warehouses.

Suggested Readings

1. Perry R H and Green Don W. 2007. *Perry's Chemical Engineering Handbook*. (8th Edn.). McGraw-Hill, Inc., NY, USA.
2. Villbrandt F C and Dryden C E. 1959. *Chemical Engineering Plant Design*. McGraw-Hill, Inc., NY, USA.
3. Leesley M E. 1982. *Computer Aided Process Plant Design*. Gulf Publishing Company, Houston.
4. Morris W T. 1976. *Engineering: Economic Analysis*. Reston Publishing Company, Inc., New York.
5. Maroulis Z B and Saravacos G D. 2003. *Food Plant Economics*. CRC Press, Boca Raton, FL, USA.
6. Peters M S and Timmerhaus K D. 2003. *Plant Design and Economics for Chemical Engineers*. McGraw-Hill, Inc., NY, USA.
7. Moore J M. 1962. *Plant Layout and Design*. Macmillan Publisher, London.
8. Backhusrt J R and Harker J H. 1973. *Process Plant Design*. Heimann Educational Books, London.
9. Clifton D S and Fyfee D E. 1977. *Project Feasibility Analysis*. John Wiley and Sons, New York.
10. Rosenau M D. 1984. *Project Management for Engineers*. Lifetime Learning Publications, New Delhi.

Waste and By-Products Utilization 3 (2+1)

Objectives

i. To understand the nature of agricultural wastes and their impact on the environment
ii. To conceptualize physical, chemical and biological basis of agricultural waste treatment
iii. To analyse and design systems for the collection, handling, treatment and utilization of wastes
iv. To understand the waste treatment processes

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from food industry, rice mill, sugarcane industry, oil mill etc.

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues. Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; biofuels and ethanol, packaging material through recycling. Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting. Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal. Assessment, treatment and disposal of solid waste; Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water. Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash. Study about briquetting of agricultural residues. Estimation of excess air for better combustion of briquettes. Study of extraction of oil from rice bran. Study on bioconversion of agricultural wastes. Recovery of germ and germ oil from by-products of cereals. Visit to various industries using waste and food by-products.

Suggested Readings

1. Bhatia S C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.
2. Garg S K. 1998. *Environmental Engineering* (Vol. II – *Sewage Disposal and Air Pollution Engineering)*. Khanna Publishers, New Delhi
3. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment and Utilization Technology*. New India Publishing Agency, New Delhi.
4. Markel I A. 1981. *Managing Livestock Waste.* The AVI Publishing Company, Inc., Connecticut, USA. AVI Publishing Co.
5. Pantastico E C B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables.* The AVI Publishing Company, Inc., Connecticut, USA.
6. Prashar A and Bansal P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
7. Shewfelt R L and Prussi S E. 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc., USA.
8. USDA. 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
9. Weichmann J. 1987. *Post-Harvest Physiology of Vegetables*. Marcel and Dekker Verlag, New York..
10. Vasso O and Winfried R (Eds.). 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science and Business Media, LLC 233 New York.

SEMESTER-VIII			
1	Student READY: (Internship (at Industry/ Research Institutes/In plant training/Hands-on-training experiential learning student project etc.) (20 weeks)	20 (0+20)	**20 (0+20)**

SKILL ENHANCEMENT COURSES (SUGGESTIVE)

1. Introduction to Drying Technology and Dryers
2. Introduction to Processing of Extruded Foods
3. Introduction to Milling (Rice, Dal, Spices, etc.)
4. Introduction to Electrical and Control Systems in Food Industry
5. Introduction to Mechanical Systems in Food Industry
6. Introduction to AutoCAD
7. Introduction to Food Safety and Sanitation
8. Introduction to Good Laboratory Practices
9. Basic Food Analysis Laboratory Techniques
10. Maintenance of Food Processing Equipment
11. Introduction to Bottling and Canning Line
12. Introduction to Manufacturing of Bakery Products

* HAEI can develop their own courses as per the need & expertise

ONLINE COURSES

(6 credit hours)

Guidelines for taking the online courses

- The students will have to take a minimum of 6 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Food Technology) program.
- The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.
- The courses can be taken preferably during the third year and 4th year of the UG program as per choice of students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered/ approved at the University level. The final transcript will indicate the title of courses taken by the student and the total weeks.

Minimum Standards for Establishing a College of Food Technology

- **Degree Nomenclature:** B. Tech. (Food Technology)

1. **Minimum intake (per year):** 60
2. **Faculty**:

A. Core faculty: 21

Food Processing Technology (0+2+4), Food Safety and Quality Assurance (0+1+2), Food Process Engineering (0+1+4), Food Business Management (0+1+1), Food Plant Operations (0+1+4)

B. Allied faculty: Faculty for Mathematics, computer science, Sociology, Psychology, English, Food Science and Technology, Microbiology, Agrometerology and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. **Land requirement (ha):** 4
4. **Essential Instructional units:**
   - Pilot plants as ELUs
   - Namakin line
   - Juice line
   - Canning line
   - Driers
   - Extrusion line
   - Laboratories and instructional facilities as per V Deans' Committee report.
   - ELP units to be established under skill development or Entrepreneurial mode- 0.5 ha.
5. **Divisons/Departments/Sections:**
   - Department of Food Processing Technology
   - Department of Food Safety & Quality Assurance
   - Department of Food Process Engineering
   - Department of Food Business Management
   - Department of Food Plant Operations
6. **Non- Teaching Staff:**

Department	Supporting staff		
	Office Assistant	Lab Technician	Lab Attendant
Food Process Technology	1	6	2
Food Safety and Quality Assurance	1	4+2*	2
Food Process Engineering	1	4+4**	2
Food Business Management	1	2	2
Food Plant Operations	1	6***	6
Total	**5**	**28**	**14**

* For basic sciences, humanities subjects (One each for English, Chemistry, Microbiology, Mathematics, Statistics, Agriculture)

** For basic engineering subjects (one each for Mechanical, Electrical, Computer, Electronics & Instrumentation, Civil Engineering)

*** Pilot Plant Operators & Mechanics.

Administrative Staff for College

Office	Position	Number	Remarks
Main	Dean/Assoc. Dean/Principal	1	
College	Administrative cum Accounts Officer or Asstt. Registrar	1	
Office	PS to Dean/Principal	1	
	Senior Clerk	4	1 Admin, 1 Estt., 1 Accounts, 1 Academics
	Junior Clerk Store keeper	4 1	1 Admin, 1 Estt., 1 Accounts, 1 T&P
	Attendant	3	
	Driver	2	1 each for car & bus
Hostels &	Hostel Assistant Warden	2	1 Male & 1 Female
Students	Hostel Attendant	2	1 Male & 1 Female
Welfare	Physical Instructor	1	Physical Education

8. Staff for College Library

Designation	Number
Assistant Librarian	1
Library Assistant	1
Clerk	1
Shelf Assistant	2

9. Department wise Name of Laboratories

The following can be the nomenclature of the teaching laboratories;

S. No.	Name of Department	Name of Laboratory
1.	Food Processing Technology	Food Process Technology Lab, Food Product Development Lab, Dairy Technology Lab Meat and Fish Processing Lab, Packaging Technology Lab, Food Rheology and Sensory Lab
2.	Food Safety and Quality Assurance	Food Chemistry Lab, Food Microbiology Lab Food Biotechnology Lab, Food Analytics Lab
3.	Food Process Engineering	Heat and Mass Transfer Lab, Fluid Mechanics Lab' Unit Operations Lab Mechanical Workshop, Electrical and Electronics Engineering Lab, Instrumentation and Process Control Lab, Drawing Hall
4.	Food Business Management	Language Lab Computer Lab Personality Development Lab Technology Transfer Lab/ Prototype Lab
5.	Food Plant Operation	Experiential Learning Units / Pilot plants

10. Building Floor Space Requirement:

S. No.	Description	Number	Dimension (ft)
1.	Dean/Principal office	01	20 × 40
2.	Main administrative office	01	40 × 60
3.	Head of department	05 (one for each department)	15 × 20 each
4.	Dept. Admin. Office	05	15 × 20
5.	Faculty room	-	10 × 12 for each faculty
6.	UG smart class room	04	Seating capacity of 60
7.	PG smart class room	as per requirement	
8.	Examination hall	02	Seating capacity of 120
9.	Laboratories	21	30 × 40 each
10.	Seminar room	01	Seating capacity of 150
11.	Meeting room	01	Seating capacity of 50
12.	Common room for students	02	15 × 20 each
13.	Auditorium	01	As per requirement
14.	NCC/NSS/Student welfare office	01	15 × 20 each
15	Library	01	-
16.	ELP Building	02	As per the requirement of pilot plants
17.	Gymnasium, indoor games, Outdoor facilities 01	-	
18.	Canteen	01	-
19.	Toilets	Sufficient numbers	At every wing/floor
20.	Parking space	as per requirement	For college and hostels
21.	Hostel	2	1 for Boys1 for Girls
22.	DG set shed	as per requirement	

Vehicles -

1. Office car
2. Student Bus
3. Mobile refrigerated vehicle

11. Department wise list of Minimum Equipment/Instruments in Laboratories

1) Department of Food Process Technology

S. No.	Name of Equipment
1.	Fruit/ vegetable Blancher
2.	Exhaust Box
3.	Retort system
4.	Kettle (steam jacketed)
5.	Steam generator
6.	Fruit/vegetable peelers
7.	Homogenizer
8.	Mixers
9.	Fruit cutting/ slicing machine

S. No.	Name of Equipment
10.	Spice mixing machine
11.	Dough Mixer
12.	Dough divider
13.	Table Sheeter
14.	Dough moulds
15.	Baking oven
16.	Bread slicer
17.	Pasta making machine
18.	Laboratory ovens
19.	Cooling chamber
20.	Pouch sealing machine
21.	Lab Roller dryer
22.	Lab Spray dryer
23.	Lab Tray dryer
24.	Lab Fluidized bed dryer
25.	Lab Vacuum dryer
26.	Lab Cabinet dryer
27.	Lab freeze dryer
28.	Foam mat dryer
29.	Grain dryer
30..	Osmotic dryer
31	Weighing machines
32.	High precision digital balance
33.	Muncell colour chart
34.	Lovibond tintometer
35.	Hunter colour lab meter
36.	Disc colour meter
37.	Portable chromameter
38.	Viscometer
39.	Shrink wrap packaging machine
40.	Form fill and sealing machine
41.	Vacuum packaging machine
42.	Heat sealing machine
43.	Fruit/ vegetable sorter
44.	Fruit/ vegetable Grader
45.	Vernier callipers of different sizes
46.	Colour dictionary chart for grain
47.	Angle of repose unit
48.	Hardness tester
49.	Soxhlet apparatus
50.	Kjeldahl apparatus

S. No.	Name of Equipment
51.	Muffle furnace
52.	pH meter
53.	Refractometers for different ranges
54.	Incubator
55.	Germinator
56.	Laboratory modern rice mill
57.	Laboratory modern dhal mill
58.	Flaking machine
59.	Popcorn machine
60.	Falling number apparatus
61.	Lab oil expeller
62.	Farinograph
63.	Sieve analysis set up
64.	Hammer mill
65.	Modem wheat milling machine
66.	Extruder
67.	Meat mincer
68.	Plate freezer
69.	Meat cutter/ chopper
70.	Conching unit
71.	Cocoa roaster
72.	Cocoa tempering unit
73.	Chocolate moulder
74.	Rolling machine
75.	S.S. utensils (pan/ fry pan/*kadhai*/ spoon plates/ knife, etc)
76.	Basket press
77.	Screw type juice extractor
78.	Centrifugal Juice extractor
79.	Hydraulic press
80.	Fruit Pulper/ Crusher
81.	Juice dispensing machine
82.	Bottle filling machine
83.	Bottle washing machine
84.	Crown corking machine
85.	Texture analyser
86.	Gas chromatography unit
87.	Respirometer
88.	Sensory evaluation set
89.	Milkotester
90.	Gerber butyrometer
91.	Cream separator

S. No.	Name of Equipment
92.	Butter making machine
93.	Ice cream machine
94.	Khoa making machine
95.	Multiple effect evaporator
96.	Cryoscope
97.	Melting point apparatus
98.	Double distillation unit
99.	Scavengerapparatus
100.	Polarimeter
101.	Ultrafiltration system
102.	Water analysis unit (kit)
103.	Density meter
124.	TDS meter
105.	Conductivity meter
106.	Water baths
107.	Autoclave
108.	Carbonation unit
109.	BOD incubators
110.	Bomb calorimeter
111.	Rotary Shaker
112.	Puncture resistance tester
113.	Bursting strength tester
114.	Tearing strength tester
115.	Tensile testing machine
116.	Box compression tester
117.	Drop tester
118.	Modified atmospheric storage
119.	Super critical fluid extraction system
120.	Rotary vacuum evaporator
121.	Lab IQF system
122.	Small Cold storage
123.	Laboratory Fermenter
124.	Microwave ovens
125.	Moisture meters

2) Department of Food Process Engineering

S. No.	Name of Equipment
1.	Flow over notches apparatus
2.	Bernoulli's apparatus
3.	Reynolds apparatus

S. No.	Name of Equipment
4.	Flow measurement by venturi meter and orifice meter
5.	Centrifugal pump (model)
6.	Reciprocating pump(model)
7.	Gear pump model
8.	Submersible pump
9.	Positive displacement pump
10.	Fluid friction measurement devices
11.	Minor head loss apparatus
12.	Model of Lancashire boiler
13.	Model of Packaged Boiler/ model
14.	Model of Babcock and Wilcox boiler
15.	Vertical water tube boiler
16.	Solar water heater
17.	Steam jet condenser: parallel flow
18.	Steam jet condenser: counter flow
19.	Surface condenser
20.	Evaporative condenser
21.	Shell and tube heat exchanger
22.	Plate Type Heat Exchanger
23.	Double pipe heat exchanger
24.	Natural convection apparatus
25.	Forced convection apparatus
26.	Thermal conductivity apparatus for solid and liquid
27.	Working model of belt conveyor
28.	Working model of bucket conveyor
29.	Working model of chain conveyor
30.	Working model of screw conveyor
31.	Universal testing machine
32.	Ball fall viscometer
33.	Capillary tube viscometer
34.	Rotational viscometer
35.	Model of multiple effect evaporator
36.	Rotary vacuum flash evaporator
37.	Cabinet drier
38.	Screw gauges
39.	Vernier calipers
40.	Micrometers
41.	B.O.D. incubators
42.	Desiccators

S. No.	Name of Equipment
43.	Refrigerated centrifugal machine
44.	Ultra filtration apparatus
45.	Micro wave oven
46.	Infra red moisture meter
47.	Universal moisture meter
48.	Hammer mill
49.	Magnum mill
50.	Colloid mill
51.	Ball mill
52.	Sieve analyser
53.	Vapour compression refrigeration cycle
54.	Refrigeration tutor
55.	Air-conditioning tutor
56.	Model of ammonia ice plant
57.	Model of cooling tower
58.	Water baths
59.	Ammeters
60.	Voltmeters
61.	Wattmeters
62.	Wet and dry bulb thermometers
63.	Hygrometers
64.	Anemometer with digital display
65.	Pressure measurement devices
66.	Different manometers
67.	U tube double column Manometer
68.	Multimeters
69.	Clamp-on meters
70.	Portable energy meters
71.	Pyranometer
72.	Transducers
73.	Flow meters
74.	Particle size analyser
75.	Dielectric Properties Analyzer
76.	Microwave power leakage detector
77.	Industrial PID controller and PLC units
78.	Agitation and mixing system
79.	Crystallizer
80.	CNC lathe machine
81.	Grinding machine

S. No.	Name of Equipment
82.	Drilling machines
83.	Welding machines
84.	Student drawing boards
85.	Electronics engineering tutor set
86.	Electrical engineering tutor set
87.	Process control tutor set

3) Departments of Food Safety & Quality

S. No.	Name of Equipment
1.	Different Microscopes
2.	Autoclave
3.	Hot Air Ovens
4.	Vacuum ovens
5.	Colony Counter
6.	Rotary Shaker
7.	Lab Centrifuge
8.	Deep Freezers of different temperature ranges
9.	Laminar Flow Unit
10.	Water Baths
11.	Oil baths
12.	BOD incubators
13.	Ozone washer
14.	Distillation Unit
15.	Lab Scale Fermentor
16.	Serological water bath
17.	Water distillation unit
18.	Digital weighing balances
19.	pH meter
20.	Protein digestion unit
21.	Protein distillation unit
22.	Soxhlet unit
23.	Desiccators
24.	Digital moisture meter
25.	Protein estimation assembly
26.	Digital pH meter
27.	Digital Thermometers
28.	Muffle Furnace
29.	Spectrophotometer
30.	Vortex mixture
31.	Colorimeter

S. No.	Name of Equipment
32.	Bomb calorimeter
33.	Vacuum flash evaporator set
34.	Paper Chromatography set
35.	Thin layer Chromatography Set
36.	Paper electrophoresis unit
37.	Magnetic stirrer with hot plate
38.	Roto-viscometer
39.	Flame photometer
40.	Gas chromatography system
41.	HPLC system
42.	Refrigerated centrifuge

4) Department of Food Business Management

1. A set of computer server, working nodes, printer for 25 students
2. Language lab set with audio management system for 25 students
3. LCD projectors with screens and other accessories
4. LED display systems
5. Internet connectivity with Wi-Fi component

5) Department of Plant Operations: A set of pilot plants adequately equipped as ELUs

AGRICULTURAL ENGINEERING

Course Curricula for Undergraduate Programme in Agricultural Engineering: UG-Certificate in Agricultural Engineering: UG-Diploma in Agricultural Engineering; B. Tech. (Agricultural Engineering)

INTRODUCTION

In the recent years, the technological developments in agricultural engineering have seen rapid momentum, specifically in the fields of precision agriculture, high-efficiency irrigation systems, farm energy systems, remote sensing and geographical studies, etc. Digital agriculture, smart farming systems, internet of things (IoT), sensors, automation and robotics, etc. are finding more and more applications. Intelligent machines and autonomous vehicles are being introduced to increase efficiency and reduce environmental impact. There is a focus on optimizing food processing operations through the measurement of food properties, innovations in equipment design and advancements in heat and mass transfer. Agricultural engineering has also expanded to include environmental aspects, with a focus on sustainable agricultural systems and the integration of expertise from various engineering fields with biological and socio-economic sciences. In addition, to address the challenges such as increasing agricultural production, the discipline is evolving to meet the needs of sustainable development, such as improved food security and reduced poverty, and reducing gaseous emissions from agricultural production, which have been contributing towards the UN Sustainable Development Goals. Progress in agricultural engineering technologies and related applications has been leading to the globalization of agricultural mechanization and modernization. Even in the developing countries, agricultural engineering is playing a major role for moving towards more commercialization of agriculture. Hence, the education and research in agricultural engineering is of paramount importance in the present context.

However, the actual benefits of these can be properly harvested only if the students have sound exposure to the latent developments in the field in addition to having due acquaintance with the traditional and

indigenous knowledge in the related fields. Also, it is imperative that the students acquire both professional and soft skills to contribute to the proper adoption of technologies by the society. It will also make the students more acceptable and fitting as a leader of change that the society strives to see in the next generation graduates.

In view of these, the restructuring of undergraduate programs in Agricultural Engineering has been carried out as per NEP-2020 guidelines. It is aimed to build among students a strong foundation of knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge. The restructured course curriculum aims at strengthening critical thinking, creativity, communication and collaboration among students. More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has also been made for advanced skill development through project work or experiential learning/ incubation, etc. These activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and critical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

The details of the course structure for the Undergraduate courses in Agricultural Engineering (UG-Certificate, UG-Diploma and B. Tech.) have been prepared after having multistage in-depth deliberations and discussions with the deans and faculty members of the Agricultural Engineering discipline of different SAUs and CAUs, stakeholders from related industries, Govt. institutions and alumni. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The B. Tech. (Agricultural Engineering) programme will be of 180 credits, which includes 174 credits offered by the parent institute and 6 credits of online courses (to be taken by the student as per his/her/ze choice). In addition, there will be four credits of two non-gradial courses (*Deeksharambh* (Introduction-cum-Foundation course): 2 credits and Study tour: 2 credits).
- After the admission of students in the university, the students will register for the *Deeksharambh* of two weeks' duration in the 1st semester. The course will include, but not restricted to, discussions on operational framework of academic process in university, interactions with alumni, business leaders, scientists and employers, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the course is dedicated for skill development/ enhancement in agricultural engineering sector with a few introductory courses. After satisfactory completion of 1st year

(two semesters) and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award *of UG-Certificate in Agricultural Engineering* on exit. The students continuing the study further, would not have to attend the internship after 1st year.

- The second year has been designed with the basic engineering courses as well as fundamental courses in agricultural engineering with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural engineering. After satisfactory completion of the courses of 2nd year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of *UG-Diploma in Agricultural Engineering* on exit. The students continuing the study further, would not have to attend the internship after 2nd year.
- The Skill Enhancement courses will be offered in three stages. In the first year, the course entitled Skill Enhancement (8 credits) will aim at skill enhancement for employment and entrepreneurship. The students will have flexibility and choice in selection of skill areas from a basket of skill enhancement modules to be offered/ listed by the parent institute. After two to three days' common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.
- In the final year, the Project-I (3 credits in 7th semester) and Project-II (4 credits in 8th semester) are meant for advanced skill development for research, employment and entrepreneurship. Under these courses, the student will have the option to take up a research project (R and D based, field study based) for developing research skills in form of project or take up incubation/ experiential learning-based activity for entrepreneurship development. The Project-I and II can also be taken up in collaboration with any organization/ industry.
- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/companies/ NGOs/ progressive entrepreneurs for running the skill enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.
- The third year and fourth year courses have been designed to impart specialized knowledge to the students in the major disciplines. In the final year, the student will have the liberty to choose any three elective subjects, preferably from one or related disciplines. The objective is to enable the student to acquire deeper understanding in any particular field.

- There will be adequate choice of electives/ specialized courses for the students. The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The student may also opt any relevant course offered in the same semester by other constituent colleges of the HAEI as Elective.
- In the final year, the students will also undergo an 8-week In-plant training/ research internship to expose them to real working situations in industry/ research institutions. In-plant training may be conducted in split manner in more than one industry/ organization/ institute.
- During the 5th semester, the students will have a study tour of 10-14 days duration, which will be counted as 2 credits (Non-gradial).
- The students will take a minimum of 6 credits of online courses (any one or more courses totaling at least 24 weeks or 80 hours' duration) during the third and fourth year as a partial requirement for the B. Tech. (Agricultural Engineering) programme. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.
- At each stage of exit (UG-Certificate/ UG-Diploma and B. Tech.), the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own enterprise. The social skills acquired by the students will also make the students more empathetic towards the society and social issues.
- The credits (and contact hours) have been proposed in such a way that class room teaching can be accommodated in 5 days in a week. On Saturdays, the students will take up activities as NSS/ NCC, 'Physical Education, First Aid, Yoga Practices and Meditation during the 1st and 2nd year. The courses as Seminar and Case study (with analysis and presentation of findings in seminars as well as in reports form) will be taken in the 3rd year. This will increase their acquaintance with the social/ technical problems, improve their analytical ability of the issues/ challenges and enhance their social responsibility. However, these are suggestive only and the Universities can plan their timetables as per the local facilities/ university norms and needs.
- In case, the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, the students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

Entry and Exit Options

The entry and exit options for the B.Sc. (Hons.) programs in Agricultural Engineering are shown in the Figure 1 below:

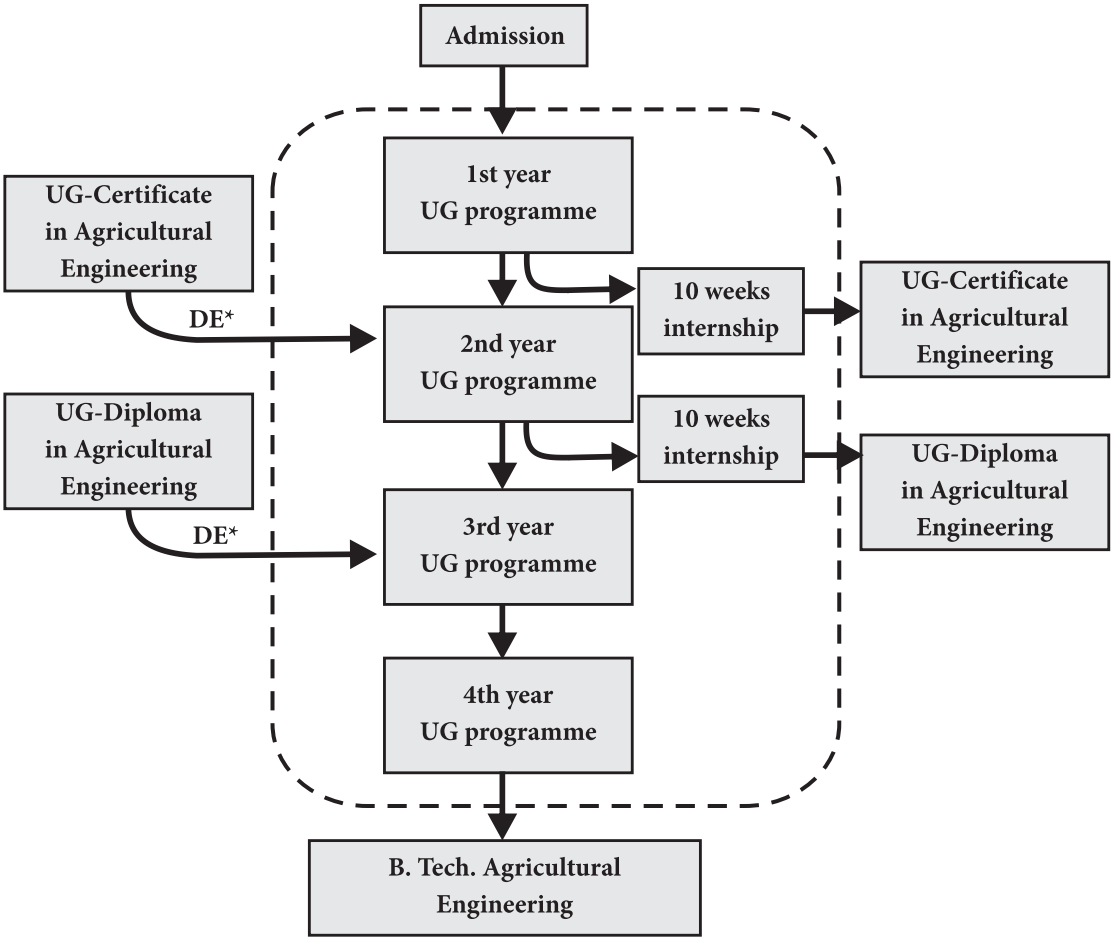


Fig. 1 Entry and Exit options for the UG programs in Agricultural Engineering

***Direct Entry in the respective year**

Exit options

- **UG-Certificate (Agricultural Engineering)** (exit after first year and completion of 10 weeks' internship).
- **UG-Diploma (Agricultural Engineering)** (exit after second year and completion of 10 weeks' internship).
- **B. Tech. (Agricultural Engineering)** (on successful completion of four-year degree requirements).

Admission eligibility in Ist year UG programme: 10+2 Science with Mathematics from Central/State Board/University as one subject or as per the criteria decided by the ICAR/ SAU/HAEI.

The Universities may consider allowing lateral entry for the candidates having diploma in Agricultural Engineering (as such courses are available in many states and lateral entry is practiced in some Universities). In such cases, the candidates having diploma in Agricultural Engineering (with minimum 3 years course programme after 10th or equivalent) may be allowed admission into the 2nd year of the UG programme, as per the provisions to be notified by the respective AU from time to time.

ACADEMIC PROGRAMME

Semester wise course distribution

S. No.	Course Title	Credit Hours	Total Credit hours
First Year			
Semester-I			
1	*Deeksharambh*	0+2 (NG) Non-gradial	**20 (11+9)**
2	Crop Production and Protection Technologies	4 (3+1)	
3	Introduction to Agricultural Engineering	4 (3+1)	
4	Surveying and Levelling	3 (1+2)	
5	Workshop Technology and Practice	2 (0+2)	
6	Basic Electrical Gadgets and Instruments	3 (2+1)	
7	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8	NSS- I/ NCC- I	1 (0+1)	
Semester-II			
1	Skill Enhancement	8 (0+8)	**21 (5+16)**
2	Engineering Drawing	2 (0+2)	
3	Computer Programing and Data Structures	2 (0+2)	
4	Farming Based Livelihood Systems	3 (2+1)	
5	Environmental Studies and Disaster Management	3 (2+1)	
6	Communication Skills	2 (1+1)	
7	NSS-II/ NCC- II	1 (0+1)	
Post Ssemester-II			
1	Internship (for 10 weeks, only for exit option for award of UG-Certificate)	10 (0+10)	
Second Year			
Semester- III			
1	Engineering Mathematics- I	3 (3+0)	**25 (16+9)**
2	Engineering Physics	3 (2+1)	
3	Engineering Chemistry	3 (2+1)	
4	Engineering Mechanics	3 (2+1)	
5	Soil Mechanics	2 (1+1)	

S. No.	Course Title	Credit Hours	Total Credit hours
6	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	
7	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	
8	Farm Machinery & Equipment- I	3 (2+1)	
9	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
	Semester-IV		
1	Engineering Mathematics-II	3 (3+0)	
2	Theory of Structures	2 (1+1)	
3	Building Construction & Cost Estimation	2 (2+0)	
4	Watershed Hydrology	3 (2+1)	
5	Soil and Water Conservation Engineering	3 (2+1)	**25 (18+7)**
6	Farm Machinery & Equipment II	3 (2+1)	
7	Renewable Energy Sources	3 (2+1)	
8	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
9	Entrepreneurship Development and Business Management	3 (2+1)	
	Post Semester-IV		
1	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10 (0+10)	
	Third Year		
	Semester-V		
1	Strength of Materials	2 (1+1)	
2	Theory of Machines	2 (2+0)	
3	Thermodynamics and Heat Transfer	3 (3+0)	
4	Tractor & Automotive Engines	3 (2+1)	
5	Irrigation and Drainage Engineering	4 (3+1)	**21 (15+6) +2 (Non-gradial)**
6	Food and Dairy Engineering	4 (3+1)	
7	Personality Development	2 (1+1)	
8	Seminar	1 (0+1)	
9	Study tour (10-14 days)	2 (0+2) NG	
	Semester-VI		
1	Tractor Systems & Controls	3 (2+1)	
2	Groundwater, Wells and Pumps	3 (2+1)	
3	Sensors, Artificial Intelligence and Robotics in Agriculture	3 (2+1)	
4	Agricultural Structures & Environment Control	3 (2+1)	
5	Bioenergy Systems: Design and Applications	3 (2+1)	**21 (13+8)**
6	Refrigeration and Air-conditioning	3 (2+1)	
8	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
9	Case Study	1 (0+1)	

S. No.	Course Title	Credit Hours	Total Credit hours
Fourth Year			
Semester-VII			
1	Project- I	3 (0+3)	**20 (10+10)**
2	Engineering Graphics and Design	2 (0+2)	
3	Food Quality and Safety	3 (2+1)	
4	Watershed Planning and Management	3 (2+1)	
5	Sprinkler & Micro Irrigation Systems	2 (1+1)	
6	Machine Design	2 (2+0)	
7	Electrical Machines	3 (2+1)	
8	Agricultural Statistics and Data Analysis	2 (1+1)	
Semester-VIII			
1	Project -II	4 (0+4)	**21 (6+15)**
2	In-plant Training/ Research Internship	8 (0+8)	
4	Elective- I	3 (2+1)	
3	Elective- II	3 (2+1)	
4	Elective- III	3 (2+1)	
		TOTAL	**174 (94+80)**
	*On-line courses	6	**6**
		Grand Total	**174+6***

Department/ section wise course breakup

S. No.	Course Title	Credit hours	Total
Foundation courses/ Ability Enhancement Courses, etc.			
1	Deeksharambh	0+2 (Non-gradial)*	4 (0+4)
2	NSS-I/ NCC - I	1 (0+1)	
3	NSS-I/ NCC - II	1 (0+1)	
4	Physical Education, First Aid, Yoga Practice & Meditation	2 (0+2)	
Basic Agriculture			
1	Crop Production and Protection Technologies	4 (3+1)	12 (8+4)
2	Farming Based Livelihood Systems*	3 (2+1)	
3	Environmental Studies and Disaster Management*	3 (2+1)	
4	Agricultural Statistics and Data Analysis	2 (1+1)	
Social Sciences			
1	Communication Skills*	2 (1+1)	7 (4+3)
2	Personality Development*	2 (1+1)	
3	Entrepreneurship Development and Business Management*	3 (2+1)	

S. No.	Course Title	Credit hours	Total
	Common Agricultural Engineering		
1	Introduction To Agricultural Engineering	4 (3+1)	6 (3+3)
2	Seminar	1 (0+1)	
3	Case Study	1 (0+1)	
4	Study Tour	2 (0+2) NG*	
	Skill Enhancement Courses/ Project		
1	Skill Enhancement	8 (0+8)	15 (0+15)
2	Project- I	3 (0+3)	
3	Project- II	4 (0+4)	
	In-plant training/ Internship		
1	Internship only for exit option with UG-Certificate	10 (0+10)#	8 (0+8) #Credits not included in the total credits calculated for B. Tech. programme
2	Internship only for exit option with UG-Diploma	10 (0+10)#	
3	In-plant Training/ Research Internship	8 (0+8)	
	Basic Sciences		
1	Engineering Mathematics- I	3 (3+0)	12 (10+2)
2	Engineering Mathematics- II	3 (3+0)	
3	Engineering Physics	3 (2+1)	
4	Engineering Chemistry	3 (2+1)	
	Agricultural Structures and Civil and Environmental Engineering		
1	Surveying and Levelling	3 (1+2)	17 (10+7)
2	Engineering Mechanics	3 (2+1)	
3	Soil Mechanics	2 (1+1)	
4	Theory of Structure	2 (1+1)	
5	Building Construction and Cost Estimation	2 (2+0)	
6	Strength of Materials	2 (1+1)	
7	Agricultural Structures and Environmental Control	3 (2+1)	
	Mechanical Engineering		
1	Workshop Technology and Practices	2 (0+2)	16 (9+7)
2	Engineering Drawing	2 (0+2)	
3	Theory of Machines	2 (2+0)	
4	Thermodynamics and Heat Transfer	3 (3+0)	
5	Refrigeration and Air Conditioning	3 (2+1)	
6	Machine Design	2 (2+0)	
7	Engineering Graphics and Design	2 (0+2)	
	Electrical and Electronics Engineering		
1	Basic Electrical Gadgets and Instruments	3 (2+1)	6 (4+2)
2	Electrical Machines	3 (2+1)	

S. No.	Course Title	Credit hours	Total
Computer Science and Engineering			
1	Agricultural Informatics and Artificial Intelligence*	3 (2+1)	8 (4+4)
2	Computer programming and data structures	2 (0+2)	
3	Sensors, Artificial Intelligence and Robotics in Agriculture	3 (2+1)	
Farm Machinery and Power Engineering			
1	Farm Machinery and Equipment- I	3 (2+1)	12 (8+4)
2	Farm Machinery and Equipment- II	3 (2+1)	
3	Tractor and Automotive Engines	3 (2+1)	
4	Tractor Systems and Controls	3 (2+1)	
Renewable Energy Engineering			
1	Renewable Energy Sources	3 (2+1)	6 (4+2)
2	Bio-energy Systems: Design and Applications	3 (2+1)	
Soil and Water Conservation Engineering			
1	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	12 (8+4)
2	Watershed Hydrology	3 (2+1)	
3	Soil and Water Conservation Engineering	3 (2+1)	
4	Watershed Planning and Management	3 (2+1)	
Irrigation and Drainage Engineering			
1	Irrigation and Drainage Engineering	4 (3+1)	9 (6+3)
2	Groundwater, Wells and Pumps	3 (2+1)	
3	Sprinkler and Micro Irrigation Systems	2 (1+1)	
Processing and Food Engineering			
1	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	15 (10+5)
2	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
3	Food and Dairy Engineering	4 (3+1)	
4	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
5	Food Quality and Safety	3 (2+1)	

* Common courses across the disciplines

ELECTIVE COURSES

1	Mechanics of Tillage and Traction	3 (2+1)	9 (any three courses to be chosen)
2	Farm Machinery Design and Production	3 (2+1)	
3	Tractor Design and Testing	3 (2+1)	
4	Hydraulic Drives and Controls	3 (2+1)	
5	Human Engineering and Safety	3 (2+1)	
6	Precision Agriculture and System Management	3 (2+1)	
7	Photovoltaic Technology and Systems	3 (2+1)	
8	Wind Power Technology and Systems	3 (2+1)	
9	Waste and By-products Utilization	3 (2+1)	
10	Floods and Control Measures	3 (2+1)	
11	Remote Sensing and GIS Applications	3 (2+1)	
12	Information Technology for Land and Water Management	3 (2+1)	
13	Wasteland Development	3 (2+1)	
14	Minor Irrigation and Command Area Development	3 (2+1)	
15	Management of Canal Irrigation System	3 (2+1)	
16	Water Quality and Management Measures	3 (2+1)	
17	Landscape Irrigation Design and Management	3 (2+1)	
18	Application of Plastics in Agriculture	3 (2+1)	
19	Precision Farming Techniques for Protected Cultivation	3 (2+1)	
20	Environmental Engineering	3 (2+1)	
21	Development of Processed Food Products	3 (2+1)	
22	Food Packaging Technology	3 (2+1)	
23	Food Plant and Equipment Design	3 (2+1)	
24	Emerging Technologies in Food Processing	3 (3+0)	
25	Processing of Livestock, Fish and Marine Products	3 (2+1)	
26	Food Business Management and Entrepreneurship Development	3 (3+0)	
27	MATLAB Programming	3 (1+2)	
28	Python Programming	3 (1+2)	
29	Artificial Intelligence	3 (2+1)	
30	Advances in Automation and Robotics in Agriculture	3 (2+1)	
31	Machine Learning	3 (2+1)	

32	Operations Research	3 (3+0)	
33	Mechatronics	3 (2+1)	
34	Natural Fibres: Extraction & Properties	3 (2+1)	
35	Natural Fibre Applications in Agriculture	3 (2+1)	
36	Processing of Natural Fibres	3 (2+1)	
37	Agricultural Marketing and Trade	3 (2+1)	

Credits Allocation Scheme of UG Agricultural Engineering programs (Credit hours)

Sem-ester	Core Courses* (majors/ Minors)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill En-hancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial courses	Online Cours-es/ MOOC
I	12	4[2]	3[3]	1[4]	-	-	20	2[1]	
II	2	3[5]	3[6]	2[7] +1[8] + 2[9]	8	-	21	-	
Post-II semester	-	-	-	-	-	10[10]			
III	23	-		2[11]	-	-	25		
IV	22	3[12]	-	-	-	-	25	-	**6**
Post-IV semester	-	-	-	-	-	10[13]			
V	19	-	-	2[14]	-	-	21	2[15]	
VI	21	-	-	-	-	-	21	-	
VII	17	-	-	-	-	3	20	-	
VIII	9	-	-	-	-	12	21	-	
Total	**125***	**10**	**6**	**10**	**8**	**15**	**174**	**4**	**6**

[1] *Deeksharambh* (Induction-cum-Foundation Course); [2] Crop Production and Protection Technologies

[3] Agricultural Informatics and Artificial Intelligence ; [4] NCC-I/ NSS-I; [5] Farming Based Livelihood Systems;

[6] Environmental Studies and Disaster Management; [7] Communication Skills;

[8] NCC-II/ NSS-II; [9] Computer Programming and Data Structures

[10] Internship (only for those opting for an exit with UG-Certificate)

[11] Physical Education, First Aid, Yoga Practices and Meditation

[12] Entrepreneurship Development and Business Management

[13] Internship (only for those opting for an exit with UG-Diploma); [14] Personality Development; [15] Study tour (10-14 days)

*Includes the Elective courses.

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major & minor/s)	:	125
Common courses (MDC+VAC+AEC)	:	26
Skill Enhancement Courses (SEC)	:	8
Internship/ in-plant training	:	8
Project		7
* Online courses	:	6
Total	:	**174+6***

The credits of *Deeksharambh* (0+2) and Study tour (0+2) have not been included in the total 180 credit hours.

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Programme) Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, prospective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strengths and weaknesses of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Crop Production and Protection Technologies 4 (3+1)

Objective

To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences and to have an idea of the different types of machineries/ equipment that can be adopted for these operations

Theory

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage, tilth and its characteristics; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture.

Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping.

Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter– its composition and decomposition, effect on soil fertility; Soil reaction – acidic, saline and sodic soils; Quality of irrigation water.

Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

Types of horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural crops and their management.

Practical

Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test; Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse/ polyhouse.

Suggested Readings

1. Ahamad S, Anwar A and Sharma P K (Eds). 2018. *Plant Disease Management in Horticultural Crops*. 405 p. Daya Publishing House, Delhi.
2. Biswas T D and Mukharjee S K. 1987. *A Text Book of Soil Science*. 314p. Tata McGraw-Hill, New Delhi.
3. Brady N C and Ray R Weil. 2002. *The Nature and Properties of Soil*. Pearson Education Inc., New Delhi.
4. Chadha K L. 2003. *Handbook of Horticulture*. 1031p. ICAR Publication, New Delhi.
5. Das D K. 2020. *Introductory to Soil Science*. Kalyani Publishers, Ludhiana.
6. Dey G C. 2013. *Fundamentals of Agronomy*. Jain Book Depot, Delhi.
7. Ghildyal B P and Tripathy R P. 1987. *Soil Physics*. 656p. Wiley Eastern Ltd., New Delhi.
8. Hillel D. 1982. *Introduction to Soil Physics*. Academic Press, New York.
9. Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. 728p. ISSC, IARI, New Delhi.
10. Janick J. 1979. *Horticultural Science*. 608p. Surjeet Publications, Delhi.
11. Kumar N. 2017. *Introduction to Horticulture*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Muthukrishnan N, Ganapathy N, Nalini R and Rajendran R. 2005. *Pest Management in Horticultural Crops*. New Madura Publishers, Madurai, Tamil Nadu.
13. Reddy S R. 2020. *Principles of Agronomy*. Kalyani Publishers, Ludhiana.
14. Reddy Yellamanda T and Reddy Shankar G H. 1995. *Principles of Agronomy*. Kalyani Publishers, Ludhiana.
15. Sehgal J L. 1996. *Soil Pedology*. Kalyani Publishers, Ludhiana.
16. Singh J. 2018. *Fundamentals of Horticulture*. Kalyani Publishers, Ludhiana.
17. Singh S S and Singh R. 2013. *Principles and practices of Agronomy*. Kalyani Publishers, Ludhiana.
18. Sudheer K P and Indira V. 2016. *Post harvest Technology of Horticultural Crops*. New India Publishing Agency, New Delhi.

Introduction to Agricultural Engineering 4 (3+1)

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities.

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad.

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts.

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures. Use of topographical survey and contour maps. Different types of water harvesting structures.

Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components.

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures.

Classification of different types of agricultural commodities as durables, perishables, etc.; Moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements; Study of various types of biogas plants and operational parameters; Study of various solar energy application systems; Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump; Study of various post-harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to

implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Suggested Readings

1. Chakraverty A. 1999. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH Publishing Co. Ltd., New Delhi.
2. Dash S K, Bebartta J P and Kar A. 2012. *Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Jain S C and Philip G. 2009. *Farm Machinery- An Approach*. (2nd Edn.), Standard Publishers and Distributors, New Delhi.
4. Mal B C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers, New Delhi.
5. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. Jain Brothers, New Delhi.
6. Michael A M. 2012. *Irrigation: Theory and Practice. 772p.* Vikas Publishing House, New Delhi.
7. Nakra C P. 1980. *Farm Machines and Equipment*. Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi.
8. Rai G D. 1995. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
9. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
10. Sahay K M and Singh K K. 1994. *Unit Operations of Agricultural Processing*. 388p. Vikas Publishing House Pvt. Ltd., New Delhi.
11. Suresh R and Kumar Sanjay. 2018. *Farm Power and Machinery Engineering*. Standard Publisher Distributors, New Delhi.
12. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.

Surveying and Levelling 3 (1+2)

Objective

To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures.

Theory

Surveying: introduction, classification and basic principles; Linear measurements, chain surveying, cross staff survey, compass survey, planimeter; Errors in measurements, their elimination and correction; Plane table surveying, methods, advantages and disadvantages.

Levelling, levelling difficulties and error in levelling, contouring, computation of area and volume. Theodolite traversing, introduction to setting of curves; Total station, electronic theodolite; Introduction to GPS survey.

Practical

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Measurement of slope in the field; Study on contour and its characteristics; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by Theodolite; Height of object by using Theodolite; Setting out curves by Theodolite; Use of minor instruments; Use of total station, EDM in the field; Use of modern computers for surveying

Suggested Readings

1. Agor R. *A Text Book of Surveying & Levelling*. Khanna Publishers, New Delhi.
2. Arora K R. 1990. *Surveying (Vol. 1)*, Standard Book House, Delhi.
3. Kanetkar T P. 1993. *Surveying and Levelling*. Pune Vidyarthi Griha, Prakashan, Pune.
4. Punmia B C. 1987. *Surveying (Vol. 1)*. Laxmi Publications, New Delhi.

Workshop Technology and Practice 2 (0+2)

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

Practical

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of butt joint and lap joint with ARC welding; Preparation of lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper;

changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing

Suggested Readings

1. Chapman W A J. 2018. *Workshop Technology* (Vol. I and II). Arnold Publishers, New Delhi.
2. Hajra Choudhury S K, Roy N and Hajra Choudhury A K. 2017. *Elements of Workshop Technology* (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. *A Text Book of Workshop Technology*. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. *A Course in Workshop Technology* (Vol. I and II). Dhanpat Rai and Sons, New Delhi.

Basic Electrical Gadgets and Instruments 3 (2+1)

Objective

To enable the students to take up repair and maintenance of different common electrical gadgets and instruments.

Theory

Introduction to different electrical appliances used in agricultural buildings, structures and farm operations; Difference between AC and DC supply system; Introduction to AC fundamentals; AC through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q-factor and bandwidth.

Three- phase AC circuit: Concept of balanced three-phase AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three phase power measurement like (one wattmeter and two –wattmeter method).

Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier and capacitive filter zener diode as voltage regulator.

Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods, fixed, self biasing and potential divider biasing method; OP-AMP, Ideal OP-AMP characteristics, Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator).

Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates, SOP rule and K-map), binary adder.

Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.

Practical

Basic Electrical and Electronics Gadgets. To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring); To prepare an electrical

switch board to control two light points using two two-way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit; To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter; To measure the power consumption in a three-phase circuit using two-wattmeter method.

Instrumentation

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To verify different logic gates; To measure unknown resistance using Wheatstone bridge; To measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourdentube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing applications.

Suggested Readings

1. Boylestad R L and Nashelsky L N. 2011. *Electronic Device and Circuit Theory*. Pearson Education, London.
2. Ghosh S. 2007. *Fundamentals of Electrical and Electronics Engineering*. (2nd Edn.), PHI Learning, New Delhi.
3. Metha V K and Metha R. 2012. *Basic Electrical Engineering*. (5th Edn.), S Chand & Co., New Delhi.
4. Metha V K and Metha R. 2012. *Principle of Electronics*. (5th Edn.), S Chand & Co., New Delhi.
5. Rajput R K. 2007. *Basic Electrical and Electronics Engineering*. Laxmi Publications, New Delhi.
6. Theraja B L and Theraja A K. 2005. *A Text Book of Electrical Technology*. Vol. I & II. S Chand & Co., New Delhi..

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objective

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
ii. To provide basic knowledge of computer with applications in Agriculture and to make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis,

Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (www): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development; Application of innovative ways to use information and communication technologies (IT) in Agriculture; Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation; IT applications for computation of water and nutrient requirement of crops; Computer-controlled devices (automated systems) for Agri-input management; Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc.; Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information; Decision support systems: Concepts components and applications in agriculture; Agriculture Expert System; Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools; Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search;Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DOS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA)

Suggested Readings

1. Choudhary K R. 2020. *Fundamentals of Artificial Intelligence*. 716p. Springer India, Private Ltd.
2. Date C J. 2000. *Introduction to Database Management System*. Addison-Wesley.
3. ITL Educations Solutions Ltd. 2005. *Introduction to Information Technology*, 668 p. Pearson Education, London.

4. Kumar E. 2020. *Artificial Intelligence*. Wiley, New Jersey.
5. Nilson N J. 2001. *Principles of Artificial Intelligence*. Narosa.
6. Rajaraman V and Adabala N. *Fundamentals of Computers*. (6th Edn.). 448p. PHI Learning Pvt. Ltd, New Delhi.
7. Russell S. 2013. *Artificial Intelligence: A Modern Approach*. Pearson, London.
8. Sethi D P and Pradhan M. 2017. *Concepts and Techniques of Programming in C*. I.K. International Publishing House Pvt. Limited, New Delhi.
9. Vanitha G. 2023. *Agro-Informatics*. NIPA, New Delhi..

NCC- I **1 (0+1)**

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizens

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness activities

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline. Drill- aim, general words of command, attention, stands at ease, stand easy and turning. Sizing, numbering, forming in three ranks, open and close order march, and dressing. Saluting at the halt, getting on parade, dismissing, and falling out. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. Marking time, forward march, and halt. Changing step, formation of squad and squad drill. Command and control, organization, badges of rank, honors, and awards. Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defence organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

NSS- I **1 (0+1)**

Objectives

i. Evoking social consciousness among students through various activities, viz., working together, constructive, and creative social work

ii. To be skilful in executing democratic leadership, developing skill in program

iii. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness activities

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS. Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health. NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change. Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace- building. Volunteerism and *shramdaan.* Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism. Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and right to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Semester II

Skill Enhancement 8 (0+8)

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

i. Operation and maintenance of farm machinery.
ii. Repair and maintenance of tractors and power tillers.
iii. Management of agricultural machinery custom hiring and maintenance facilities.
iv. Fabrication, operation and maintenance of renewable energy devices.
v. Operation and maintenance of drones used for agricultural applications.
vi. Machine vision, sensors and sensors architecture.
vii. Design of solar PV system using softwares.
viii. Installation and maintenance of on-grid and off-grid solar systems.
ix. Design and maintenance of agri-voltaic systems.
x. Valorization of agri-biomass and organic waste.
xi. Energy audit, energy conservation and energy efficiency.

xii. Repair and maintenance of pumps and irrigation systems.

xiii. Installation and maintenance of micro-irrigation systems.

xiv. Application of remote sensing and GIS for agricultural water management.

xv. Operation and maintenance of hydro-meteorological instruments.

xvi. Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well.

xvii. Installation and maintenance of roof top rain water harvesting systems.

xviii. Operation and maintenance of soil conservation structures.

xix. Construction, management and maintenance of protected cultivation structures.

xx. Agro processing methods, equipment operation and maintenance.

xxi. Operation and management of multi-commodity agro-processing centre.

xxii. Primary processing and value addition and cold chain logistics.

xxiii. Food grain godown and warehouse management.

xxiv. Post-harvest value chain management including logistics.

After two to three days common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these skill areas. The selection of the module(s) will be entirely on the student's choice.

Indicative details of the skill enhancement modules are given at the end of this section. The credit hours for each module have been kept as 0+4. However, the institution is at liberty to modify the credit hours/ contents for the skill enhancement modules depending on the level of skill to be imparted to the students. For example, if a student wishes to take up three or four skill modules, the contents and credits can be modified for those skill modules, making the total 8 credits However, in no case, more than four modules are recommended for offering to a student.

It is emphasized that the purpose is to impart practical knowledge/ skill for operating the system and none of the course should be taken in theoretical mode. In specific cases, the skill enhancement in the specific area can be further continued during the 10 weeks' internship in case of exits for UG-certificate and UG-Diploma for further strengthening of the skill.

The above modules and details are indicative only and the institutions have the liberty to formulate new modules and modify the content of the modules relevant to the respective regions or even modify the titles of the above modules. It is advised that the institutions should define the detailed breakup of the skill areas depending on the facilities/ expertise available.

The course can also be offered in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners. The timetable for the remaining part of the semester will be adjusted accordingly as mentioned earlier.

Engineering Drawing 2 (0+2)

Objective

To enable the students to draw engineering drawings for some simple machines/ equipment

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, references planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

Suggested Readings

1. Bhatt N D. 2010. *Elementary Engineering Drawing*. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt N D and Panchal V M. 2013. *Machine Drawing*. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana K L and Kannaiah P. 2010. *Machine Drawing*. Scitech Publications (India) Pvt. Ltd., Chennai..

Computer Programming and Data Structures 2 (0+2)

Objective

To make the students conversant on computer programming languages, specifically C language as well as to familiarize them with programming for simple agricultural engineering applications

Practical

Introduction to high level languages; Structure programming, C programming, a simple C programming, execution of a C program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple

programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Creating user defined functions; Developing structures and union; Using local, global and external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/ Deletion in queues.

Suggested Readings

1. Agarwal A. 2005. *The Complete Reference Guide: Data Structure through C*. Cyber Tech Publications, New Delhi..
2. Balagurusamy E. 1990. *Programming in 'C'*. Tata McGraw Hill, New Delhi.
3. Bronson G and Menconi S. 2000.*A First Book of ANSI C: Fundamentals of C Programming*, (3rd Edn.), Brooks/ Cole, New Delhi.
4. Drozdek A. 2012. *Data Structures and Algorithms in C++*. Vikas Publishing House/ Thomson International Student Edition.
5. Goodrich M T, Tamassia R and Mount D. 2011. *Data structures and Algorithms in C++*. Wiley Student Edition, John Wiley and Sons.
6. Langsam Y, Augenstein M and Tanenbaum A M. 2003. *Data structures using C and C++*, 896 p. PHI/Pearson Education, London.
7. Rajaraman V. 1985. *Computer Oriented Numerical Methods*. Prentice Hall of India. Pvt. Ltd, New Delhi.
8. Rajaraman V. 1995. *Computer Programming in C*. Prentice Hall of India Pvt. Ltd., New Delhi.
9. Sahni S. 2006. *Data Structures, Algorithms and Applications in C++*. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
10. Weiss M A. 2007. *Data Structures and Algorithm Analysis in C++*. Pearson Education, London.

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming-based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckery etc.), Horticultural crops, Agro-forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., small, medium and

large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture- based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal A. and Narain S. 1989. *Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development*. Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience (*Vol. 7). Department for International Development, London, UK.
3. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030- Regional Analysis*. Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy.
4. Dixon J, Gulliver A and Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO & World Bank, Rome.
5. Evenson R E. 2000. *Agricultural Productivity and Production in Developing Countries. (In) FAO, The State of Food and Agriculture*. FAO, Rome, Italy.
6. Bhatt B P, Kumar A, Thakur P K, Dey A, Kumar U, Kumar S et al. (Eds.). *Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar.* ICAR Research Complex for Eastern RegionTech. Bull. No. R-40/PAT-26, Patna - 800 014, Bihar
7. Panwar A S, Ravisankar N, Prusty A K, Shamim M, Singh R, Bhaskar S. 2019. *Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment*. Indian Council of Agricultural Research, New Delhi.
8. Reddy S R. 2016. *Farming System and Sustainable Agriculture.* Kalyani Publishers, New Delhi.
9. Singh J P, Ravisankar N, Prusty A K, Sikka A K, Gangwar B. 2016. *Region Specific Integrated Farming System Models for Improved Production, Profitability and Nutrition.* ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia S S. and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

i. To expose and acquire knowledge on the environment

ii. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/ mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/ Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples.

Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster

Suggested Readings

1. Bharucha E. 2004. *Text book for Environmental studies*. University Grants Commission, New Delhi.
2. De A K. 2010. *Environmental Chemistry*. 384p. NIPA, New Delhi.
3. Chakrabarti P G D. 2011. *Disaster management - India's risk management policy frameworks and key challenges*. 36 p. Centre for Social Marketsm Bengaluru.
4. Miller G T and Spoolman S E. 2009. *Living in the Environment (Concepts, Connections, and Solutions*). Brooks/cole, Cengage Learning, Belmont, USA
5. Parthiban K T. Vennila S, Prasanthrajan M, Umesh Kanna S. 2023. *Forest, Environment, Biodiversity and Sustainable development*. Narendra Publishing House, New Delhi.
6. Prasanthrajan M and Mahendran P P. 2008. *A text book on Ecology and Environmental Science*. Agrotech Publishing Academy, Udaipur
7. Sharma PD. 2009.*Ecology and Environment*. Rastogi Publications, Meerut.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication skill and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Barbara Pease & All an Pease. 2006. Definitive BK of Body Language. RHUS.
2. Carnegic D. 2018 1997. *The Quick and Easy Way to Effective Speaking*. Finger Print Publishing.
3. Francis Peter S J. 2012. *Soft Skills and Professional Communication*. Tata McGraw Hill, New Delhi.
4. Kumar S and Pushpa Lata. 2011. *Communication Skills*. Oxford University Press.
5. Mark Goulstan. 2015. Just Listen. Ama com; Reprint edn. Harper Collins.
6. Napolen Hill. 2014. Think & Grow Rich. Finger Print.
7. Neuliep James W. 2003. *Intercultural Communication A Contextual Approach*. Houghton Mifflin Co Boston.
8. Raman M and Singh P. 2000. *Business Communication*. Oxford University Press.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press, London.

NCC-II 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

NSS- II **1 (0+1)**

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs. Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations. Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Post-II semester

Internship (only for exit option for award of UG-Certificate) **10 (0+10)**

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and will be competent to start an enterprise.

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Engineering Mathematics-I 3 (3+0)

Objective

To make the students acquainted with the basic mathematics applied in engineering and their applications in solving engineering problems

Theory

Differential Equations: First order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation.

Higher order differential equations: Methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.

Partial differential equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Matrices: Elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem- its use to find inverse of the matrix, linear transformation, diagonalization of matrices.

Suggested Readings

1. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers, Delhi.
2. Narayan S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd., New Delhi.
3. Narayan S. 2004. *Differential Calculus*. S. Chand and Co. Ltd., New Delhi.
4. Narayan S. 2004. *Integral Calculus*. S. Chand and Co. Ltd., New Delhi.

Engineering Physics 3 (2+1)

Objective

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Magnetism: Dia, para and ferro-magnetism- classification; Langrevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory; Introduction to quantum

mechanics: wave particles duality, deBroglie concept uncertainty principle, time dependent and time independent Schrodinger equation.

Spectroscopy: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; Solid state physics: statement of Bloch function, bands in solids, effective mass, distinction between metals, insulators and semi-conductors.

Semiconductors: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; Superconductivity: super conductivity, critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, introduction to high T_c superconductors.

LASERS and MASERS: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; Holography and optical fibre: optical fibre- physical structure, basic theory, type of modes, characteristics of optical fibre and applications; Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; Determine dielectric constant of material using De Sautys bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor using a p-n junction diode; Study the LCR circuit; Find the wave length of light by using prism and spectrometer; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Suggested Readings

1. Avadhanulu M N. 2013. *An Introduction to Lasers theory and applications*. S. Chand Publishing, NOIDA, UP.
2. Chattopadhyay D and Rakshit P C. 2011. *Electricity and Magnetism*. S. Chand Publishing, NOIDA, UP.
3. Ghatak A K and Lokanathan S. 2022. *Quantum Mechanics*, *Theory and Application*. Trinity Press, GA, USA.
4. Griffiths D J and Schroeter. 2018. *Introduction to Quantum Mechanics*. Cambridge University Press.
5. Khandelwal D P. 1985. *A Laboratory Manual of Physics*. Vani Publications, Delhi.
6. Kittel C. 2005. *Introduction to Solid State Physics*. Wiley Eastern Pvt. Ltd., New Delhi
7. Laud B B. 2011. *Lasers and Non-linear Optics*. New Age International Publishers, New Delhi.
8. Mani H S and Mehta G K. 2022. *Modern Physics*. Affiliated East-West Press, New Delhi.
9. Omar M A. 2002. *Elementary Solid-State Physics*. Pearson Education, London.
10. Prakash S. 2011. Optics. *Pragati Prakashan*, Meerut.
11. Saraf B and Khandelwal D P. 1982. *Physics through Experiments.* Vol. I & II. Vikas Publication, New Delhi.
12. Subramanyam N, Lal B and Avadhanulu M N. 2012. *A Textbook of Optics*. S. Chand Publishing, NOIDA.

13. White H E. 2019. *Introduction to Atomic Spectra*. Mc-Graw Hill Publication, New Delhi.
14. Worsnop B L and Flint H C. 1951. *Advanced Practical Physics*. Littlehampton Book Services Ltd., west Sussex, England.

Engineering Chemistry 3 (2+1)

Objective

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule: Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb.

Colloids: Classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis, causes, types and methods of prevention- proper designing.

Corrosion: Cathodic protection using pure metal and metal alloys, use of inhibitors.

Water: Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion, basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating.

Fuels: Classifications, calorific value and its determination by bomb calorimeter.

Principles of food chemistry: Lipids, proteins, carbohydrates and their classifications, vitamins and their importance. Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method. Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavoring reagents of foods.

Lubricants: Classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability.

Type of polymerization with examples (addition, free radical); Different properties of polymers-chemical resistance, crystallinity.

Polymers: Effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles of determination of molecular weight by light scattering methods.

Introduction to IR spectroscopy: Basic principles of spectroscopy, Beer-Lamberts law, types of vibration, symmetric, asymmetric vibration and it type, absorbances of different functional group in IR.

Practical

To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their

ingredients; To study the different types of food preservatives and their active principles; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To estimate chloride in water samples; To study the different properties of lubricants; To determine λ_{max} and verification of Beer-Lambert law.

Suggested Readings

1. Bahl B S, Bahl A and Tuli B D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd, Delhi.
2. Finar I L. 2002. *Organic Chemistry*. (Vol I and II). Pearson, London.
3. Glasstone S and Lewis D. 1963. *Elements of Physical Chemistry*. 758p. The Macmillan Company of India Limited.
4. Jain P C and Jain M. 2016. *Engineering Chemistry*. (16th Edn.), Dhanpat Rai Publication, New Delhi.
5. Morrison R T, Boyd R N and Bhattacharjee S K. 2010. *Organic Chemistry*. Pearson, London.
6. Sharam Y R. 2013. *Elementary Organic Spectroscopy*. S. Chand and Co. Ltd, Delhi.

Engineering Mechanics 3 (2+1)

Objective

To make the students acquainted with the principles of engineering mechanics and the calculation of different stresses to be helpful for design of engineering structures

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units. Composition and resolution of forces, analytical method, graphical method. Laws of forces, moments and their application, levers, parallel forces and couples. Equilibrium of forces, free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections. Moment of inertia: Methods of finding out M.I., methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections. Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack. Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads. Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems. Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexture. Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft. Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

Suggested Readings

1. Bansal R K. 2005. *A Text Book of Engineering Mechanics*. Laxmi Publishers, New Delhi.
2. Khurmi R S. 2006. *Strength of Materials*. S. Chand Publishing, NOIDA.
3. Khurmi R S. 2018. *A Text Book of Engineering Mechanics*. S. Chand Publishing, Noida.
4. Prasad I B. 2004. *Applied Mechanics and Strength of Materials*. Khanna Publishers, New Delhi.
5. Prasad I B. 2004. *Applied Mechanics*. Khanna Publishers, New Delhi.
6. Sundarajan V. 2002. *Engineering Mechanics and Dynamics*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Timoshenko S and Young D H. 2003. *Engineering Mechanics*. McGraw Hill Book Co., New Delhi.

Soil Mechanics 2 (1+1)

Objective

To make the students acquainted with the principles of soil mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures

Theory

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit; Classification of soils, effective and neutral stress, Boussinesq and Westerguard's analysis, New-mark's influence chart, stress distribution and diagrams. Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, triangle test and vane shear test. Numerical exercise based on various types of tests. Compaction of soils, standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one-dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method. Earth pressure: Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises; Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method.

Practical

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Casagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test.

Suggested Readings

1. Punmia B C, Jain A K and Jain A K. 2005. *Soil Mechanics and Foundations*. Laxmi Publications (P) Ltd. New Delhi.
2. Ranjan G and Rao A S R. 1993. *Basic and Applied Soil Mechanics*. Welley Eastern Ltd., New Delhi.
3. Singh A. 1994. *Soil Engineering*. (Vol. I.) CBS Publishers and Distributions, Delhi.

Fluid Mechanics and Open Channel Hydraulics 3 (2+1)

Objective

To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

Theory

Properties of fluids: Ideal and real fluid, units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies. Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon. Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe. Laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes. Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter. Dimensional analysis and similitude: Rayleigh's method and Buckingham's `pi' theorem, types of similarities, dimensionless numbers; Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow; Determination of meta-centric height; Verification of Bernoulli's theorem, determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter; Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froude's number and Reynold's number; Study of various types of pumps and its components.

Suggested Reading

1. Bansal R K. 2019. *A Text book of Fluid Mechanics*. Laxmi Publications, New Delhi.
2. Ramanuthan S. 2011. *Hydraulics, Fluid Mechanics & Hydraulic Machines*. Dhanpat Rai & Sons, Delhi.
3. Khurmi R S and Khurmi N. 1987. *Hydraulics, Fluid Mechanics and Hydraulic Machines*. S. Chand & Co. Ltd., New Delhi.
4. Modi P N and Seth S M. 2017. *Hydraulics & Fluid Mechanics including Hydraulic Machines*. Standard Book House, Delhi.

Engineering Properties of Agricultural Produce and Food Science 3 (2+1)

Objective

To make the students acquainted with the different engineering properties of agricultural produce and to help them understand the importance of these properties in handling, processing and storage

Theory

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.

Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.

Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian,

pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods.

Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques.

Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.

Practical

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

Suggested Readings

1. Mohesin N N. 1980. *Physical Properties of Plants & Animals*. Gordon & Breach Science Publishers, New York.
2. Rao M A and Rizvi S H. 1995. *Engineering Properties of Foods*. Marcel Dekker Inc., New York.
3. Serpil S and Servet G S. 2005. *Physical Properties of Foods*. Springer Science+Business Media, LLC, New York.
4. Singhal O P and Samuel D V K. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan, New Delhi.

Farm Machinery and Equipment- I 3 (2+1)

Objective

To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc., and their economics of operation

Theory

Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.

Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.

Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation. Testing and Evaluation of tillage and sowing equipment and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Suggested Readings

1. Jain S C and Phillips G. 2003. *Farm Machinery- An Approach*. Standard Publishers and Distributors.
2. Kepner R A, Bainer R and Barger E L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors, New Delhi.
3. Lal R and Datta A C. 1978. *Agricultural Engineering Through Worked Out Examples*. Saroj Prakashan, Allahabad.

4. Nakra C P. 2003. *Farm Machines and Equipment*. Dhanpat Rai and Publishing Co., New Delhi
5. Smith H P and Wilkes L H. 2011. *Farm Machinery and Equipment*. McGraw Hill Publication, New York.
6. Srivastav A K, Goering C E and Rohrbach R P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Mich.
7. Srivastava A C. 1991. *Elements of Farm Machinery*. Oxford and IBH Publication, New Delhi.
8. Srivastava T K. 2007. *A Work Book on Practical Farm Machinery* (Vol. I and II). Saroj Prakashan, Allahabad.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices
ii. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga.

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

- Yoga; History of Yoga, Types of Yoga, Introduction to Yoga
- Asanas: Definition and Importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan– left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar, Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First aid equipment and upkeep. First AID techniques, First aid related with respiratory system. First aid related with Heart, Blood & Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Semester IV

Engineering Mathematics-II 3 (3+0)

Objective

To make the students acquainted with the application of various advanced mathematics such as vector calculus, Fourier series and Laplace transform and applications of numerical methods in engineering

Theory

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs), functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half range series expansion, series expansion of functions with finite discontinuity; Laplace Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations.

Numerical methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four.

Suggested Readings

1. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers, Delhi.
2. Narayan S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd., New Delhi.
3. Narayan S. 2004. *Differential Calculus*. S. Chand and Co. Ltd., New Delhi.
4. Narayan S. 2004. *Integral Calculus*. S. Chand and Co. Ltd., New Delhi.
5. Ramana B V. 2008. *Engineering Mathematics*. Tata McGraw-Hill, New Delhi.

Theory of Structures 2 (1+1)

Objective

To make the students acquainted with the principles of structural design and to enable them to design small and medium RCC and steel structures

Theory

Types of Load and use of BIS code, Design of steel structures: Specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, ETABS, etc. for design of roof truss.

Design of RCC structures: Specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two-way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures.

Practical

Design and drawing of steel roof truss including tension member, compression member, and member under bending; use of design softwares; Design and drawing of RCC building, including single reinforced beam, double reinforced beam, one-way slab, two-way slabs, columns and foundations; use of design softwares for simple RCC structures.

Suggested Readings

1. Bhavikatti S S. 2014. *Design of Steel Structures: By Limit State Method as Per IS: 800-2007*. I K International Publishing House Pvt. Ltd., New Delhi.
2. Duggal S K. 2017. *Limit State Design of Steel Structures*. McGraw Hill Education, Noida.
3. Punmia B C, Jain A K and Jain A K. 2016. *Limit State Design of Reinforced Concrete*. Laxmi Publications, Chennai.
4. Raju N K. 2019.*Design of Reinforced Concrete Structures: IS:456-2000*. CBS Publishers & Distributors, New Delhi.

Building Construction and Cost Estimation 2 (2+0)

Objective

To make the students acquainted with the methods of construction of agricultural buildings and to enable them to prepare various types of estimates of buildings

Theory

Building materials: Description of important building materials, rocks, different stones; formation of stones, types of stones, quarrying process, stone products and uses; bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades.

Concrete: Grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials.

Building construction: Building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and waterproofing, white washing, distempering and painting, steps for building construction, needs of different

agricultural buildings, types and uses, types of roofs, slope and flat roof buildings.

Estimating and costing: Types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development.

Cost economics: Measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period).

Suggested Readings

1. Duggal S K. 2012. *Building Material*. New Age International Publishers, New Delhi.
2. Dutta B N. 2000. *Estimating and Costing*. UBS publishers, Bengaluru.
3. Punmia B C, Jain A K and Jain A K. 1984. *Building Construction*. Laxmi Publications (P) Ltd., New Delhi.
4. Rangwala S C. 1994. *Engineering Materials*. Charotar Publishing House, Anand.
5. Sane Y S. 1964. *Planning and Designing of Buildings*. Engineering Book Publishing Co., Pune.

Watershed Hydrology 3 (2+1)

Objective

To make the students acquainted with the different hydrological processes, their methods of analysis so as to enable them to apply these for watershed development, water harvesting, minor irrigation, drought and flood control, etc.

Theory

Hydrological cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges.

Frequency analysis of point rainfall; Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship.

Hydrologic processes–interception, infiltration-factors influencing, measurement and indices; Evaporation- estimation and measurement; Runoff- factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, rational method, Cook's method and SCS curve number method.

Geomorphology of watersheds–linear, aerial and relief aspects of watersheds-stream order, drainage density and stream frequency; Hydrograph-components, base flow separation, unit hydrograph theory, s-curve, synthetic hydrograph, applications and limitations.

Flood routing–channel and reservoir routing; Hydrology of dry land areas, Troll's climatic classification; Drought- classification, causes and impacts, drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves; Study of depth - area – duration curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records;

Computation of infiltration indices; Computation of peak runoff and runoff volume by Cook's method and rational formula; Computation of runoff volume by SCS curve number method; Study of stream gauging instruments- current meter and stage level recorder; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow ; Study of unit hydrograph; Study of synthetic hydrograph; Study of flood routing; Study of various discharge measuring devices.

Suggested Readings

1. Chow V T, Maidment D R and Mays L W. 2010. *Applied Hydrology*. McGraw Hill, New York.
2. Das G. 2000. *Hydrology and Soil Conservation Engineering*. PHI, New Delhi.
3. Garg S K. 1998. *Hydrology and Water Resources Engineering*. Khanna Publishers, Delhi.
4. Linsley R K, Kohler M A and Paulhus J L H. 1984. *Hydrology for Engineers*. McGraw-Hill Publishing Co., Japan.
5. Mutreja K N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., New Delhi.
6. Panigrahi B and Panigrahi K. 2016. *Engineering Hydrology*. New India Publishing Agency, New Delhi.
7. Raghunath H M. 2006. *Hydrology: Principles Analysis and Design*, (2nd Edn.), New Age International (P) Limited Publishers, New Delhi.
8. Reddy P J R. 2011. *A Text Book of Hydrology*. University Science Press, New Delhi.
9. Subramanya K. 2008. *Engineering Hydrology*, (3rd Edn.), Tata McGraw-Hill, New Delhi.
10. Suresh R. 2005. *Watershed Hydrology*. Standard Publishers and Distributors, Delhi.
11. Varshney R S. 1986. *Engineering Hydrology*. Nem Chand and Brothers, Roorkee, U.P..

Soil and Water Conservation Engineering 3 (2+1)

Objective

To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation

Theory

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion.

Water erosion: Mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>25 and EI_{30} methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

Water erosion control measures: Agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully

and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump.

Soil erosion control structures: Introduction, classification and functional requirements. Permanent structures for soil conservation and gully control-check dams, drop, chute and drop inlet spillways-design requirements, planning for design, design procedures-hydrologic, hydraulic and structural design and stability analysis.

Wind erosion: Factors affecting, mechanics, soil loss estimation and control measures-vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.

Land capability classification: dryland farming; rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

Water harvesting techniques: Classification based on source, storage and use, runoff harvesting- short-term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds.

Practical

Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation; Determination of length of slope (LS) and cropping practice (CP) factors; Estimation/measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor; Determination of sediment concentration through oven drying method. Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs; Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond- design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed.

Suggested Readings

1. Chow V T. 1985. *Open-Channel Hydraulics*. McGraw- Hill Book Company, Inc.
2. Das G. 2000. *Hydrology and Soil Conservation Engineering*. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Frevert R K, Schwab G O, Edminster T W and Barnes K K. 2009. *Soil and Water Conservation Engineering*. (4th Edn.), John Wiley and Sons, New York.

4. Mahnot SC. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service, New Delhi.
5. Mal B C. 2014. *Introduction to Soil and Water Conservation Engineering*. Kalyani Publishers, Ludhiana.
6. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. (Volume II) (4th Edn.), Jain Brothers, New Delhi.
7. Murthy V V N. 2002. *Land and Water Management Engineering*. (4th Edn.), Kalyani Publishers, New Delhi.
8. Norman H. 1985. *Soil Conservation*. Cornell University Press, New York.
9. Samra J S, Sharda, V N and Sikka A K. 2002. *Water Harvesting and Recycling: Indian Experiences*. CSWCRTI, Dehradun.
10. Sharda V N, Juyal G P, Prakash C and Joshi B P. 2007. *Training Manual: Soil Conservation and Watershed Management* (Vol.II), CSWCRTI, Dehradun.
11. Singh G, Venkataraman C, Sastry G and Joshi B P. 1996. *Manual of Soil and Water Conservation Practices*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.
13. USDA. 1964. *Engineering Hand Book on Drop Spillways (Section-11)*. USDA, Soil Conservation Service.

Farm Machinery and Equipment II — 3 (2+1)

Objective

To make the students acquainted with the basic construction and operational features, and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines, etc.

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Harvesting of crops: Harvesting methods, harvesting terminology; Mowers– types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay.

Threshing: manual and mechanical systems: Types of threshing drums and their applications; Types of threshers-tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine

troubles and troubleshooting; Chaff cutters-working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details.

Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting-cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.

Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and interculture equipment; Study of sprayers-types, functional components, calibration; Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator; Familiarization with manual and powered weeding equipment and identification of functional components; Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters; Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of functional units of grain combines and their types, calculations for grain losses in a combine; Study of root crop diggers and familiarization with the functional units and attachments; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations various machines; Visit to implement manufacturing unit.

Suggested Readings

1. Jain S C and Phillips G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors, Delhi.
2. Kepner R A, Bainer R and Barger E L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors, Delhi.
3. Lal R and Datta A C. 1978. *Agricultural Engineering through Worked out Examples*. Saroj Prakashan, Allahabad.
4. Nakra C P. 2003. *Farm Machines and Equipment*. Dhanpat Rai and Publishing Co., Delhi
5. Smith H P and Wilkes L H. 2011. *Farm Machinery and Equipment*. McGraw Hill Publication, New York.
6. Srivastav A K, Goering C E and Rohrbach R P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Mich.
7. Srivastava A C. 1991. *Elements of Farm Machinery*. Oxford and IBH Publication, New Delhi.
8. Srivastava T K. 2007. *A work Book on Practical Farm Machinery*. Vol. I and II. Saroj Prakashan, Allahabad.
9. Suresh R and Kumar S. 2018. *Farm Power and Machinery Engineering*. Standard Publishers, Delhi.

Renewable Energy Sources 3 (2+1)

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations

Theory

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources.

Solar energy: Energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system; Solar photo voltaics- basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station; Calculation of energy through photovoltaic power generation and cost economics.

Wind energy: Energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system.

Biogas: Basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design and use of different commercial biogas plants.

Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification and Dendro-thermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Suggested Readings

1. Basu P. 2018. *Biomass Gasification and Pyrolysis Practical Design and Theory*. Academic Press, Cambridge.
2. Deublein D and Steinhauser A. 2008. *Biogas from Waste and Renewable Resources*. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

3. Duffie J A and Beckman W A. 2013. *Solar Engineering of Thermal Process*. John Wiley and Sons, Hoboken, NJ.
4. Julian Chen C. 2011. *Physics of Solar Energy*. John Wiley & Sons, Inc., Hoboken, NJ.
5. Khan B H. 2006. *Non-Conventional Energy Resources*. McGraw Hill, NY.
6. Knothe G, Gerpen J V and Krahl J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press, Elsevier, The Netherlands.
7. Patel M R. 2005. *Wind and Solar Power Systems*. CRC Press, Bota Racon.
8. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
9. Rai G D. 2020. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
10. Reed T B and Das A. 1988. *Handbook of Biomass Downdraft Gassifier Engine Systems*. SERI, USA.
11. Ryszard P. 2010. *Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization*. McGraw-Hill, NY.
12. Krauter S C W. 2008. *Solar Electric Power Generation – Photovoltaic Energy Systems*. Springer, Berlin..

Post-Harvest Engineering of Cereals, Pulses and Oilseeds 3 (2+1)

Objective

To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds, and the different equipment for the operations

Theory

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds.

Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

Principles of grain storage: different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage godown.

Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating.

Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

Practical

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant; Determination of EMC (static and dynamic method); Study of psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

Suggested Readings

1. Chakraverty A. 1999. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. 368p. Oxford & IBH publishing Co. Ltd, New Delhi.
2. Dash S K, Bebartta J P and Kar A. 2012. *Rice Processing and Allied Operations*. 310p. Kalyani Publishers, New Delhi.
3. Geankoplis C J. 2002. *Transport Processes and Unit Operations*. 938p. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Mangaraj S, Dash S K, Swain S and Ali N. 2016. *Agricultural Process Engineering*. Vol II. Kalyani Publishers, New Delhi.
5. McCabe W L, Smith J C and Harriott P. 1993. *Unit Operations of Chemical Engineering*. 1154 p. McGraw Hill, Singapore.
6. Sahay K M and Singh K K. 1994. *Unit Operations of Agricultural Processing*. 340p. Vikas Publishing House Pvt. Ltd, New Delhi.
7. Swain S, Dash S K, Mangaraj S and Ali N. 2016. *Agricultural Process Engineering*. Vol I. Kalyani Publishers, New Delhi.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide the student an insight into the concept and scope of entrepreneurship
ii. To expose to various aspects of establishment and management of a small business unit
iii. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages/salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agri-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises*. 523p. Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management*. Himalaya Publishing House, New Delhi.
3. Desai V. 1997. *Small Scale Industries and Entrepreneurship*. 780p. Himalaya Publishing House, New Delhi.
4. Grover I. 2008. *Handbook on Empowerment and Entrepreneurship*. 192p. Agrotech Publishing Academy, Udaipur, Rajasthan.
5. Gupta C B. 2001. *Management Theory and Practice*. Sultan Chand & Sons, New Delhi.
6. Khanka S S. 1999. *Entrepreneurial Development*. S. Chand & Co, New Delhi.
7. Mehra P. 2016. *Business Communication for Managers*. 432p. Pearson India, New Delhi.
8. Pandey M and Tewari D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
9. Singh D. 1995. *Effective Managerial Leadership.* 130p. Deep & Deep Publications, New Delhi.
10. Singhal R K. 2013. *Entrepreneurship Development and Management*. 300p. S K Kataria and Sons, New Delhi.

11. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill Publishing Company Ltd, New Delhi.

Post-IV semester

Internship (only for exit option for award of UG-Diploma) 10 weeks **10 (0+10)**

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-Diploma, they will be able to get proper engagement/ employment and will be competent to start an enterprise

Activity

The students will undergo internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

Semester V

Strength of Materials **2 (1+1)**

Objective

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

1. Introduction to strength of materials.
2. Slope and deflection of beams: Slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection.
3. Theory of columns and struts, problems of column and struts.
4. Steel connections: Analysis of rivet connections, analysis of welded connections.
5. Stability analysis of masonry dam; problems on masonry dam.
6. Statically indeterminate structures- analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three moment equation.
7. Analysis of beam using moment distribution method and solving problems.

Practical

To determine the quality of check of two different aggregates through impact test; To perform the tensile test of steel specimen - to observe the behaviour of materials under load - to calculate the value of e- ultimate stress, permissible stress, percentage elongation etc. And to study its fracture; To prepare mortar specimen of different cement, demoulding of the specimen next day for compression and tension test after 2nd and 4th week; To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2nd and 4th week; To perform compression and tension test on mortar specimen prepared 2 weeks before; To perform compression and bending test of the concrete specimen prepared 2 weeks before; To perform compression and tension test on mortar specimen prepared 4 weeks before; To perform compression and bending test of the concrete specimen prepared 4 weeks before; To determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points; To perform Brinell's hardness tests on a given specimen; To study the behaviour of materials under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Suggested Readings

1. Junarkar S B. 2001. *Mechanics of Structures* (Vo-I). Choratar Publishing House, Anand.
2. Khurmi R S. 2006. *Strength of Materials*. S. Chand Publishing, New Delhi.
3. Lehri R S and Leheri R S. 2006. *Strength of Materials*. S.K. Kataria & Sons, New Delhi.
4. Ramamrutham S and Narayanan R. 2003. *Strengths of Materials*. Dhanpat Rai and Sons, Nai Sarak, New Delhi.
5. Vazirani V N, Ratawani M M and Duggal S K. 2012. *Analysis of Structures*. Khanna Publishers, New Delhi.

Theory of Machines 2 (2+0)

Objectives

i. To enable the students to analyse the relative motion between various parts of machine and forces which act on them

ii. To apply the theories in designing the various parts of the machine

Theory

Simple mechanism: Elements, links, pairs, kinematics chain, and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain, slider crank chain and their inversions; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method.

Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method.

Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications.

Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; chain drives, classification of chain drive, terms used in chain drive.

Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.

Static and dynamic balancing, balancing of rotating masses in one and different planes.

Suggested Readings

1. Ballaney P L. 2016. *A Text Book of Theory of Machines*. Khanna Publishers, New Delhi.
2. Bansal R K. 2009. *A Text Book of Theory of Machines*. Laxmi Publications (P) Ltd., New Delhi.
3. Khurmi R S and Gupta J K. 2010. *A Text Book of Theory of Machines*. Euresia Publishing House (P) Ltd, New Delhi.
4. Ratan S S. 2010. *A Text Book of Theory of Machines*. Tata McGraw Hill Publishing Company Ltd, New Delhi.

Thermodynamics and Heat Transfer 3 (3+0)

Objectives

i. To make the students acquainted with principles of thermodynamics and heat transfer
ii. To make them understand the mathematical and practical aspects of heat exchangers

Theory

Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems- thermodynamic equilibrium, properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat.

First law of thermodynamics: internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1; characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion and throttling process; Second law of thermodynamics: limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics; Clausius statement, Kelvin-Planck statement; perpetual motion machine of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.

Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation

materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection, non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection.

Thermal radiation, black body radiation, Stefan-Boltzman law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity.

Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.

Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Suggested Readings

1. Gupta C P and Prakash R. 2008. *Engineering Heat Transfer*. Nem Chand and Bros., Roorkee.
2. Holman J P. 2018. *Heat Transfer*. McGraw Hill Book Co., New Delhi.
3. Incropera F P and De Witt D P. 2016. *Fundamentals of Heat and Mass Transfer*. John Wiley and Sons, New York.
4. Kumar D S. 2016. *Engineering Thermodynamics*. S.K. Kataria & Sons, Delhi.
5. Rajput R K. 2019. *A Text Book of Heat and Mass Transfer*. S. Chand & Company Ltd., New Delhi.

Tractor and Automotive Engines 3 (2+1)

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines.

Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies.

Study of engine components their construction, operating principles and functions; Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area.

Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio.

Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system-

injection pump, their types, working principles; Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics; Lubrication system- need, types, functional components; Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency.

Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator; Basics of engine testing.

Practical

Study of different systems of CI engines; Study of engine parts and functions, working principles, etc.; Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system, and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical system; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

1. Ganesan V. 1999. *Internal Combustion Engines*. Mc Graw Hill, New Delhi.
2. Goering C E and Hansen A C. 2004. *Engine and Tractor Power*. ASAE. St Joseph, Michigan.
3. Heitner J. 2004. *Automotive Mechanics: Principles and Practices*. 608p. CBS Publishers, New Delhi.
4. Liljedahl J B, Turnquist P K, Smith D W and Hoki M. 1989. *Tractors and Their Power Units*. Van Nostrand Rainhold, New York.
5. Mathur M L and Sharma R P. 1996. *A course in Internal Combustion Engines*. Dhanpat Rai and Sons, New Delhi.
6. Rodichev V and Rodicheva G. 1984. *Tractors and Automobiles*. Mir Publishers, Moscow.
7. Singh K. 2020. *Automobile Engineering. (*Vol II.). 728p. Standard Publishers and Distributors, New Delhi.

Irrigation and Drainage Engineering 4 (3+1)

Objectives

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods.

Design and lining of irrigation field channels, on-farm structures for water conveyance, control and distribution; Underground pipe conveyance system: components and design; land grading; Criteria for land levelling, land levelling design methods.

Soil-water-plant relationship: Soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies.

Surface methods of water application: Border, check basin and furrow irrigation-adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient.

Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations; Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope; Layout, construction and installation of drains; Drainage structures, vertical drainage, bio-drainage, tile drains, mole drain.

Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practical

Measurement of soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method; Study on *in-situ* measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and sub-surface drainage system; Visit to a waterlogged area and study of a drainage project.

Suggested Readings

1. Allen R G, Pereira L S, Raes D and Smith M. 1998. Crop Evapotranspiration Guidelines for Computing Crop Water Requirement. (In) *Irrigation and Drainage Paper,* 56, FAO of United Nations, Rome.
2. Bhattacharya A K. 2008. *Drainage Engineering*. 82p. ICAR Publications, New Delhi.

3. Bhattacharya A K and Michael A M. 2013. *Land Drainage, Principles, Methods and Applications*. Vikas Publication House, Noida (UP).
4. Israelsen O W, Hansen V E and Stringham G E. 1980. *Irrigation Principles and Practices*. 430p. John Wiley & Sons, Inc. USA.
5. Majumdar D K. 2013. *Irrigation Water Management Principles*. 572p. PHI Learning Private Limited, New Delhi.
6. Michael A M. 2012. *Irrigation: Theory and Practice*. 772p. Vikas Publishing House, New Delhi.
7. Michael A M and Ojha T P. 2014. *Principles of Agricultural Engineering*. Vol II. (5th Edn). 1123p. Jain Brothers Publication, New Delhi.
8. Murthy V V N. 2013. *Land and water Management Engineering*. Kalyani Publishers, New Delhi.
9. Panigrahi B. 2013. *A Handbook on Irrigation and Drainage*. New India Publishing Agency, New Delhi.
10. Ritzema H P. 1994. *Drainage Principles and Applications*. ILRI Publication 16, Netherlands.

Food and Dairy Engineering 4 (3+1)

Objectives

i. To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products
ii. To make them understand the different types of equipment and their working principles used for these.

Theory

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance.

Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: thermo-bacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing.

Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating.

Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter,

rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.

Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.

Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles.

Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

Practical

Preparation of flow charts for different food processing industries; Study of different parts of retort and canning process; Study of different types of evaporators and multiple effect evaporation system; Study of drum dryer and spray dryer and comparison of product qualities; Study of different types of mixers for solids and liquids; determination of mixing effectiveness and mixing index; Study of settling and sedimentation process in a tank; Study of different types of filters; Study of membrane modules and different types of membranes; Study of measurement of different properties of milk and milk products; Study of milk pasteurizer, sterilizer and homogenizer; Study on preparation of cream and butter; Study of preparation of cheese, paneer and ice cream; Study of different types of packaging materials; Study of different types of filling machines for liquids and powder/ granules; Study of layout of a food processing plant; Visit to food processing industries and dairy plants to study the plant layout and unit operations.

Suggested Readings

1. Ahmed T. 1997. *Dairy Plant Engineering and Management*. 816p. Kitab Mahal, Daryaganj, New Delhi.
2. Dash S K, Chandra P and Kar A. 2024. *Food Engineering Principles and Practice*. 550p. CRC Press, Boca Raton, USA.
3. McCabe W L, Smith J C and Harriott. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
4. Rao D G. 2009. *Fundamentals of Food Engineering*. 640p. PHI learning Pvt. Ltd, New Delhi.
5. Singh R P and Heldman D R. 1993. *Introduction to Food Engineering*. Academic Press, USA.
6. Toledo R T 1997. *Fundamentals of Food Process Engineering*. 602p. CBS Publishers, New Delhi.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Andrews S. 2008. *How to Succeed at Interviews*. Tata McGraw-Hill.
2. Heller R. 2002. *Effective Leadership. Essential Manager series*. D K Publishing, New York.
3. Hindle T. 2009. *Reducing Stress. Essential Manager series*. D K Publishing, New York.
4. Lucas S. 2001. *Art of Public Speaking*. Tata - Mc-Graw Hill, London.
5. Mile D J. 2004. *Power of Positive Thinking*. Rohan Book Company, Delhi.
6. Kumar P. 2005. *All about Self- Motivation*. Goodwill Publishing House, New Delhi.
7. Smith B. 2004. *Body Language*. Rohan Book Company, Delhi.
8. Shaffer D R. 2009. Social and Personality Development (6thEdn.). 608p. Belmont, CA: Wadsworth.

Seminar 1 (0+1)

Objectives

i. To enable students to improve their knowledge and understanding of a topic
ii. To develop confidence and competence to identify and compare technical and practical issues related to the area of course specialization and to present it before a group of people

Practical

The student will be assigned to present on a technical and practical issue or on an emerging field. The activities should include establishing motivation for any topic of interest and develop a thought process for technical presentation, conduct a detailed literature survey and to build a document with respect to technical publications, analysis and comprehension of proof-of-concept and related data, and effective presentation with improved soft skills. It should also involve use of new and recent technologies for creating technical reports and presentation. The evaluation shall be based on the ability of the student to describe, interpret and analyze technical issues and competence in presenting.

Study tour- Non-gradial 2 (0+2)

The study tour will be of 10-14 days duration within the 5th semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organisations/ industries (related to the profession), they will also be exposed to the geographical, social, socio-economic and cultural diversity of different places/ states. After the visit, the students will submit a report/ make a presentation.

Semester VI

Tractor Systems and Controls 3 (2+1)

Objectives

i. To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems

ii. To understand the ergonomical and safety considerations in tractor

Theory

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements.

Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers.

Suggested Readings

1. Barger E L, Liljedahl J B and McKibben E C. 1967. *Tractor and their Power Units*. Wiley Eastern.
2. Giri N K. 2013. *Automobile Mechanics (SI Units)*. 1013p. Khanna Publishers, Delhi.
3. Jain S C and Rai C R. 2013. *Farm Tractor, Maintenance and Repair*. Standard Publisher and Distributers, Delhi.
4. Singh K. 2020. *Automobile Engineering*. Standard Publisher and Distributers, Delhi.
5. Srivastav A K, Goering C E and Rohrbach R P. 2005. *Engineering Principles of Agricultural Machines*. 604p. ASAE. St. Joseph, Michigan, USA. .

Groundwater, Wells and Pumps 3 (2+1)

Objective

To make the students acquainted with the quality of ground water, equipment and methods for construction of wells, and different types of water lifting devices

Theory

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of groundwater, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells.

Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells.

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise groundwater development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of groundwater.

Quality of groundwater, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water.

Pumping systems: Water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by This method, Coopers-Jacob method, Chow method and Theis Recovery method; Design of well; Study of well losses and well efficiency; Determination of safe yield by Hill's method; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of groundwater balance; Study of various artificial ground- water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site; Visit to a groundwater project and a river lift project.

Suggested Readings

1. Garg S P. 1987. *Groundwater and Tube Wells*. 563p. Oxford & IBH Publishing Co. Ltd., New Delhi.
2. Lal R. 1993. *Irrigation Hydraulics*. 456p. Ajiwan Shiksha Sansthan, Allahabad.
3. Michael A M, Khepar S D and Sondhi S K. 2008. *Water Well & Pump Engineering*. 720p. Tata Mc-Graw Hill, New Delhi.
4. Nagabhusaniah H S. 2020. *Groundwater in Hydrosphere*. CBS Publishers and Distributors, New Delhi.
5. Raghunath H M. 2007. *Groundwater*. 520p. New Age International (P) Limited, New Delhi.
6. Todd D K and Mays L W. 2011. *Groundwater Hydrology*. John Wiley & Sons, New York.

Sensors, Artificial Intelligence and Robotics in Agriculture 3 (2+1)

Objectives

i. Basics and selection of sensors for different agricultural applications
ii. Application of artificial intelligence and AI programming techniques
iii. Problem-solving through search and knowledge representation and reasoning with AI
iv. Use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm and basics on neural network

Theory

Sensors Fundamentals: Introduction to sensors and transducers; Need for sensors in the agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect–Pyroelectric effect- Magneto mechanical effect (magnetostriction) – Magneto resistive effect.

Basics of detector materials/sensor type (Silicon diod, InGaAS etc.) and their characteristics. Fundamentals of visual, NIR, IR and FTIR spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results.

Sensors in different applications: Occupancy and motion detectors; Position, displacement, and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature sensors, Optical sensors and electromagnetic wave detector.

Capacitance sensors: Weather sensors, imaging sensors and their application in agriculture.

Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor etc.

Biosensors, general components of biosensor, biomolecules in biosensors such as enzyme, DNA, antibody, Nanomaterials in biosensors- Quantum dots.

Selection of Sensors:

Introduction to Artificial Intelligence: *Overview*- foundations, scope, problems, history and approaches of AI. Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, AI programming techniques. Classical AI, concept of expert system, conflict resolution, multiple rules, forward chaining, backward chaining; Advantages and limitations of AI systems.

Problem-solving through Search: Forward and backward, state-space, blind, heuristic, problem reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, bidirectional search, heuristic search, problems and examples.

Knowledge Representation and Reasoning: Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graphs.

Robotics: Introduction to Robotics-classification with respect to geometrical configuration (anatomy), selection based on the agriculture application; Hardware for robot, sensors and actuator in robot, control of robot, system interface and integration in robot; Communication- internal and external communications; Fundamentals of microprocessor architecture; Introduction to use of open source hardware (arduino and raspberry pi); robot programming, controlling algorithm-basic on neural network; Feedback system, safety sensors; Controlled system and chain type: Serial manipulator and Parallel Manipulator. Components of Industrial robotics-precession of movement-

resolution, accuracy and Repeatability-Dynamic characteristics- speed of motion, load carrying capacity and speed of response.

Application in Agriculture: Introduction to precision farming tools for implementation of precision agriculture; Application of site-specific management - nutrient management, agro-chemicals and fertilizer management, weeds management; Application of drone- pesticides/ nutrient spraying, environmental monitoring; Yield monitoring and mapping, soil sampling and analysis; Protected cultivation - smart irrigation system; precision livestock farming, application in food processing; image processing- shape analysis, feature detection and object location; gas and chemical sensor for electronic nose and electronic tongue.

Practical

Identify various sensors viz. Proximity sensors, ultrasonic sensors, optical sensors, electrochemical sensors and mechanical sensors; Measurement of displacement, force and pressure using different sensors; Use of load sensor on tractors to predict pulling requirements for ground engaging equipment; Introduction to open source programming languages, advantages and drawbacks of open source programming; Programming in Embedded- C, Concepts of C language; Identify various components in open source hardware (arduino and raspberry pi); Using of open source hardware and program for LED blink; Using of open source hardware and program for buzzer; Measurement of distance using ultrasonic sensor and IR sensor using open source hardware and programs; Experiment using moisture, temperature and relative humidity sensors for automatic irrigation and protected cultivation; Detection based spraying system using ultrasound for spraying operation using opens source hardware by programming with sensor and testing; Detection based spraying system using ultrasound for spraying operation – installation on sprayer unit with actuator/sensor and testing; Learning on open source image processing software for shape analysis and object detection; Learning about the different applications of robots in agriculture; Fabrication and integration of sensors; Visit to robot fabrication facilities/workshop.

Suggested Readings

1. Bräunl T. 2013. *Embedded Robotics Mobile Robot Design and Applications with Embedded Systems*. Springer, Berlin Heidelberg.
2. Craig John J. 2005. *Introduction to Robotics*. (3rd Edn.). 400p. Pearson Education Inc., Kondon.
3. Ghoshal A. 2006. *Robotics: Fundamental Concepts and Analysis*. 423p. Oxford University Press, New Delhi.
4. Gonzalez, R C and Woods R E. 2018. *Digital Image Processing*. (3rd Edn.). Pearson Education, NY.
5. Jha S N. 2015. *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*. 266p. Elsevier, USA.
6. Jha S N (Ed.). 2010. *Nondestructive Evaluation of Food Quality: Theory and Practice*. 288p. Springer – Verlag GmbH Berlin
7. Nikku S B. 2020. *Introduction to Robotics – Analysis, Control, Applications*. (3rd Edn.). 520p. John Wiley & Sons Ltd, USA.
8. Nilsson N J. 1980. *Principles of Artificial Intelligence*. 476p. Morgan Kaufmann Publishers Inc., USA.
9. Rich E, Knight K and Nair S B. 2010. *Artificial Intelligence*. (3rd Edn.). 585p. Tata McGraw Hill, New Delhi.

10. Saha S K. 2014. *Introduction to Robotics*. 599p. Tata McGraw Hills Education, Nerw Delhi.
11. Schilling, R J. 1990. *Fundamentals of robotics – Analysis and control. 450p.* Prentice Hall of India, New Delhi.

Agricultural Structures and Environment Control 3 (2+1)

Objectives

i. To make the students acquainted with the different types of agricultural structures
ii. To enable them to prepare plan and estimate for different farm structures and environment control measures.

Theory

Farm and farmstead, farmstead planning and lay out; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control, systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures.

Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Greenhouses- types, poly houses /shed nets, cladding materials, plant environment interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system.

Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage godown, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds.

Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family.

Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a green house; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Suggested Readings

1. Banerjee G C. 2007. *A Text Book of Animal Husbandry*. 1079p. Oxford & IBH Publishing Co, New Delhi.

2. Dutta B N. 2016. *Estimating and Costing in Civil Engineering*. Dutta & Co, Lucknow.
3. Garg S K. 2010. *Water Supply Engineering*. 1180p. Khanna Publishers, New Delhi.
4. Khanna P N. 1958. *Indian Practical Civil Engineer's Hand Book*. 688p. Engineer's Publishers, New Delhi.
5. Nathonson J A. 1996. *Basic Environmental Technology*. Prentice Hall of India, New Delhi.
6. Ojha T P and Michael A M. 1966. *Principles of Agricultural Engineering*. (Vol. I.) Jain Brothers, New Delhi.
7. Pandey P H. 2004. *Principles and Practices of Agricultural Structures and Environmental Control*. 547 p. Kalyani Publishers, Ludhiana.
8. Rao P V. 2012. *Text Book of Environmental Engineering*. Prentice Hall of India, New Delhi.
9. Sahay K M and Singh K K. 2004. *Unit Operations of Agricultural Processing*. 386p. Vikas Publishing Pvt. Ltd, Noida.

Bioenergy Systems: Design and Applications 3 (2+1)

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems.

Biomass production- wastelands, classification and their use through energy plantation; Selection of species, methods of field preparation and transplanting; Harvesting of biomass and coppicing characteristics; Biomass preparation techniques for harnessing (size reduction, densification and drying).

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes.

Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles;

Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Suggested Readings

1. Basu P. 2018. *Biomass Gasification, Pyrolysis and Torrefaction*. 582p. Academic Press, Elsevier, Amsterdam.
3. Knothe G, Gerpen J V and Krahl J. (Eds). 2010. *The Biodiesel Handbook*. 494p. AOCS Press, New York.
4. Rai G D. 2013. *Non-Conventional Energy Sources*. 912p. Khanna Publishers, New Delhi.
5. Reed T B and Das A. 1988. *Handbook of Biomass Downdraft Gasifier Engine Systems*. 140p. SERI, US.

Refrigeration and Air Conditioning 3 (2+1)

Objectives

i. To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment
ii. To enable them to design the refrigeration and air conditioning systems

Theory

Definition of pure substance, phases of a pure substance, phase change process of a pure substances; compressed liquid and saturated liquid, saturated vapour and superheated vapour, saturated temperature and saturated pressure; T-V diagram for heating of water at constant pressure.

Latent heat: Latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram; property tables, state-liquid and vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid.

Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T-S, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system.

Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric processes.

Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency; Study of heat pump test rig; Study of Ice plant test rig; Study of psychrometric chart and various psychrometric processes; Solving problems on psychrometrics; Study of window air conditioner; Study cold storage for fruit and vegetables, freezing load and time calculations for food materials; Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to chilling or ice making and cold storage plants.

Suggested Readings

1. Arora C P. 2012. *Refrigeration and Air Conditioning*. 962p. Tata-McGraw-Hill, New Delhi.
2. Khurmi R S. 2016. *Refrigeration and Air Conditioning*. 720p. S Chand and Co. Ltd, New Delhi.

Post-Harvest Engineering of Horticultural Crops 2 (1+1)

Objective

To make the students acquainted with unit operations in processing of major horticultural crops and working principles of different machineries for these.

Theory

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling).

Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction; Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment.

Drying: Dryers for fruits and vegetables, osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans; Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical and cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores.

Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers; Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw

and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practical

Preparation of different processed horticultural products; Study of fruit graders; Study of different types of peelers and slicers; Study of juicer and pulper; Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching; Study of different dryers for fruits and vegetables; Study of foam mat drying and osmotic dehydration processes; Study of different activities in pack house; Cold storage heat load calculations and design; Study of different types of packaging materials; Study of CAS and MAP of vegetables; Study of shrink packaging of foods; Study of hammer mill, pulveriser for grinding of spices to powder; Visit to fruit and vegetable processing/ spice processing plant.

Suggested Readings

1. Dash S K, Chandra P and Kar A. 2024. *Food Engineering Principles and Practice*. 550p. CRC Press, Boca Raton, USA.
2. Fellows P J. 2008. *Food Processing Technology Principles and Practices*. Woodhead Publishing.
3. Lal G, Siddappa G S and Tondon G L. 2009. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
4. Mangaraj S, Ali N, Swain S and Dash S K. 2016. Agricultural Process Engineering. Vol. III. 348p. Kalyani Publishers, New Delhi.
5. Pandey P H. 1997. *Post-harvest Technology of Fruits and Vegetables (Principles and Practices)*. Saroj Prakashan, Allahabad.
6. Srivastava R P and Kumar S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. Kalyani Publishers, New Delhi.
7. Sudheer K P and Indira V. 2007. *Post-Harvest Engineering of Horticultural Crops*. 320p. New India Publishing, New Delhi.

Case study 1 (0+1)

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

1. Study the status of farm mechanization and agro-processing in a particular village and to suggest improvement measures
2. Study a specific watershed and suggest measures for rejuvenating the watershed
3. Study the losses of fruits and vegetables in a local market yard and suggest remedial measures
4. Study the supply chain for a commodity and suggest a suitable value chain
5. Visit to a village to study the energy consumption pattern and suggest measures for efficient energy use and integration of renewable energy for different farm operations
6. Visit to an orchard and suggest measures for optimized water use
7. Visit to a retail store/ farm machinery dealer and report on supply chain network
8. Visit to a retail store and study the different types of packaging materials
9. Visit to an entrepreneur and study his journey to success (or reasons of failure)

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

The activity and presentations are recommended to be accommodated on Saturdays. A teacher will be designated as the facilitator for the programme.

Semester VII

Project-I **3 (0+3)**

Objective

To strengthen the skill of the students and for developing their confidence to take up either research or employment/ entrepreneurship as a future career.

Activity

The activities should aim at development of advanced skill for research/ employment and entrepreneurship. The activities can be planned considering the total 7 credit hours allocated in the 7th and 8th semesters, viz. Project I (0+3 credit hours in 7th semester) and Project II (0+4 credit hours in the 8th semester).

The course can be taken either for developing research skills in form of project (R and D based, field study based) or for entrepreneurship development (incubation/ experiential learning based). The student will have the option to choose the mode of this course in consultation with a faculty mentor (each student will be attached to a mentor either from the College/ University or from any organisation/ industry).

Engineering Graphics and Design 2 (0+2)

Objective

i. To acquaint the students with CAD softwares for drawing of machine components

ii. To integrate the computers at various levels of planning and manufacturing

Practical

Application of computers for design; CAD- introduction, overview of CAD window; Various options on drawing screen; Practice on draw and dimension tool bar; Practice on OSNAP, line thickness and format tool bar; Practice on mirror, offset; Practice on array commands; Practice on trim, extend; Practice on trim chamfer and fillet commands; Practice on copy, move, scale and rotate commands; Drawing of 2 D- drawing using draw tool bar; Practice on creating boundary, region, hatch and gradient commands; Practice on Editing polyline- PEDIT and Explode commands; Setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes; 2D- drawing of machine parts with all dimensions and allowances; Drawing of foot step bearing, knuckle joint; Sectioning of foot step bearing and stuffing box; Drawing of hexagonal, nut and bolt and other machine parts; Practice on 3-D commands- Extrusion and lift, sweep and press pull, revolving, joining; Demonstration on CNC machine and practice problems.

Suggested Readings

1. Lee K. 1999. *Principles of CAD/CAM/CAE Systems*. 582p. Addison Wesley Longman, Inc. USA.
2. Rao P N. 2002. *CAD/CAM Principles and Applications*. 735p. McGraw-Hill Education Pvt. Ltd., New Delhi.
3. Sareen K and Grewal C D. 2010. *CAD/CAM Theory and Practice*. S. Chand & Company Ltd., New Delhi.
4. Zeid I. 2011. *Mastering CAD/ CAM with Engineering*. McGraw-Hill Education Pvt. Ltd., New Delhi..

Food Quality and Safety 3 (2+1)

Objective

To enable the student to know about the concept and aim of food quality and safety, food quality characteristics – physical, chemical and biological properties, different hazards and their prevention, different methods for measuring food quality as well as the food safety management system

Theory

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices.

Quality control, quality control tools, statistical quality control: Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials; Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.

Non-destructive methods for evaluation of food quality: NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy. Sensory evaluation methods, panel selection methods, Interpretation of sensory results.

Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC; Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC); Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry.

Practical

Study of statistical process control in food processing industry; Study of sampling techniques, tools and protocols used in different types of food handling, processing and marketing establishments; Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds and pulses from godowns and market shops in relation to specifications provided by standardization techniques; Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI; Detection of adulteration and examination of spices for Agmark/ FSSAI standards; Detection of adulteration and examination of milk and milk products for FSSAI standards; Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification; Visit to a professional quality control laboratory; Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

Suggested Readings

1. Acharya K T. 2017. *Everyday Indian Processed foods*. 184p. National Book Trust, New Delhi.
2. Gupta V. (Ed.). 2006. *The Food Safety and Standards Act, 2006 along with Rules & Regulations*. 1500p. Commercial Law Publishers (India) Pvt. Ltd, New Delhi.
3. Jha S N. 2015. *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice. 266p.* Elsevier, USA.
4. Jha S N. (Ed.). 2010. *Nondestructive Evaluation of Food Quality: Theory and Practice*. 288p. Springer – Verlag GmbH Berlin Heidelberg, Germany.
5. Mudambi S R, Rao S M and Rajgopal M V. 2006. *Food Science*. 224p. New Age International Publishers, New Delhi.
6. Negi H P S, Sharma S and Sekhon K S. 2007. *Hand book of Cereal Technology*. 233p. Kalyani Publishers, Ludhiana.
7. Potter N N and Hotchikss J H. 1995. *Food Science*. 624p. Chapman and Hall, New York.
8. Raj D, Sharma R and Joshi V K. 2011. *Quality Control for Value Addition in Food Processing*. 324p. New India Publishing Agency, New Delhi.
9. Ranganna S. 1986. *Hand book of Analysis and Quality Control for Fruit and Vegetable Products*. 1135p. Tata McGraw-Hill Education, New York.
10. Sharma A. 2017. *A Textbook of Food Science and Technology*. 356p. CBS Publishers & Distributors, New Delhi.

11. Srivastava R P and Kumar S. 2017. *Fruit and Vegetable Preservation: Principles and Practices*. 356p. CBS Publishers and Distributors, New Delhi.

Websites and weblinks:

12. https://www.fssai.gov.in/cms/food-safety-and-standards-regulations.php
13. https://www.fssai.gov.in/cms/food-recall.php
14. https://www.fao.org/fao-who-codexalimentarius/en/

Watershed Planning and Management 3 (2+1)

Objective

To acquaint the students with different aspects of watershed planning and management including participatory approaches and also on the integrated watershed management practices

Theory

Watershed- introduction and characteristics; Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index.

Community mobilization and participatory institution building: participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture.

Water budgeting in a watershed; Management measures - rainwater conservation technologies *in-situ* and *ex-situ* storage, water harvesting and recycling; Dry farming techniques - inter-terrace and inter-bund land management; Integrated watershed management- concept, components, arable lands - agriculture and horticulture, non-arable lands- forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology.

Application of remote sensing and GIS in watershed planning and management; Introduction to Remote Sensing and GIS, Map projections and co-ordinate system. Spatial data structure: Raster, vector. Spatial relationship. Topology. Delineation of watersheds and generation of stream network; Preparation of various thematic maps in watershed; Hydrological Response Unit (HRU); Prioritization of watersheds; Watershed characterization; Watershed action plan; Analytical Hierarchy Process; Watershed evaluation and impact assessment; Quantification of surface and groundwater resources in watersheds; Computer models used for hydrologic and watershed modelling; Soil water assessment tool (SWAT); Case studies.

Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including cost-benefit analysis; Financial management and accounting procedure

Practical

Delineation of watersheds using toposheets; Surveying and preparation of watershed map; Quantitative analysis of watershed characteristics and parameters; Investigations on watershed

for planning and development including PRA; Analysis of hydrologic data for planning watershed management; Measurement of discharge and sediment in a watershed; Water budgeting of watersheds; Study of thematic maps using remote sensing; Study of watershed action plan using GIS; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study on components of earth embankments and its design; Study of watershed management technologies; Study of role of various functionaries in watershed development programs; Study of accounting and financial management systems in watershed entities; Visit to watershed development project areas.

Suggested Readings

1. Das G. 2008. *Hydrology and Soil Conservation Engineering: Including Watershed Management*. (2nd Edn.). 552p. Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal J C, Singh R P, Sharma S, Das S K, Padmanabhan M V and Mishra P K. 1995. *Field Manual on Watershed Management*, CRIDA, Hyderabad.
3. Mahnot S C. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service, New Delhi.
4. Rajora R. 2019. *Integrated Watershed Management*. Rawat Publications, New Delhi.
5. Sharda V N, Sikka A K and Juyal G P. 2006. *Participatory Integrated Watershed Management: A Field Manual*. Central Soil and Water Conservation Research and Training Institute, Dehradun.
6. Singh G D and Poonia T C. 2003. *Fundamentals of Watershed Management Technology*. Yash Publishing House, Bikaner.
7. Thomas C G. 2010. *Land Husbandry and Watershed Management*. Kalyani Publishers, Ludhiana..

Sprinkler and Micro Irrigation Systems 2 (1+1)

Objective

To make the students acquainted with the importance of micro irrigation systems, their design and lay out for efficient water, fertilizer and pesticides applications.

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system; Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency.

Micro Irrigation systems: types- drip, spray, and bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler; Study of discharge and uniformity coefficient; Design and installation of sprinkler irrigation system; Study of cost economics of sprinkler irrigation system; Study on maintenance of sprinkler irrigation system; Field visit to a sprinkler irrigation project; Study of different components of drip irrigation; Design and installation of drip irrigation system; Determination of pressure discharge relationship and emission uniformity for given emitter; Study of different types of filters and determination of filtration efficiency; Study of fertigation, types of liquid fertilisers, determination of rate of injection and calibration for chemigation/ fertigation; Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters; Study on maintenance of drip irrigation system; Study of cost economics of drip irrigation system; Field visit to micro irrigation system and evaluation of drip system; Field visit to study foggers.

Suggested Readings

1. Jain S C and Philip G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors, Delhi.
2. Mane M S and Ayare B L. 2007. *Principles of Sprinkler Irrigation system*. Jain Brothers, New Delhi.
3. Mane M S, Ayare B L and Magar S S. 2006. *Principles of Drip Irrigation systems*. Jain Brothers, New Delhi.
4. Michael A M, Shrimohan and Swaminathan K R. 1972. *Design and evaluation of irrigation methods (IARI Monograph No.1)*. Water Technology Center, IARI New Delhi.
5. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing, New Delhi.
6. Sivanappan R K. 1992. *Sprinkler Irrigation*. Oxford & IBH Publishing House, New Delhi.
7. Suresh R. 2010. *Micro Irrigation - Theory and Practices*. Standard Publishers Distributors, Delhi.

Machine Design 2 (2+0)

Objective

To make the students acquainted with design considerations for various machine components so as to enable them to take up the work of new design

Theory

Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings.

Suggested Readings

1. Bhandari V B. 2007. *Introduction to Machine Design*. Tata Mc. Graw Hill Publishing House. New Delhi.
2. Jain R K. 2013. *Machine Design*. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
3. Khurmi R S and Gupta J K. 2014. *A Text Book of Machine Design*. S. Chand & Company Ltd., New Delhi.
4. Sharma P C and Agarwal D K. 2010. *Machine Design*. S. K. Kataria & Sons, New Delhi.

Electrical Machines 3 (2+1)

Objectives

i. To make the students acquainted with operating principles of various electrical motors and other machines
ii. To help them gain practical exposure of different electrical devices and their controls

Theory

Introduction to electrical machines; Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit: concept of magnetic flux production, magneto motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses.

Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load/ load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; D.C. machines: principles operation and performance of DC machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control.

Three phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition. phasor diagram, starting and speed control methods; Single phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics.

Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and estimate copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3-point Starter; To start and run the D.C. motor (shunt, series and compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and

draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; To perform no-load test on 3-phase induction motor and to determine its no-load losses; To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters and to draw the circle diagram; To perform no load on1-phase induction motor to determine its no-load losses; To perform blocked-rotor test on 1-phase induction motor and to determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-test on 1-phase induction motor and plot torque-speed characteristic.

Suggested Readings

1. Anwani M L. 1997. *Basic Electrical Engineering*. Dhanpat Rai & Co. (P) Ltd., New Delhi.
2. Boylestad Robert L and Louis N. 2015. *Electronic Devices and Circuit*. (11th Edn.), Pearson India.
3. Shaney A K. 1997. *Measurement of Electrical and Electronic Instrumentation*. Khanna Publications
4. Thareja B L and Theraja A K. 2005. *A Textbook of Electrical Technology. (*Vol-I) S. Chand & Company Ltd., New Delhi.
5. Theraja B L and Theraja A K. 2005. *A Textbook of Electrical Technology. (*Vol-II*)* S. Chand & Company Ltd., New Delhi.

Agricultural Statistics and Data Analysis 2 (1+1)

Objective

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts.

Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation.

Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean.

Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table).

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table) and m × n.

Suggested Readings

1. Agrawal B L. 1991. *Basic Statistics.* Wiley Eastern Ltd. New Age International Ltd., New Delhi
2. Chandel S R S. 1999. *A Handbook of Agricultural Statistics*. Achal Prakasan Mandir, Kanpur.
3. Gupta S C and Kapoor V K. 1970. *Fundamentals of Mathematical Statistics*. S Chand & Sons, New Delhi.
4. Gupta S C and Kapoor V K. 2019. *Fundamental Applied Statistics*. S Chand & Sons, New Delhi.
5. Nageswara Rao G. 2007. *Statistics for Agricultural Sciences*. BS Publications, New Delhi.
6. Rangaswamy R. 2018. *A Text Book of Agricultural Statistics*. New Age Int. Publications Ltd., New Delhi.

Semester VIII

S. No.	Course Title	Credit hours
1.	Project -II	4 (0+4)
2.	In-plant Training/ Research Internship	8 (0+8)
3.	Elective- I	3 (2+1)
4.	Elective- II	3 (2+1)
5.	Elective- III	3 (2+1)
	Total	**21 (6+15)**

Project-II 4 (0+4)

This will be the continuation of work/ study taken under the course Project- I

In-plant Training/ Research Internship (8 weeks) 8 (0+8)

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute. In addition, students will have an opportunity to enhance those skills,

obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice.

Activity

The students will have internship/ training for 8 weeks' duration in industries/ research organisations/ institutions. The College/ University will facilitate attaching the students to the organisations. In-plant training may be conducted in split manner in more than one industry/ organization/ institute.

After completion of training/ internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

Note: Considering that the students will be out of the campus for 8 weeks within the semester, the timetable for the remaining part of the semester should be so adjusted that each credit hour will have minimum of 15 classes.

Electives- I 3 (2+1)

The options for Elective courses and the details are given after this section.

Elective- II 3 (2+1)

The options for Elective courses and the details are given after this section.

Elective- III 3 (2+1)

The options for Elective courses and the details are given after this section.

ELECTIVE COURSES

The detailed syllabi of elective courses is given below.

Mechanics of Tillage and Traction 3 (2+1)

Objectives

i. To know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools
ii. To know the application of dimensional analysis on soil dynamics and traction
iii. To understand the effect of soil compaction on crop growth
iv. To know the use of GIS in soil dynamics

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship; Design of tillage tools, principles of soil cutting, design equation, force analysis; Application of dimensional analysis in soil dynamics and traction prediction equation.

Introduction to traction and mechanics, off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; Application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage; Soil parameters related to puddling and floatation; Draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Suggested Readings

1. Gill W R and Vanden Berg G E. 1968. *Soil Dynamics in Tillage and Traction*. Agricultural Research Service, USDA, Washington D.C.
2. Liljedahl J B, Turnquist P K, Smith D W and Hoki M. 2004. *Tractors and their Power Units*. 463p. CBS Publishers, New Delhi.
3. Macmillan R H. 2002. *The Mechanics of Tractor-Implement Performance*. 166p. International Development Technologies Centre, University of Melbourne, Australia.
4. Terzaghi K, Peck R B and Mesri G. 1996. *Soil Mechanics in Engineering Practices*. 549p. John Willey & Sons Inc., New York.

Farm Machinery Design and Production 3 (2+1)

Objective

To enable the students to design farm machinery and to understand the production principles

Theory

Introduction to design parameters of agricultural machines and design procedure, characteristics of farm machinery design, research and development aspects of farm machinery; Introduction to safety in power transmission; Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery; Cutting tools including CNC tools and finishing tools; Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and fixtures; Industrial lay-out planning, quality production management, reliability; Economics of process selection, familiarization with project report.

Practical

Familiarization with different design aspects of farm machinery and selected components; Solving design problems on farm machines and equipment; Visit to agricultural machinery manufacturing industry, tractor manufacturing industry; Study of jigs and fixtures in relation to agricultural machinery; Study of fits, tolerances and limits; Layout planning of a small scale

industry; Problems on economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Suggested Readings

1. Adinath M and Gupta A B. 1996. *Manufacturing Technology*. 384p. New Age International (P) Ltd, New Delhi.
2. Narula V. 2009. *Manufacturing Processes*. S K Kataria & Sons, New Delhi.
3. Richey C B. 1961. *Agricultural Engineering Handbook*. McGraw-Hill Inc., USA.
4. Sharma D N and Mukesh S. 2021. *Farm Machinery Design (Principles and Problems).* (4th Edn.), Jain Brothers, New Delhi.
5. Sharma P C and Aggarwal D K. 2010. *Machine Design*. S K Kataria & Sons, New Delhi.
6. Singh S. 2016. *Mechanical Engineer's Handbook.* Khanna Publications, New Delhi.

Tractor Design and Testing 3 (2+1)

Objectives

i. Parameters for balanced design of tractor for stability and weight distribution
ii. Special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.
iii. Perform testing of tractor

Theory

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability and weight distribution; Traction theory; hydraulic lift and hitch system design; Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches; Rolling friction and anti-friction bearings; Design of Ackerman Steering and tractor hydraulic steering; Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.; Design of seat and controls of an agricultural tractor; Tractor Testing.

Practical

Design problem of tractor clutch (single/multiple disc clutch); Design of gear box (synchromesh/ constant mesh), variable speed constant mesh drive; Selection of tractor tires; Problem on design of governor; Design and selection of hydraulic pump; Engine testing as per BIS code; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test; Hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Suggested Readings

1. Liljedahl J B, Turnquist P K, Smith D W and Hoki M. 2004. *Tractors and their Power Units*. CBS Publishers and Distributors, New Delhi.
2. Maleev V L. 1964. *Internal Combustion Engines*. McGraw-Hill Inc., US.

3. Mehta M L, Verma S R, Mishra S K and Sharma V K. 1995. *Testing and Evaluation of Agricultural Machinery*. National Agricultural Technology Information Centre, Ludhiana.
4. Richey C B. 1961. *Agricultural Engineering Handbook*. McGraw-Hill Inc., US.
5. Singh K. 2018. *Automobile Engineering*– Vol I and Vol II. Standard Publishers and Distributors, New Delhi.

Hydraulic Drives and Controls 3 (2+1)

Objective

To enable the students to understand the basic principles of hydraulic power system and tractor hydraulic system and different control measures

Theory

Basics of hydraulics: Pascal's law, flow, energy, work, and power; Hydraulic systems, colour coding, reservoirs, strainers and filters, filtering material and elements, accumulators, pressure gauges and volume meters; Hydraulic circuit, fittings and connectors; Pumps and its classifications, operation, performance, displacement; Design of gear pumps, vane pumps, piston pumps. hydraulic actuators; Cylinders, construction and applications, maintenance; Hydraulic motors, valves, pressure-control valves, directional- control valves, flow-control valves, valve installation, valve failures and remedies, valve assembly, troubleshooting of valves; Hydraulic circuit diagrams; USA Standards Institute (USASI) symbols; Tractor hydraulics, nudging system, ADDC, application of hydraulics and pneumatics drives in agricultural systems.

Practical

Introduction to hydraulic systems; Study of hydraulic pumps, hydraulic actuators; Study of hydraulic motors, hydraulic valves, colour codes and circuits; Building simple hydraulic circuits, hydraulics in tractors; Introduction to pneumatics, pneumatics devices, pneumatics in agriculture

Suggested Readings

1. Anthony E. 2014. *Fluid Power and Applications*. Pearson Education Limited, USA.
2. Kepner R A, Roy B and E L B. 2000. *Principles of Farm Machinery*, CBC Publishers & Distributors, New Delhi.
3. Kuhar J E. (Ed.). 1992. *Hydraulics (Fundamentals of Service Series)*. 224p. John Deere and Co., US.
4. Majumdar S R. 2002. *Oil Hydraulic System: Principles and Maintenance*. 548p. McGraw-Hill, New Delhi.
5. Meritt H E. 1991. *Hydraulic Control Systems*. 368p. John Wiley & Sons Inc., NY.

Human Engineering and Safety 3 (2+1)

Objective

To enable the students to understand the importance of human factors/ human engineering in farm machine design as well as for Implementation of ODMR and other safety aspects in farm operation

Theory

Human factors in system development- concept of systems, basic processes in system development, performance reliability, human performance; Information input process, visual displays, major types and use of displays, auditory displays; Speech communications; Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems; Human motor activities, controls, tools and related devices; Anthropometry: arrangement and utilization of work space, atmospheric conditions, thermo-regulation in human, thermal comfort, environmental factors, air pollution; Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor and trailer operation, etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter; Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view; Use of heart rate monitor; Study of general fatigue of the subject using Blink Ratio Method, anthropometric measurements of a selected subject; Optimum work space layout and locations of controls for different tractors; Familiarization with the noise and vibration equipment; Familiarization with safety gadgets for various farm machines; Studies on drudgery of farm women in manual drawn equipment.

Suggested Readings

1. Astrand P and Rodahl K. 1977. *Textbook of Work Physiology*. Mc Hill Corporation, New York.
2. Chapanis A. 1996. *Human Factors in System Engineering*. John Wiley & Sons, New York.
3. Dul J and Weerdmeester B. 1993. *Ergonomics for Beginners. A Quick Reference Guide*. Taylor and Francis, London.
4. Keegan J J and Radke A O. 1964. Designing Vehicle Seats for Greater Comfort. *SAE Journal* 72:50~5.
5. Mark S S and McCormick E J. 1993. *Human Factors in Engineering and Design*. McGraw Hill, New York.
6. Mathews J and Knight A A. 1971. *Ergonomics in Agricultural Equipment Design*. National Institute of Agricultural Engineering, Silsoe, Bedford.
7. Yadav R and Tewari V K. 1998. *Tractor Operator Workplace Design-A Review*. Journal of Terra mechanics, 35(1): 41-53.

Precision Agriculture and System Management 3 (2+1)

Objectives

i. To enable the students to understand the principles of precision agriculture and system management and the use of different equipment in precision agriculture

ii. To learn the GIS based precision agriculture, sensors and application of sensors for data generation

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines,

power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc.; Introduction to GIS based precision agriculture and its applications; Introduction to sensors and application of sensors for data generation; Database management; System concept, system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations; Application of PERT and CPM in machinery system management.

Practical

Familiarization with precision agriculture problems and issues; Familiarization with various machines for resource conservation; Solving problems related to various capacities, pattern efficiency, system limitation, etc; Problems related to cost analysis, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc.

Suggested Readings

1. DeMers M N. 2008. *Fundamentals of Geographic Information Systems*. (3rd Edn.). 484p. Wiley India Pvt Ltd.
2. Dutta S K. 1987.*Soil Conservation and Land Management*. International Book Distributors, Dehradun.
3. Hunt D. 1956. *Farm Power and Machinery Management*. Iowa State College Press, Iowa.
4. Kuhar J E. 1977. *The Precision Farming Guide for Agriculturist*. Lori J. Dhabalt, USA.
5. Sharma D N, Jain M and Lohan S K. 2021. *Farm Power and Machinery Management*. Jain Brothers, Ludhiana.
6. Sigma and Jagmohan. 1976. *Earth Moving Machinery*. Oxford & IBH, New Delhi.
7. Wood S. 1977. *Heavy Construction: Equipment and Methods*. Prentice Hall, Englewood Cliffs, N.J.

Photovoltaic Technology and Systems 3 (2+1)

Objectives

i. To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems
ii. To know the installation of PV system both off grid and on grid

Theory

Solar PV technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation.

Introduction to batteries, battery classification, lead acid battery, nickel cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter.

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Suggested Readings

1. Derrick A, Francis C and Bokalders V. 1991. *Solar Photo-voltaic Products*. Intermediate Technology Publications, London.
2. Meinel A B and Meinel M P. 1976. *Applied Solar Energy: An Introduction*. 581p. Addison-Wesley Pub. Co., Michigan.
3. Rai G D. 1998. *Non-conventional Sources of Energy*. Khanna Pub, New Delhi.
4. Rathore N S, Kurchania A K and Panwar N L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications, Udaipur.
5. Solanki C S. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications. 478p.* PHI Learning Private Ltd, New Delhi.

Wind Power Technology and Systems 3 (2+1)

Objective

To enable the students to calculate and analyse wind resource and energy production from a wind turbine, understand the typical control methods for wind turbines and the modes of wind power generation

Theory

Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation; Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator; Types of wind energy systems, wind to electrical energy conversion alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system.

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system; Control and monitoring system of a wind farm, wind farm siting; Wind map of India, wind-electric energy stations in India.

Practical

Detailed design and drawing of wind turbine; Study of horizontal axis wind turbine; Study of vertical axis wind turbine; Study of variation of wind speed with elevation; Study of validation of Weibull probability density function; Study of wind power density duration curve; Electrical characteristics and commissioning of complete aero-generator wind power system; Visit to a wind farm.

Suggested Readings

1. Kothari D P, Singal K C and Ranjan R. 2012. *Renewable Energy Sources and Emerging Technologies*. PHI Learning Private Limited. New Delhi.
2. Powar A G and Mohod A G. 2010. *Fundamentals of Wind Energy Utilization*. Jain Brothers Publisher, Karol Bagh, New Delhi.
3. Rai G D. 1998. *Non-conventional Sources of Energy*. Khanna Publishers, New Delhi.
4. Rao S and Parulekar B B. 2007. *Energy Technology*. Khanna Publishers, New Delhi.
5. Rathore N S, Kurchania A K and Panwar N L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications, Udaipur.
6. Solanki C S. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications*. PHI Learning Private Ltd., New Delhi.
7. Tiwari G N and Ghosal M K. 2005. *Renewable Energy Resources: Basic Principles and Applications*. Narosa Publishing House, New Delhi.

Waste and By-Products Utilization 3 (2+1)

Objectives

i. To enable the students to understand the nature of agricultural wastes and the physical, chemical and biological basis of agricultural waste treatment

ii. To analyse and design systems for the collection, handling, treatment and utilization of wastes

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting.

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste. Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by-products.

Suggested Readings

1. Bhatia S C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.
2. Garg S K. 1998. *Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering*. Khanna Publishers, New Delhi
3. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment & Utilization Technology*. New India Publishing Agency, New Delhi.
4. Markel I A. 1981. *Managing Livestock Waste*. 419p. AVI Publishing Co, New Delhi.
5. Pantastico E C B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-Tropical Fruits and Vegetables.* 560p. AVI Publishing Co, New Delhi.
6. Prashar A and Bansal P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
7. Shewfelt R L and Prussi S E (Eds.). 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc, NY.
8. USDA. 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
9. Vasso O and Winfried R (Eds). 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science & Business Media, New York.
10. Weichmann J (Ed.) 1987. *Post-Harvest Physiology of Vegetables*. 597p. Marcel and Dekker Verlag, NY.

Floods and Control Measures — 3 (2+1)

Objective

To enable the students to Understand the flood forecasting and warning systems, different permanent and temporary control measures of flood, and to design of storage structures and dams

Theory

Floods- causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood, flood estimation- methods of estimation; Estimation of flood peak- rational method, empirical methods, unit hydrograph method; Statistics in hydrology, flood frequency methods- log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis, flood forecasting; Flood routing- channel routing, Muskingum method, reservoir routing, modified Pul's method; Flood control- history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.

Gully erosion and its control structures- design and implementation; Earthen embankments- functions, classification, hydraulic fill and rolled fill dams, homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes.

Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding, etc., stability of slopes- analysis of failure by different methods; Planning of flood control projects and their economics.

Practical

Determination of flood stage-discharge relationship in a watershed; Determination of flood peak-area relationships; Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of probable maximum flood, standard project flood and spillway design flood; Design of levees for flood control; Designing, planning and cost- benefit analysis of a flood control project; Design of earthen dams; Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition; Stability of slopes of earth dams by friction circle and other methods; Construction of flow net for isotropic and anisotropic media; Computation of seepage by different methods; Determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; Study of reservoir rule curve; Visit to earthen dam and flood control reservoir.

Suggested Readings

1. Arora K R. 2014. *Soil Mechanics and Foundation Engineering (Geotechnical Engineering)*. Standard Publishers Distributors, Delhi.
2. Bureau of Reclamation. 1987. *Design of Small Dams*. US Department of Interior, Washington DC, USA.
3. Garg S K. 2014. *Soil Mechanics and Foundation Engineering*. Khanna Publishers, Delhi.
4. Garg S K. 2018. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, Delhi
5. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. (Vol. II) (4th Edn.), Jain Brothers, New Delhi.
6. Modi P N. 2010. *Irrigation and Water Power Engineering*. Standard Publishers Distributors, Delhi.
7. Murthy V V N and Jha M K. 2023. *Land and Water Management Engineering*. (3rd Edn.), Kalyani Publishers, New Delhi.
8. Mutreja K N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., Delhi.
9. Stephens T. 2010. *Manual on Small Earth Dams - A Guide to Siting, Design and Construction*. Food and Agriculture Organization of the United Nations, Rome.
10. Subramanya K. 2008. *Engineering Hydrology*. (3rd Edn.). Tata McGraw-Hill Publishing Co., New Delhi.
11. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.

Remote Sensing and GIS Applications 3 (2+1)

Objective

To enable the students to know about the remote sensing methods and applications in NRM, digital image processing and concepts of GIS and data management

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; Electromagnetic spectrum, energy interactions in the atmosphere and with the earth surface; Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures, different types of sensors and platforms, contrast ratio and possible causes of low contrast, aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs; Air-photo interpretation- interpretation elements; Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing, GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; Use of software for image interpretation; Interpretation of aerial photographs and satellite imagery; Basic GIS operations such as image display; Study of various features of GIS software package; Scanning, digitization of maps and data editing; Data base query and map algebra; GIS supported case studies in water resources management.

Suggested Readings

1. Elangovan K. 2006. GIS *Fundamentals Applications and Implementations*. New India Publication Agency, New Delhi.
2. George J. 2005. *Fundamentals of Remote Sensing*. (2nd Edn.) Universities Press (India) Private Limited, Hyderabad.
3. Jensen J R. 2013. *Remote Sensing of the Environment: An Earth Resource Perspective*. Pearson Education Limited, UK.
4. Lillesand T, Kiefer R W and Chipman J. 2015. *Remote Sensing and Image Interpretation*. (7th Edn.), John Wiley and Sons, Singapore.
5. Reddy A M. 2006. *Textbook of Remote Sensing and Geographical Information Systems*. BS Publications, Hyderabad.

6. Sabins F F. 2007. *Remote Sensing: Principles and Interpretation*. (3rd Edn.). Waveland Press Inc., Illinois, USA.
7. Sahu K C. 2008. *Text Book of Remote Sensing and Geographic Information Systems*. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz G A and Engman E T. 2000. *Remote Sensing in Hydrology and Water Management*. Springer, New York..

Information Technology for Land and Water Management 3 (2+1)

Objective

To enable the students to understand the application of IT natural resources management and design and application of decision support system and expert systems for NRM

Theory

Concept of Information Technology (IT) and its application potential, role of IT in natural resources management; Existing system of information generation and organizations involved in the field of land and water management; Application and production of multimedia, internet application tools and web technology, networking system of information, problems and prospects of new information and communication technology; Development of database concept for effective natural resources management; Application of remote sensing, geographic information system (GIS) and GPS; Rational data base management system, object oriented approaches; Information system, decision support systems and expert systems; Agricultural information management systems- use of mathematical models and programs; Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management; Video-conferencing of scientific information.

Practical

Multimedia production; Internet applications: E-mail, voice mail, web tools and technologies; Handling and maintenance of new information technologies and exploiting their potentials; Exercises on database management using database and spreadsheet programs; Usage of remote sensing, GIS and GPS survey in information generation and processing; Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc.; Exercises on simple decision support and expert systems for management of natural resources; Multimedia production using different softwares; Exercises on development of information system on selected theme(s); Video-conferencing of scientific information.

Suggested Readings

1. Bian F and Xie Y (Eds.). 2015. *Geo-Informatics in Resource Management and Sustainable Ecosystem*. Springer, New York.
2. De D and Basavaprabhu J. (Eds). 2010. *Communication Support for Sustainable Development*. Ganga Kaveri Publishing House, Varanasi.
3. FAO. 2013. *Climate-Smart Agriculture- Source Book*. FAO, Rome.
4. FAO. 1998. *Land and Water Resources Information Systems*. FAO Land and Water Bulletin 7, Rome.

5. ICFAI Business School (IBS). 2012. *Information Technology and Systems*. IBS Centre for Management Research, Hyderabad.
6. Loucks D P and Beek E V. 2005. *Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications*. UNESCO, Paris.
7. Malliva R and Thomas M. 2012. *Arid Lands Water Evaluation and Management*. Environmental Science. Springer, New York.
8. Sarvanan R. 2011. *Information and Communication Technology for Agriculture and Rural Development*. New India Publishing Agency, New Delhi.
9. Soam S K, Sreekanth P D and Rao N H (Eds). 2013. *Geospatial Technologies for Natural Resources Management*. New India Publishing Agency, Delhi.

Wasteland Development 3 (2+1)

Objectives

i. To enable the students to plan for wasteland development keeping in view of agro-climatic conditions, development options, contingency plans, conservation measures, water harvesting and recycling methods in consideration
ii. To know the different land reclamation and rehabilitation measures for wasteland development and use of micro-irrigation for sustainable wasteland development against adverse situations like drought and water-scarce situations

Theory

Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions, Troll's climatic classification, denuded range land and marginal lands; Wastelands- factors causing waste lands, classification and mapping of wastelands, planning of wasteland development-constraints, agro-climatic conditions, development options, contingency plans; Conservation structures- gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods; Afforestation-agro-horti-forestry-silvipasture methods, forage and fuel crops, socioeconomic constraints; Shifting cultivation, optimal land use options; Wasteland development-hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands; Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management; Micro-irrigation in wastelands development; Sustainable wasteland development- drought situations, socio-economic perspectives; Participatory approach in wasteland management; Preparation of proposal for wasteland development and benefit-cost analysis.

Practical

Mapping and classification of wastelands; Identification of factors causing wastelands; Estimation of vegetation density and classification; Planning and design of engineering measures for reclamation of wastelands; Design and estimation of different soil and water conservation structures under arid, semi-arid and humid conditions; Planning and design of micro-irrigation in wasteland development; Study on utilization of fly-ash in hydraulic structures; Study on mine spoil areas by plantation; Study on mine spoil areas by back filling of fly-ash; Study on environmental impact assessment (EIA) of mine spoil areas; Cost estimation of the various wasteland development

measures; Study on PRA exercise on wasteland management; Preparation of DPR of wasteland development projects; Visit to wasteland development project sites.

Suggested Readings

1. Abrol I P and Dhruvanarayana V V. 1998. *Technologies for Wasteland Development*. ICAR, New Delhi.
2. Ambast S K, Gupta S K and Singh G. (Eds). 2007. *Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands*. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Karthikeyan C, Thangaraja K, Fernandez C C and Chandrakandon K. 2009. *Dryland Agriculture and Wasteland Management*. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
4. Lal R and Stewart B A. (Eds). 2015. *Soil Management of Smallholder Agriculture*. Advances in Soil Science (Vol. 21). CRC Press, USA.
5. Malliva R and Missimer T. 2012. *Arid Lands Water Evaluation and Management*. Springer Heidelberg, New York.
6. Pachauri R K and Sridharan P V. (Eds) 2003. *Looking Back to Think Ahead Green India 2047*. TERI, New Delhi.
7. Swaminathan M S. 2010. *Science and Integrated Rural Development*. Concept Publishing Company (P) Ltd., Delhi.
8. Virmani S M (Ed.). 2010. *Degraded and Wastelands of India: Status and Spatial Distribution.* ICAR, New Delhi.
9. Yadav H R. 2013. *Management of Wastelands*. Concept Publishing Company. New Delhi.

Minor Irrigation and Command Area Development 3 (2+1)

Objective

To enable the students to importance of command area development programs in irrigation projects and to plan, design, execute and evaluate on-farm development works

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation projects; Types of minor irrigation systems in India, surface water and groundwater projects; Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank irrigation: grouping of tanks, storage capacity, supply works and sluices; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams.

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association; Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity.

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house; Planning and design of OFD works; Cost estimation of OFD work; Study of cross-drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

Suggested Readings

1. Arora K R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg S K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, New Delhi.
3. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
4. Reddi G H S and Reddy T Y. 2005. *Efficient Use of Irrigation Water*. Kalyani Publishers, Ludhiana.
5. Sahasrabudhe S R. 2011. *Irrigation Engineering and Hydraulic Structures*. S K Kataria & Sons, New Delhi.

Management of Canal Irrigation System 3 (2+1)

Objective

To enable the students to analyse water requirement and availability in a canal command, to take up design of lined and unlined canals and enable to control of losses of water in canal commands and for design and layout of different canal outlet structures

Theory

Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation; Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty; Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory; Maintenance of unlined irrigation canals, measurement of discharge in canals; Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi; Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials, design of lined canals; Functions of distributary head and cross regulators; Canal falls, their necessity and factors affecting canal fall, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties.

Practical

Estimation of water requirement of canal commands; Determination of canal capacity; Layout of canal alignments on topographic maps; Drawing of canal sections in cutting; Design of canal by full banking and partial cutting; Determination of longitudinal section (L-section) of canals; Design of irrigation canals based on silt theories (unlined canal); Design of lined canals; Formulation of warabandi system in canal command areas; Study of various types of canal outlet; Study of various types of canal regulators; Study of canal escapes; Study of various types of canal falls; Visit to a canal off taking site; Visit to a canal command area; Visit and discussion with functionaries of water user association.

Suggested Readings

1. Arora K R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg S K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, New Delhi.
3. Sahasrabudhe S R. 2011. *Irrigation Engineering and Hydraulic Structures*. S K Kataria & Sons. New Delhi.

Water Quality and Management Measures 3 (2+1)

Objective

To enable the students to understand the quality of surface and ground water, water contamination due to inorganic and organic compounds and the water decontamination technologies and the cultural and management practices for using poor quality water for irrigation

Theory

Natural factors affecting quality of surface water and groundwater, sources and pollution of groundwater; Water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria; Point and non-point water pollution sources; Water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds; Arsenic and fluoride contamination in groundwater and remedial measures; Water decontamination technologies; Cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; Soil chemical analysis and estimation of lime and gypsum requirements; Study of salinity development under shallow and deep water table conditions; Study of saline water ingress in coastal areas; Study of contamination movement and transport in soil profile; Study of turbidity of water through turbidity meter; Study of different water decontamination techniques; Study of different cultural and management practices for using poor quality water for irrigation; Visit to a water treatment plant; Visit to a water quality laboratory; Field visit to industrial effluent disposal sites.

Suggested Readings

1. FAO. 1996. *Control of Water Pollution from Agriculture - FAO Irrigation and Drainage.* Paper 55.
2. Gray N F. 2010. *Water Technology*. 768p. CRC Press, London.
3. Hussain S K. 1986. *Text Book of Water Supply and Sanitary Engineering*. Oxford & IBH Publishing Co., New Delhi.
4. Manahan S E. 2009. *Fundamentals of Environmental Chemistry*. CRC Press, New York.
5. McGauhey P H. 1968. *Engineering Management of Water Quality*. McGraw Hill Book Company, New York.
6. Minhas P S and Tyagi N K. 1998. *Guidelines for Irrigation with Saline and Alkali Waters*. 36p. Bull. No, 1/98, CSSRI, Karnal.
7. Punmia B C and Lal P B B. 1981. *Irrigation and Water Power Engineering*. Standard Publishers Distributors, Delhi..

Landscape Irrigation Design and Management 3 (2+1)

Objective

To enable the students to know about the different conventional and modern methods of landscape irrigation, various types of landscapes and their suitability with regard to different irrigation methods, design the modern landscape irrigation systems, automation of the landscape irrigation system and irrigation scheduling with proper methods of irrigation for different landscapes

Theory

Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems; Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes; Segments of landscape irrigation systems, main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application; Use of sensors for irrigation automation and use of IOT in landscape irrigation.

Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

Study of irrigation equipment for landscapes; Design and installation of irrigation system for landscape; Determination of water requirement; Determination of power requirement, pump selection; Irrigation scheduling of landscapes; Study of irrigation controllers and other equipment; Use of AutoCAD in irrigation design; Study of blocks and symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.; Study of various types of sensors for irrigation automation; Study of IoT in landscaping irrigation; Visit to landscape irrigation system and its evaluation.

Suggested Readings

1. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
2. Singh N P. 2010. *Landscape Irrigation and Floriculture Terminology*. Bangalore.
3. Smith S W. 1996. *Landscape Irrigation: Design and Management*. John Wiley and Sons, Inc., New York.

Application of Plastics in Agriculture 3 (2+1)

Objective

To enable the students to understand the applications in moisture conservation, canal and pond lining, use of plastic pipes in irrigation and drainage; know about soil solarisation, mulching, covering materials in green houses, shade houses, poly houses, surface covered cultivation, plastic fencing, nets for insects, birds etc. and in food grain structures, packaging materials, aquaculture, etc.

Theory

Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures; Water management- use of plastics in in-situ moisture conservation and rain water harvesting; Plastic film lining in canal, pond and reservoir, plastic pipes for irrigation water management, bore-well casing and subsurface drainage, drip and sprinkler irrigation systems, use of polymers in control of percolation losses in fields; Soil conditioning- soil solarisation, effects of different colour plastic mulching in surface covered cultivation; Nursery management- use of plastics in nursery raising, nursery bags, trays, etc.; Controlled environmental cultivation- plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers; Plastic nets for crop protection- anti insect nets, bird protection nets, plastic fencing.

Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products, Plastic CAP covers for storage of food grains in open; Use of plastics as alternate material for manufacturing farm equipment and machinery; Plastics for aquacultural engineering and animal husbandry- animal shelters, vermi-beds and inland fisheries; Silage film technique for fodder preservation; Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications.

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds; Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals; Study of components of subsurface drainage system; Study of different colour plastic mulch laying; Design, estimation and installation of green, poly and shade net houses, low tunnels, etc; Study on CAP device for food grain storage; Study of innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP; Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters; Preparation of vermi-bed and silage film for fodder preservation; Study of plastic parts in making farm machinery; Visits to nearby manufacturing units/ dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ poly-house/ shade-house/ net-house etc; Visits to farmers' fields with these installations.

Suggested Readings

1. Brown R P. 2004. *Polymers in Agriculture and Horticulture*. RAPRA Review Reports: 15(2), RAPRA Technology Limited, U.K.
2. Central Pollution Control Board. 2012. *Material on Plastic Waste Management*. Parivesh Bhawan, East Arjun Nagar, Delhi.
3. Chanda M and Roy S K. 2008. *Plastics Fundamentals, Properties, and Testing*. CRC Press, London.
4. Dubois. 1978. *Plastics in Agriculture*. Applied Science Publishers Limited, Essex, England.
5. Harper C A. 2006. *Handbook of Plastics Technologies*. *The Complete Guide to Properties and Performance*. McGraw-Hill, New Delhi.
6. Ojha T P and Michael A M. 2012. *Principles of Agricultural Engineering - I*. Jain Brothers, New Delhi.
7. Pandey P H. 2014. *Principles and Practices of Agricultural Structures and Environmental Control*. Kalyani Publishers, Ludhiana, India.
8. Sarkar A N. 1994. *Integrated Horticulture Development in Eastern Himalayas. 292p.* M.D. Publications Pvt. Ltd., New Delhi
9. Singh B, Singh B, Sabir N and Hasan M. 2014. *Advances in Protected Cultivation*. New India Publishing Agency, New Delhi.
10. Srivastava R K, Maheswari R C, Ojha T P and Alam A. 1988. *Plastics in Agriculture*. Jain Brothers, Karol Bagh, New Delhi..

Precision Farming Techniques for Protected Cultivation 3 (2+1)

Objectives

i. To enable the students to design and construction of green houses in different agro-climatic zones, greenhouse cooling and heating systems, environmental parameter and control, ventilation systems

ii. To assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation and to know about hydroponics, post-harvest management, pest management and economic aspects of a green house

Theory

Protected cultivation: introduction, history, origin, development, national and international scenario.

Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment; Design and construction of greenhouses-site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation.

Planting techniques in green house cultivation; Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement; Maintenance of irrigation and fogging systems.

Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application.

Greenhouse climate measurement, control and management; Insect and disease management in greenhouse and net houses; Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis.

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; Design and installation of irrigation system; Design and installation of fogging system; Study of different greenhouse environment control instruments; Study of operation, maintenance and fault detection in irrigation system; Study of operation, maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Suggested Readings

1. Sharma P. 2007. *Precision Farming*. Daya Publishing House, New Delhi.
2. Singh B and Singh B. 2014. *Advances in Protected Cultivation*. New India Publishing Company, New Delhi.

Environmental Engineering 3 (2+1)

Objectives

i. The water requirements for domestic, industrial and commercial demand and sources of water supply, analysis of water quality. importance to sanitation, domestic waste water treatment, sewer design, disposal of waste water in urban and rural areas

ii. The air pollution, types of pollutants, and their abetments

Theory

Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand- variation in demand, population estimation- design period, population forecasting methods; Sources of water supply- surface and sub-surface sources of water, surface sources-lakes, rivers, reservoirs; Intakes and transportation of water- various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits- design of pressure pipes as gravity mains, Darcy-Wesbach, Manning, Hazen-William formula, flow in pipes system- forces acting on pressure conduits-cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and testing of pipes, testing of pipes;

Selection of pumps, efficiency of pumps, economic diameter of pumping mains; Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods.

Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas; Sewer: types, design discharge and hydraulic design, Introduction to domestic wastewater treatment. Design of septic tank, sewerage system- domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen; Solid water collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas.

Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments.

Practical

Study of population forecasting problems; Determination of turbidity, pH and EC of water; Study of suspended solids, dissolved solids and total solids; Study of temporary and permanent hardness; Determination of fluorides and chlorides in drinking water; Determination of dissolved oxygen, COD and BOD of water; Study of hydraulics of pipe lines and distribution network design; Visit to a water treatment plant; Study of maintenance of distribution system; Collection of air samples and their analysis; Design of septic tank, sewer pipe lines and waste disposal measures; Visit to a sewage treatment plant; Visit to a municipal solid waste management plant; Visit to a community bio gas plant.

Suggested Readings

1. Chatterjee A K. 2006. *Water Supply, Waste Disposal & Environmental Engineering*. Khanna Publishers, Delhi
2. Garg S K. 1977. *Environmental Engineering. (*Vol. I and II.) Khanna Publishers, Delhi
3. Rao P V. 2002. *Text book of Environmental Engineering*. 280p. Prentice Hall of India Pvt. Ltd, New Delhi..

Development of Processed Food Products 3 (2+1)

Objective

To enable the students to know about the

i. Unit operations and equipment used for different food processing operations
ii. Processing technologies for value addition of cereals, pulses, oilseeds, vegetables, fruits, milk, fish, meat and poultry products

Theory

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk,

sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind; Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Practical

Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/ vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Suggested Readings

1. Acharya K T. 2017. *Everyday Indian Processed Foods*. 184p. National Book Trust, New Delhi.
2. Mudambi S R, Rao S M and Rajgopal M V. 2006. *Food Science*. 224p. New Age International Publishers, New Delhi.
3. Negi H P S, Sharma S and Sekhon K S. 2007. *Handbook of Cereal Technology*. 174p. Kalyani Publishers, New Delhi.
4. Potter N N and Hotchkiss J H. 1995. *Food Science*. Chapman and Hall, New York.
5. Rao D G. 2009. *Fundamentals of Food Engineering*. 704p. PHI Learning Pvt. Ltd, New Delhi.
6. Srivastava R P and Kumar S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Company, Lucknow.

Food Packaging Technology 3 (2+1)

Objectives

i. To understand the interaction of food, packaging and environment
ii. To understand the different methods of package development and packaging
iii. To select the best type and form of packaging of specific food for specific end users

Theory

Factors affecting shelf life of food material during storage, interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy.

Packaging of foods, requirement, importance and scope, environmental considerations; Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; Different types of packaging materials, their key properties and applications; Metal cans- manufacture of two piece and three piece cans; Plastic packaging- different types of polymers and lamination used in food packaging and their barrier properties; Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding; Glass containers- types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers; Paper and paper board packaging- paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards; Relative advantages and disadvantages of different packaging materials, effect of these materials on packed commodities.

Nutritional labelling on packages; CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging; Packaging requirement for raw and processed foods and selection of packaging materials; Disposal and recycle of packaging waste.

Package testing- testing methods for flexible materials, rigid materials and semi rigid materials, tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.)

Practical

Identification of different types of packaging materials; Determination of tensile/ compressive strength of given material/ package; To perform different destructive and non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; Measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging material; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package and visit to relevant industries.

Suggested Readings

1. Coles R, McDowell D and Kirwan M J. 2003. *Food Packaging Technology*. 346p. Blackwell Publishing Co, Oxford, UK.
2. Gosby N T. 2001. *Food Packaging Materials*. Applied Science Publication
3. John P J. 2008. *A Handbook on Food Packaging.* Narendra Publishing House, Delhi.
4. Mahadevia M and Gowramma R V. 2007. *Food Packaging Materials*. Tata McGraw Hill, New Delhi.
5. Robertson G L. 2001. *Food Packaging and Shelf life: A Practical Guide*. Narendra Publishing House. ISBN 9781420078442.
6. Robertson G L. 2005. *Food Packaging: Principles and Practice*. (2nd Edn.) CRP Press, Boca Raton.

Food Plant and Equipment Design 3 (2+1)

Objectives

i. To Understand the managerial aspects of food processing plant
ii. To Understand Govt. policy on small and medium scale food processing enterprise
iii. To Understand the procedure of obtaining license and registration for operating food processing business

Theory

Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams; Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout; Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout.

Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment; Design codes, pressure vessel design; Design of cleaners; Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger; Design of belt conveyer, screw conveyer and bucket elevator; Design of grain dryers; Design of milling equipment; Optimization of design with respect to process efficiency, energy and cost; Computer Aided Design.

Practical

Study of salient features and layout of preprocessing house; Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit; Evaluation of given layout; Design of pressure vessel; Design of cleaners; Design of milling equipment; Design of tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger; Design of grain dryer; Design of belt conveyor, bucket elevator, screw conveyor.

Suggested Readings

1. Bhattacharya B C. 2008. *Introduction to Chemical Equipment Design*. CBS Publishers and Distributors, Delhi.
2. Dawande S D. 1999. *Process Design of Equipment*. Central Techno Publication, Nagpur.
3. Geankoplis C J. 1993. *Transport Processes and Unit Operations*. Prentice-Hall, NJ, USA
4. Hall H S and Rosen Y S. 1963. *Milk Plant Layout*. FAO Publication, Rome.
5. López-Gomez A. 2005. *Food Plant Design*. Taylor and Francis, NY.
6. Mahajan M. 2016. *Operations Research*. Dhanpat Rai and Co., Delhi.
7. Mahajani V V and Umarji S B. 2009. *Process Equipment Design*. Macmillan.
8. Maroulis Z B and Saravacos G D. 2007. *Food Plant Economics*. Taylor and Francis, LLC.
9. Maroulis Z B. 2003. *Food Process Design*. Marcel Dekker, Inc., New York.
10. Robberts T C. 2016. *Food Plant Engineering Systems.* CRC Press, Washington.

Emerging Technologies in Food Processing 3 (3+0)

Objectives

i. To know about various emerging technologies in food processing.
ii. To know the practical applications of various emerging technologies in food processing.

Theory

Introduction, different emerging technologies and their scope and applications.

Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems, radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies.

Principles and equipment for Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ ionising radiation, Ultraviolet radiation processing.

Pulsed X-ray processing, Pulsed light processing, Cold plasma Processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge.

Nanomaterial utilisation in food processing, manufacture of nanomaterials, applications.

Suggested Readings

1. Dash S K, Chandra P and Kar A. 2024. *Food Engineering: Principles and Practices*. CRC Press, (Taylor and Francis)- Boca Raton.
2. Passos M L and Ribeiro C P (Eds.). 2010. *Innovation in Food Engineering – New Techniques and Products*. 747p. CRC Press, Boca Raton.
3. Sun Da-Wen. 2005. *Thermal Food Processing – New technologies and Quality Issues*. 664p. CRC Press, Boca Raton.
4. Sun Da-Wen. 2014. *Emerging technologies in food processing.* 666p. Academic Press, Elsevier.
5. Tewari and Juneja. 2007. *Advances in Thermal and Non-Thermal Food Preservation*. 288p. Wiley–Blackwell.

Processing of Livestock, Fish and Marine Products 3 (2+1)

Objectives

i. To learn various processes and methods for processing of livestock, fish and marine products

ii. To Understand the livestock and marine product processing and its applications in industries

Theory

Production, economics, and processing scenario of meat, fish, and poultry; Processing and preservation of eggs, production of egg yolk and egg yellow powder; Poultry processing: Unit operations for various poultry products; Fish processing: Unit operations for various fish products; Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meat using antibiotics and chemical additives; Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing; Abattoir design and layout, meat plant sanitation and safety; By-products utilization.

Practical

Hands on exercise on the processing of fish, meat and egg and preparation of value-added products; Visit to processing plants.

Suggested Readings

1. Bechtel P J. 2012. *Muscle as Food*. 472p. Academic Press, New York.
2. Hui Y H. 2012. *Handbook of Meat and Meat Processing*. 1000p. CRC Press, Boca Raton.
3. Lawrie R A and Ledward D. 2006. *Lawrie's Meat Science*. 464p. Cambridge: Woodhead Publishing Limited, England.
4. Stadelmen W J and Cotterill O J. 1973. *Egg Science and Technology*. 309p. Avi Publishing Co Inc. USA.

Food Business Management and Entrepreneurship Development 3 (3+0)

Objective

To enable the students to learn various aspects of business management and entrepreneurship development in food processing

Theory

Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development; Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure; Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources; Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector; Government policies for promotion of entrepreneurship in food processing; Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis; Resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management; Case study of a food business.

Suggested Readings

1. Awasthi D and Jaggi R. 2003. *Entrepreneurship and Management Inputs for Entrepreneurs in Food Processing Sector*. 32p. EDII, Ahmedabad.
2. Bell G F and Balkwill J. 1996. *Management in Engineering*. 520p. Prentice Hall International, New York.
3. Bharatia C R. 2011. *Food Technology and Entrepreneurship Management*. Surendra Publications, Delhi.
4. Jordan L. 2015. *Food Industry: Food Processing and Management. (*2nd Edn.). 472p. Callisto, USA.

MATLAB Programming 3 (1+2)

Objective

To enable the students to know the different features of MATLAB and have hands-on exercise on it and use the MATLAB for different agricultural engineering applications

Theory

Introduction: platform and features, prerequisites and system requirements, advantages and disadvantages. Commands, environment, working with variables and arrays, workspace,

variables and functions, data types, operator, formatting text. MATLAB Control Statements: if statement, if-else statement, if-elseif statement, nested if-else, switch. MATLAB loops: for loop, while loop, nested loop, break, continue. MATLAB error control: error control statement-try and catch.

Arrays and functions: matrices and arrays, multi-dimensional arrays, compatible array, sparse matrices; Functions: normal functions, predefined functions, user-defined functions, anonymous Function 2D Plots: fplot(), Semilogx(), Semilogy(), loglog(), fill(), Bar(), errorbar(), barh(), plotyy(), area(), Pie(), hist(), stem(), Stairs(), compass(), comet(), contour(), quiver(), pcolor(); 3D Plots: plot3(), fill3(), contour3(), surf(), surfc(), mesh(), meshz(), waterfall(), stem3(), ribbon(), sphere(), ellipsoid(), cylinder(), slice()

Practical

Hands on experience with MATLAB functionalities and its installation on different platforms; MATLAB project based on real time Agricultural Engineering problems.

Python Programming 3 (1+2)

Objectives

i. To enable the students to know the different features of Python programming and have hands-on exercise on it

ii. To use the Python programming for different agricultural engineering applications

Theory

Introduction: history, applications, installation. Variables, data types, keywords, literals, operators, comments. Conditional statements: if else, loops, for loop, while loop, break, continue, pass. strings, lists, tuples, list vs tuple. Functions: functions, built-in functions, lambda functions. Files I/O, modules, exceptions, date, Regex, read CSV File, write CSV File, read excel file, write excel file, assert, list comprehension, collection. Module, math module, OS module, random module, statistics module, sys module, IDEs, arrays, command line arguments, stack and queue. Python OOPs: OOPs concepts, object class, constructors, inheritance, abstraction.

Practical

Hands on experience with Python and its installation on different platforms; Accessing python from GUI and from command prompt / terminal, a project based on real time agricultural engineering problems.

Artificial Intelligence Applications 3 (2+1)

Objective

To enable the students to know the details of problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning, communicating, perceiving, and acting in artificial intelligence

Theory

Foundation and history of artificial intelligence; Intelligent agents, structure of agents; AI programming languages, introduction to LISP and PROLOG; Solving problems by searching, problem solving agents, infrastructure for search algorithms, measuring problem solving performance, blind search strategies, breadth first search, depth first search, heuristic search techniques, best first- A* algorithm, AO* algorithm; Hill climbing search, Genetic algorithms; Games, game tree, game playing, min-max algorithms, alpha beta pruning; Logical agents, knowledge representation issues, predicate logic, logic programming; Constraint satisfaction problems, backtracking search; Knowledge representation- representing knowledge using rules, rules based deduction systems, semantic nets, frames, inheritance, temporal reasoning; Quantifying uncertainty, reasoning under uncertainty; Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempstershafer theory, Fuzzy reasoning; Classical planning- planning, representation for planning, partial order planning algorithm; Planning and acting in the real world- planning in situational calculus, high-level actions; Supervised learning, artificial neural networks, neural network structures, single-layer feed-forward neural networks (perceptron), multilayer feed-forward neural networks, learning in multilayer networks; Knowledge in learning- a logical formulation of learning, explanation-based learning; Natural language processing- principles of natural language processing; Expert systems, knowledge acquisition concepts; Robotics, AI application to robotics; Current trends in intelligent systems.

Practical

Hands on exercise on problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning in artificial intelligence, communicating, perceiving, and acting in artificial intelligence and verifying engineering concepts in artificial intelligence.

Suggested Readings

1. Nilson N J. 2002. *Principles of Artificial Intelligence*. Narosa Publishing House, New Delhi.
2. Rich E and Knight K. 1991. *Artificial Intelligence*. Tata McGraw-Hill, New Delhi.
3. Russell S and Norvig P. 1998. *Artificial Intelligence: A Modern Approach*. Prentice Hall.
4. Winston P H. 1992. *Artificial intelligence*. (3rd Edn.) Addison-Wesley Publishing Company, Boston, MA..

Advances in Automation and Robotics in Agriculture 3 (2+1)

Objective

To enable the students to gain advanced knowledge and skill for application of automation and robotics in agriculture, know about the modelling of robot mechanisms, robot control architectures and robot design and considerations for agricultural operations

Theory

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyperspectral sensor, Stereo vision system, Optical flow sensor,

GPS sensor-RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty.

Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy), Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments, Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior-based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry.

Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms. Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geofencing, Triggering, Software for robot control and navigation, Probabilistic Robot Localization- Localization, Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture-Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages; Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction.

AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns -Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system.

Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practical

Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modelling; PID control of actuators and their calibration for precise control; Practical on robot actuator control systems for determination of mass, inertia, friction, and forces; Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software; Sensor-driven robot control for obstacle avoidance using different sensors; Calibration of GPS sensors and 3-D fixing for precise control; Robot control

architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body, etc; Robot design consideration for sowing and transplanting operation; Robot design for weeding operation; Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops; Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms; Robots for variable rate application of agricultural inputs; Driverless and autonomous tractor for straight control calibration of movement; Control of humanoid robots for selected agricultural operations and active voice command control.

Suggested Readings

1. Ben-Ari, Mordechai and Mondada, Francesco. 2017. *Elements of Robotics*. Springer Nature.
2. Braunl T. 2013. *Embedded Robotics Mobile Robot Design and Applications with Embedded Systems*. Springer Berlin.
3. Craig J J. 2005. *Introduction to Robotics Mechanics and Control*. 5 Pearson Education, Inc., NJ.
4. Miller Mark R and Miller R. 2017. *Robots and Robotics, Principles, Systems, and Industrial Applications*. McGraw-Hill Education.
5. Schilling R J. 1990. *Fundamentals of Robotics- Analysis and Control*. Prentice Hall of India.
6. Siegwart R, Nourbakhsh Illah Reza and Scaramuzza D. 2011. *Introduction to autonomous Mobile Robots*. MIT Press.
7. Zhang D and Bin W.Eds. 2017. *Robotics and mechatronics for agriculture*. CRC Press, Boca Raton.

Machine Learning 3 (2+1)

Objectives

i. To know the basics of machine learning
ii. To know the applications of machine learning in different fields

Theory

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bia, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods; Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems; Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation.

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, Vapnik Chernonenkis dimension, linear dichotomies and capacity. Unsupervised learning, clustering methods based on Euclidian distance and probabilities,

hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Practical

Hands on experience with Machine Learning functionalities and its use in agricultural engineering and allied fields.

Suggested Readings

1. Ethem A. 2009. *Introduction to Machine Learning*. (3rd Edn.) MIT Press, USA.
2. Muller Andreas C. 2009. *Introduction to Machine Learning with Python- A Guide for Data Scientists*. Sarah Guido, O'Reilly.
3. Muller J P and Massaron L. 2021. *Machine Learning for Dummies*. (2nd Edn.) Weily.

Operations Research 3 (3+0)

Objectives

i. To understand the importance of operations research for solving field problems
ii. To understand and apply linear programming, transportation problem, etc. for agricultural engineering applications
iii. To understand the project planning and network analysis

Theory

Introduction to operations research: elementary concepts and objectives, applications of operations research in decision making; Linear programming problem-mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions; Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem, introduction and mathematical formulation, solution of Assignment problem; Inventory control, introduction and general notations, economic lot size models with known demand; Replacement theory, introduction and elementary concepts, replacement of items deteriorating with time; Sequencing problem: introduction and general notations, solution of a sequencing problem; Queuing theory: introduction and classification of queues, solution of queuing models; Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT).

Suggested Readings

1. Taha H. 2003. *Operations Research*. Macmillan Publishing Company.
2. Winston W L. 2004. *Operations Research: Applications and Algorithms*. 4th Edition, Duxbury Press, Pacific Grove, CA.

Mechatronics 3 (2+1)

Objective

i. To Know the measurement system, control systems, microprocessor-based controllers of A.C. & D.C. motor

ii. To Understand the principles behind the working of different data acquisition, digital signal processing

iii. To Know the different application of microcontrollers, PLC. robotics, robot components, robot classification and specification

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach; Sensors and transducers- performance terminology, displacement, position and proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers;

Actuators and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems.

System modelling and control- mathematical models, engineering systems, electro-mechanical and hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes and PID controller.

Micro-processor and computer- computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC, robotics, robot classification and specification, robot components, work envelopes, other basic parameters of robots, robot applications, robot applications in manufacturing, material transfer and machine loading/ unloading, processing operations like welding and painting, assembly operations, inspection, automation, future applications.

Practical

Study of different types transducers; Selection of sensor for a particular application from catalogue and internet; Design of a mechatronics product/ system; Application of mechatronics for enhancing product values; Study of electrical actuation systems with A.C. Motor and with D.C. Motor; Study of electrical actuation systems with Stepper Motor; Study of the PID Controller; Study of the hardware and software of mechatronics kit; Study of the pulse modulation, data presentation systems; Moving a table in X-direction within the range of proximity sensors using Control-X software; Running a motor with PLC; Running a conveyor with computer; Study of the movement of actuating cylinders and sensors.

Suggested Readings

1. Bolton W. 2015. *Mechatronics*. 664p. Pearson Education Asia, US.

2. Craig J J. 1986. *Introduction to Robotics*. Pearson Education International, US.

3. Doeblin E O. 1966. *Measurement Systems*. McGraw-Hill Inc., US.
4. Malvino A P. 1983. *Digital Computer Electronics*. 336p. McGraw-Hill Inc., US.
5. Niku S Y. 2001. *Introduction to Robotics: Analysis, systems and Applications. 349p.* Pearson Education International.
6. Stadler W. 1995. *Analytical Robotics and Mechatronics*. 576p. McGraw-Hill Inc, US.

Natural Fibres: Extraction and Properties 3 (2+1)

Objectives

i. To understand the importance of natural fibres and the quality management of natural textile fibres
ii. To understand the properties of different types of natural fibres and their extraction methods
iii. To understand the different equipment involved in natural fibres extraction

Theory

Introduction to Natural Fibres: Natural fibres definition, Detailed Classification; Natural fibres–physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres; Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres.

Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application; Jute: Cultivation-Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application.

Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting.

Physical Properties of Natural fibres: Fibre Morphology; Fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre, Fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behaviour; Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practical

Identification of natural fibres; Extractions of jute, cotton, flax, banana, sisal and ramie; Retting of Jute and Flax; Quality evaluation of jute and other fibres; Determination of mechanical and insulation properties.

Suggested Readings

1. Cook J G. 2005. *Hand Book of Textile Fibers*. (Vol.1) Wood Head Publishers, London.
2. Corbmann P B. 2001. *Textile Fiber to Fabric*. (6th Edn.) Mc Graw-Hill International Education, NY.
3. Gohl and Vilensky. 2003. *Textile Science*. (2nd Edn.) Mahajan Book Publishers, Pune.
4. Mishra S P 1998. *Fibre Science and Technology*. New Age India International Ltd., New Delhi.
5. Shenai V A. 2004. *Technology of Textile Processing- Textile Fibers*. Sevak Publications, Mumbai.
6. Sreenivasa Murthy H V 1994. *Introduction Textile Fibres*. Textile Association of India, Bombay.
7. Tammanna and Sonwalkar N. 2002. *Handbook of Silk Technology*. Wiley Eastern Limited, New Delhi.

Natural Fibre Applications in Agriculture 3 (2+1)

Objectives

i. To know the different applications of natural fibres such as in soil and water conservation, packaging, energy production and soil less farming, etc.

ii. To understand the economics of using natural fibres for these applications

Theory

Natural Fibre based Agrotextiles, Characterization and their application: Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles, Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population, Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies, Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir's equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor),Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce, Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based

packaging, natural fibre-based reaper binder, Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging.

Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification, Economic and environmental analysis of natural fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol).

Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost, Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Practical

Preparation of woven and nonwoven fabrics; Estimation of different mechanical and hydro-physical properties; Agro-textile field trial/experiment; Natural fibre-based Packaging; Production of energy from natural fibres.

Suggested Readings

1. Blackburn R S. (Ed). 2009. *Sustainable Textiles: Life Cycle and Environmental Impact*. Woodhead Publishing, New Delhi.
2. Cheng H N, Byron A E and Okos M R. (Eds). 2017. *Sustainable Fiber-Based Packaging*. John Wiley & Sons.
3. Fangueiro R and Rana S. (Eds). 2016. *Natural Fibre Composites in Geotextiles: Design and Applications*. Woodhead Publishing, New Delhi.
4. Hakeem K R, Jawaid M, and Alothman O Y. (Eds). 2019. *Biomass and Bioenergy: Processing and Properties*. Springer.
5. Hardin M R. (Ed.). 2007. *Natural and Artificial Fiber Nonwoven Textiles*. CRC Press. Boca Raton.
6. Kozłowski R M. (Ed). 2012. *Handbook of natural* fibres. Volume 2: Processing *and applications.* 544 p. Woodhead Publishing Limited, New Delhi.
7. Tripathy R P and Singh H P. (Eds). 1993. *Soil Erosion and Conservation*. New Age International (P) Limited, New Delhi..

Processing of Natural Fibres 3 (2 + 1)

Objectives

i. To understand the chemical composition of natural fibres and their conversion methods

ii. To understand the different mechanical and chemical processing methods of natural fibres

iii. To know about the different value addition methods for natural fibres

Theory

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending.

Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.

Preparatory Weaving: Winding, warping, sizing, beaming, drawing and denting; Weaving: Concept of weaving, handloom, Primary and secondary motions of loom; shedding, picking, Beat-up, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.

Basic Yarn Testing: Count, Twist, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.

Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing; Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.

Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practical

Basic concepts of spinning; Manufacture of yarn from natural fibres; Practical on weaving and knitting; Yarn and fabric testing; Pre-treatments of natural fibres; Bleaching and dyeing of natural fibres; Finishing of natural fibres.

Suggested Reading

1. Booth J E. 1996. *Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics*. (6th Edn.) Newnes Butterworths, London.

2. Brown R. 1978. *Weaving, Spinning and Dyeing Book*. Routledge and Kegan Paul, London.

3. Cegarra J P and Valladperas J. 1992. *The Dyeing of Textile Manual, the Scientific Bases and the Techniques of Application.*NecovaOflito, Italy.
4. Corbman B P. 1983. *Fibre to Fabric step by Step Weaving.* (6th Edn.) McGraw Hill, New York.
5. David G, Sinclair Roy S. 1989. *Giles Laboratory Course in Dyeing.* (4th Edn.) Society of Dyers and Colourist, London.
6. Eichhorn S J, Hearle J W S, Jaffe M and Kikutani T. 2009. *Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres,* (Vol. 1) in Woodhead Publishing Series in Textiles.
7. Fannin and Allen A. 1979. *Handloom Weaving Technology*. Van Nostrand Reinhold, New York.
8. Jarman C. 1998. *Plant Fibre Processing: A Handbook*. 64p. eBook 9781780442990.
9. Ponting K G. 1981. *A Dictionary of Dyes and Dyeing*. Bell and Hymen Ltd., London.
10. Rouette H K. 2001. *Encyclopaedia of Textile Finishes*. Springer Verlag, Berlin.
11. Saville B P. 1999. *Physical Testing of Textiles*. Woodhead Publication. CRC Press, Boca Raton.
12. Shenai V A. 1985. *Technology of Dyeing: Technology of Textile Processing.* (Vol. VI) Sevak Publication, Mumbai.
13. Shenai V A. 1985. *Technology of Printing: Technology of Textile Processing.* (Vol. IV) Sevak Publication, Mumbai.

Agricultural Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing

costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture.* Kalyani Pub, New Delhi.
3. Kohls R L and Uhl J N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi.
4. Kotler and Armstrong. 2005. *Principles of Marketing*. Pearson Prentice-Hall, New Delhi.
5. Lekhi R K and Singh J. 2006. *Agricultural Economics*. Kalyani Publishers, Delhi.
6. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi.
7. Pandey M and Tewari D. 2004. *Rural and Agricultural Marketing.* International Book Distributing Co. Ltd, New Delhi.
8. Salvatore D. 2003. *Micro Economic Theory. 768p.* OUP USA.
9. Sharma R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

SKILL ENHANCEMENT COURSES

(Indicative Activities/ Learning areas)

Operation and Maintenance of Farm Machinery 4 (0+4)

- Constructional details, adjustment and working of primary tillage equipment such as mould board plough and disc plough
- Constructional details, adjustment and working of secondary tillage equipment such as cultivators, harrows
- Constructional details, adjustment and working of weeding equipment such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculture equipment
- Constructional details, adjustment and working of rotary tillage / active tillage equipment such as tractor operated /power tiller operated rotavator
- Constructional details, adjustment and working of sowing equipment such as seed drills, planters and transplanters, minimum tillage equipment
- Adjustments and calibration of seed drills
- Working with different types of furrow openers with seed drills/ planters
- Constructional details, adjustment and working of metering mechanisms of drills and planters
- Details of precision farm equipment such as laser levelers, zero till drills, pneumatic planters etc.
- Constructional details, adjustment and working with earth moving equipment such as bulldozers, trenchers and elevators, etc.
- Constructional details, adjustment and working of transplanting equipment such as rice transplanters and vegetable transplanters
- Seedling raising technique for transplanters
- Constructional details, adjustment and working of irrigation equipment such as different types of pumps, sprinkler irrigation system/drip irrigation system
- Constructional details, adjustment and working of harvesting equipment such as root crop harvesters (bullock drawn as well as tractor operated groundnut diggers) and grain crop harvesters (self-propelled / tractor operated/ power tiller operated vertical conveyer reapers) etc.
- Constructional Details, adjustment and working of threshing equipment such as axial flow paddy threshers, combine harvesters etc.

Repair and Maintenance of Tractors and Power Tillers 4 (0+4)

- Study of different systems of tractor and power tiller
- Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval, firing order
- Study of fuel system, working principle, repair and maintenance
- Working of fuel pumps, fuel filters and injectors
- Study of lubrication system, working principle, repair and maintenance
- Working of oil filters, oil pumps etc.
- Study of cooling system, working principle, repair and maintenance
- Working of thermostat valve

- Study of tractor/ power tiller engine system
- Study of power transmission system of tractor/ power tiller (different types of clutches/gears/ sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller)
- Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance
- Study of braking system: different types of brakes/ their components and working principle/ adjustment / repair
- Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance
- Steering in power tiller: Dog clutch and other arrangements
- Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance
- Study of tyres, rims, their construction and specification, repair and maintenance
- Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation
- Engine overhauling and assembling.
- Implement hitching and detaching from tractor as well as power tiller
- Safety rules

Management of Agricultural Machinery Custom Hiring and Maintenance Facilities 4 (0+4)

- Terms associated with machinery management for correct understanding
- Different ways machinery can be obtained for use on the farm
- Factors that affect the purchase of machinery
- Advantages and limitations of two-wheel drive tractors
- Advantages and limitations of four-wheel drive tractors
- Calculation of the theoretical capacity of a farm machines
- General rules concerning field efficiency
- Calculation of field capacity of a farm machines
- Distinguishing between types of costs of machinery ownership
- Understanding how cost and machine use are related
- Calculation of salvage value of a farm machine
- Calculation of average machine investment of a farm machine
- Calculation of annual fixed cost of a farm machine
- Calculation of repair cost for a farm machine
- Calculation of fuel and lubrication costs for a tractor
- Calculation of labor cost for a farm machine
- Understanding causes of fatal tractor accidents
- Learning of procedures for safe machine operation
- Understanding the reasons for efficiency in tractor operation
- Preventative maintenance of farm Machinery

- List five areas of servicing machinery
- Calculate estimated variable cost of a farm machine
- Calculate overall cost per acre for farm machinery
- Calculate equipment width (size) to match tractor horsepower

Fabrication, Operation and Maintenance of Renewable Energy Gadgets 4 (0+4)

- Acquaintance with different renewable energy sources (solar, wind, hydro, biomass, geothermal)
- Principles of photovoltaic (PV) technology, fabrication processes for solar panels and Installation and maintenance of solar power systems
- Grid-tied vs. off-grid solar systems
- Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms
- Pico hydro and their construction and maintenance
- Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion)
- Fabrication of biomass energy systems like gasifier, Improved challah, etc.
- Routine maintenance procedures for renewable energy systems, Troubleshooting common issues
- Safety protocols for maintenance tasks; Monitoring and performance optimization
- Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning
- Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.)
- Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes

Operation and Maintenance of Drones Used for Agricultural Applications 4 (0+4)

- Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations
- Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles
- Introduction to various sensors used in agricultural drones (RGB cameras, multispectral cameras, thermal cameras, LiDAR, etc.)
- Applications of different sensors in agriculture (crop monitoring, pest detection, irrigation management, etc.), Payload integration and compatibility considerations
- Principles of flight planning for agricultural drone missions, Selection of appropriate flight parameters (altitude, speed, overlap, etc.), Use of mission planning software and tools, Pre-flight checks and safety protocols
- Techniques for data acquisition during drone flights, Post-flight data processing and analysis, Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization
- Applications of drones in crop monitoring (plant health assessment, yield estimation, disease

detection, etc.), Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data

- Using drones for early pest and disease detection, Identification of common pests and diseases in crops, Monitoring strategies for pest infestations and disease outbreaks
- Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology
- Routine maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.), Battery management and care
- Safety protocols for drone operations in agricultural settings, Understanding airspace regulations and restrictions, Emergency procedures and risk mitigation strategies
- Real-world examples of successful drone applications in agriculture, Hands-on exercises and field demonstrations
- Challenges and opportunities for the widespread adoption of drone technology in agriculture, Ethical and societal implications of drone use in farming

Machine Vision, Sensors and Sensor Architectures **4 (0+4)**

- Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis
- Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc.
- Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications
- Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.)
- Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc.
- Considerations in sensor selection and integration for specific applications
- Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation
- Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control
- Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.)
- Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc.
- Applications of 3D vision in robotics, metrology, object recognition, etc.
- Examples of multisensor systems in real-world applications
- Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms

- Case studies of IoT applications in agriculture
- Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.)
- Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems
- Applications of embedded vision in autonomous vehicles, drones, consumer electronics, etc.
- Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field
- Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost reduction, etc.), Ethical and societal implications of widespread sensor deployment and data collection

Design of Solar PV Systems Using Softwares **4 (0+4)**

- Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares
- Features for designing a solar PV system (location, load requirements, shading analysis, etc.), Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.
- Conducting a site analysis to assess the solar potential and available space for PV system installation, using software tools to perform shading analysis and identify potential obstructions or shading issues
- Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components. Optimizing the system configuration to maximize energy production and efficiency
- Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations
- Designing the electrical wiring and connection scheme for the PV array, inverters, and other components
- Running simulations to estimate the performance and energy yield of the proposed PV system, analyzing simulation results to evaluate the system's energy production, capacity factor, and financial viability
- Fine-tuning system parameters to optimize performance and maximize energy output
- Performing a financial analysis to assess the economic feasibility of the solar PV project, Calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics, Considering incentives, subsidies, and financing options for solar PV installations
- Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency, system size, electricity tariffs) on project economics, iteratively refining the system design to achieve the desired performance and economic outcomes
- Generating detailed reports and documentation summarizing the design process, simulation results, and project economics

- Case studies based on real-world projects to apply learned concepts and techniques
- Addressing common challenges and troubleshooting issues encountered during the design process.

Installation and Maintenance of On-Grid and Off-Grid Solar Systems 4 (0+4)

- Overview of solar photovoltaic technology and its applications, Explanation of on-grid and off-grid solar systems
- Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.)
- Understanding the differences between on-grid and off-grid system configurations
- Component identification and system layout design
- Conducting site assessments to determine solar potential and suitability for PV system installation. Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components
- Installation of solar panels, inverters, and other components for on-grid systems, Techniques for mounting solar panels on rooftops or ground-mounted structures
- Wiring and connection of components to the electrical grid
- Setting up off-grid solar systems, including battery-based energy storage, Installation of charge controllers, batteries, and DC loads
- Designing and configuring off-grid systems for reliable and efficient operation
- Electrical wiring practices for solar PV systems
- Understanding safety precautions and regulations related to electrical installations
- Wiring solar panels, inverters, charge controllers, and battery banks
- Commissioning and testing of solar PV systems to ensure proper functionality, conducting performance tests and verifying system parameters
- Troubleshooting common issues and addressing installation errors
- Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components
- Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration
- Techniques for integrating additional solar panels, batteries, or other components into existing systems
- System modification and expansion
- Introduction to remote monitoring systems for tracking the performance of solar PV systems, using data analytics tools to diagnose issues and optimize system performance, Hands-on practice in accessing system data and interpreting performance metrics

Design and Maintenance of Agrivoltaic Systems 4 (0+4)

- Overview of agrivoltaic systems and their benefits, Explanation of how solar panels and agriculture can coexist synergistically
- Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.), Conducting site assessments to determine solar potential and suitability for agricultural activities

- Design principles for integrating solar panels with agricultural crops or livestock, Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield
- Selection of appropriate crops and planting strategies for agrivoltaic systems
- Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture
- Safety protocols and best practices for working with solar panel arrays
- Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health
- Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions
- Designing the electrical layout for connecting solar panels to the grid or off-grid systems, Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards
- Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance
- Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions, Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns
- Overview of regulations, permits, and incentives related to agrivoltaic installations, Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics
- Visits to agrivoltaic installations and research sites for hands-on learning opportunities, Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field

Valorisation of Agri-biomass and Organic Waste **4 (0+4)**

- Concept of valorization and its role in waste-to-value processes, Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production
- Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.), Understanding the properties and potential uses of different types of biomass and waste materials
- Sample collection, preparation, and analysis
- Introduction to biological conversion methods such as anaerobic digestion and composting, Principles of microbial decomposition and fermentation in biomass conversion
- Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing, Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes
- Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion
- Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.)
- Valorization of agri-biomass and organic waste into value-added products such as biochar, bio-based chemicals, and biomaterials

- Strategies for waste minimization, reuse, and recycling in agricultural and food production systems
- Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts
- Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste

Energy Audit, Energy Conservation and Energy Efficiency **4 (0+4)**

- Key concepts and definitions related to energy conservation and efficiency
- Introduction to the principles of energy auditing and analysis
- Methods for collecting and analyzing energy consumption data
- Interpretation of energy bills, utility data, and meter readings
- Conducting energy audits for residential, commercial, and industrial facilities
- Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras)
- Use of software tools for energy data analysis and visualization
- Identifying potential areas for energy savings and efficiency improvements, Evaluation of building systems, equipment, and operations
- Hands-on exercises in identifying ECOs through site inspections and data analysis
- Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects
- Analysis of building energy performance using energy modelling software
- Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures
- Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels
- Energy efficiency standards, labeling programs, and building codes
- Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis
- Use of measurement and verification (M&V) protocols and reporting

Repair and Maintenance of Pumps and Irrigation Systems **4 (0+4)**

- Acquaint with different pumps and motors used in irrigation system
- Study of various water lifting devices and their limitations
- Study of components of centrifugal pump and its function
- Study of components of submersible pump and its function
- Components of reciprocating pump and its function
- Dismantling and assembling of irrigation pumps
- Performance testing of centrifugal pumps
- Preparation of pump housing
- Pump alignment and troubleshooting

- Knowing different accessories for electric pump
- Winding of 3-phase and single-phase electric motor
- Causes of trouble shooting in electrical pump set and their remedial measures
- Dismantling and assembling of diesel pump set
- Causes of trouble shooting in diesel pump set and their remedial measures
- Regular maintenance and overhauling, lubrication of pumps
- Study of solar pump set, and its components
- Step-wise installation of solar pump set including earthing

Installation and Maintenance of Micro Irrigation Systems **4 (0+4)**

- Acquaint with different components of micro irrigation
- Installing of micro irrigation (both drip and micro sprinkler) system
- Design of micro irrigation system (both drip and micro irrigation) in field
- Computation crop water requirement of crops
- Acquaint with fertigation equipment, their operation and maintenance
- Execution of fertigation with water soluble fertilizers
- Fixation of fertigation equipment with micro irrigation system
- Doing maintenance schedule in micro irrigation
- Operating automated micro irrigation system
- Operating IOT based irrigation system

Application of Remote Sensing and GIS for Agricultural Water Management **4 (0+4)**

- Basics of remote sensing
- Remote sensing sensors and platforms
- Introduction to GIS
- Types of projection systems
- Study of Image resolutions and coordinate system
- Source of remote sensing data and accessibility
- Operations in Google earth platform
- Introduction to basic modules of ArcGIS
- Introduction to basic modules of QGIS
- Georeferencing, rectification, digitization and shape file creation
- Basic raster/vector data operations
- Map projection and re-projection
- Preparation of contour maps and rainfall Thiessen polygons
- Map layout and styling
- Preparation of various vegetation index maps
- Preparation of various wetness index maps

- Delineation of watershed and derivation of morphological parameters

Operation and Maintenance of Hydro-Meteorological Instruments 4 (0+4)

- Study and operation of Weather Monitoring Instruments: Thermometer, Barometer, Hygrometer; Anemometer, Pyranometer and others
- Components of an automatic weather station (AWS)
- Installation of AWS and its maintenance
- Calibration and installation of Tipping bucket raingauge
- Installation of open pan evaporimeter and periodic maintenance
- Study of infiltration process using ring infiltrometer
- Measurement of flow in open channels using various methods
- Study of different weirs and flumes for flow measurement
- Installation of weirs and flumes in the channel
- Measurement of soil moisture using gravimetric method
- In-situ measurement of soil moisture using different soil moisture sensors
- Installation of digital water level recorder (DWLR)
- Measurement of groundwater level using ground water level recorder
- Study of multi-slot divisor and Coshocton wheel silt sampler for measurement of soil loss
- Measurement of flow velocity using digital current meter
- Procedure for recording field observations
- Troubleshooting of hydro-meteorological instruments

Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well (0+4)

- Different features of groundwater system
- Study of different types of geophysical survey
- Components of a resistivity meter
- Wenner-Schlumberger arrangement and comparison
- Process of geophysical survey in field
- Surveyed data analysis and interpretation
- Different types of well log and preparation of commonly used well log
- Study of different types of wells
- Study the components of a tube well/ bore well
- Study of different types of drilling methods/ equipment
- Installation of well assembly: types of casing, screen
- Study on gravel packing
- Study of well development process
- Sanitary protection of tube wells

Installation and Maintenance of Rooftop Rainwater Harvesting System **4 (0+4)**

- Survey and site selection for RRWH
- Computation of rooftop RWH potential and runoff coefficient
- Study of components of RWH system
- Catchments: grading and plastering of rooftop
- Coarse mesh, gutters; roofing materials
- Conduit: material, size of conveyance pipe
- Types of filter system used in RWH system
- Study of storage tank: capacity, overflow pipe
- Study of suitable recharge structure for groundwater
- Study of constructional details of recharge pits, recharge trench
- Types of contaminants in RWH system
- Hand pumps and its application in RWH system
- Preparation of Detail Project Report

Operation and Maintenance of Soil Conservation Structures **4 (0+4)**

- Survey for slope, stream order and land use/land cover
- Site selection of soil conservation structures based on survey
- Ground truthing of various structures
- Study of different types of soil conservation structures
- Trenching and diversions structures
- Study of types bunding and its features
- Study of types of terracing and its features
- Study of drop spill way: components, function, site suitability
- Study of drop inlet spillway: components, function, site suitability
- Study of chute spillway: components, function, site suitability
- Study of check dams- construction, site suitability
- Study of construction materials of different structures
- Cost estimation of different conservation structures
- Preparation of Detailed Project Report

Construction, Management and Maintenance of Protected Cultivation Structures **4 (0+4)**

- Study of different protected structures and their uses
- Acquaint with different components of protected structures
- Construction of different protected structures
- Study of glazing materials and their properties
- Selection of different construction materials and their specifications
- Management of micro climate parameters in protected structures
- Monitoring of micro climate inside protected structures
- Automatic monitoring of micro climate inside protected structure
- Use of Irrigation and fertigation in protected cultivation
- Visit to different hydroponics systems under protected structures

Agro Processing Methods, Equipment Operation and Maintenance **4 (0+4)**

- Acquaintance with different unit operations involved in agro-processing
- Cleaning and grading of agricultural commodities: operation and maintenance of different cleaners, graders and destoners
- Operation and maintenance of dehusker, dehuller, degermer and dryer
- Operation and maintenance of rice milling machineries
- Operation and maintenance of dal mills and oil mill
- Operation and maintenance of flour mills and pulverisers
- Operation and maintenance of boiler, pasteurizer and sterilizer
- Operation and maintenance of peeler, slicer, pulper and juicer
- Operation and maintenance of canning machineries
- Operation and maintenance of packaging machineries

Operation and Management of Multi-Commodity Agro-Processing Centre **4 (0+4)**

- Acquaintance with different agro-processing models
- Site selection, plant layout and project report preparation
- Manufacturing and management of primary processing centre
- Preparation of grain, pulse and oilseed- based products and acquaintance with operation of different equipment
- Preparation of products using flour mill
- Spice processing and acquaintance with operation of different equipment
- Operation and management of fruit and vegetable pack house
- Preparation of different fruit- based products and acquaintance with operation of different equipment
- Preparation of different vegetable- based products and acquaintance with operation of different equipment
- Manufacturing of snack foods
- Acquaintance with food safety and hygiene, and certifications
- Record keeping, inventory, finance and human resource management for agro-processing

Primary Processing and Value Addition and Cold Chain Logistics **4 (0+4)**

- Primary processing of fruits and vegetables
- Operation and maintenance of washer and graders
- Study of refrigeration system and freezing equipment
- Operation of precooling systems
- Operation and maintenance of cold storage and solar cold room
- Operation and maintenance of ripening chamber
- Cool chain logistics and cold transport: chilled transport van, semi chilled transport, refrigerated van system
- Cooling systems/ cold chain technology: Gel pack, dry ice, liquid nitrogen, eutectic plates, reefers, cold chain standards and regulations
- Supply chain management systems planning, sourcing, manufacturing, delivering, returning, types of SCM models
- Supply chain logistics, contract logistics

Food Grain Godown and Warehouse Management **4 (0+4)**

- Conversant with technical terms of grain storage, measurement of temperature, relative humidity, grain sampling and moisture content measurement, grain quality
- Acquaintance with different factors for grain deterioration during storage and main insects of stored commodities
- Acquaintance with warehouse equipment and different storage structures
- Cleaning, drying and aeration of stored products
- Determination of dimension of warehouse for bag storage
- Acquaintance with constructional features, maintenance, sanitation and hygiene of warehouses
- Study on integrated pest management, chemical and non-chemical pest and rodent control measures in grain storage system
- Detection methods of insect infestation in food grains and prevention and control of storage fungi
- Acquaintance with inventory, logistics, and collateral management
- Guideline for procurement and disposal of food grains
- Quality control of food grains

Post-harvest Value Chain Management Including Logistics **4 (0+4)**

- Understanding the concept of post-harvest value chain
- Study of existing supply chain of different commodities
- Case study and analysis of value chain of food grains
- Case study and analysis of value chain of horticultural commodities
- Sourcing and material management
- Handling, packing and storage of agricultural commodities
- Transportation and marketing of agricultural commodities
- Ware house management
- Cold storage management
- Cold chain logistics and supply chain management system
- Quality management and tracking food supply chain

ONLINE COURSES

The students will have to take a minimum of 6 credits of online courses, (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Agricultural Engineering) program.

The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradial as separate certificates would be issued by institutes offering the courses. These can be taken any time during the 3rd and 4th years of the UG programme.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

Minimum Standards for Establishing a College of Agricultural Engineering

- **Degree Nomenclature:** B. Tech (Agricultural Engineering)

1. **Minimum intake (per year):** 60

2. **Faculty: A. Core faculty**: 21

   Soil and Water Conservation Engineering (0+1+2), Irrigation and Drainage Engineering (0+1+2), Farm Machinery and Power Engineering (0+2+2), Processing and Food Engineering (0+2+2), Renewable Energy Engineering (0+1+1), Basic Engineering and Applied Sciences (0+2+3)

B. **Allied faculty**: Faculty for Mathematics, computer science, Sociology, Psychology, English, Food Science and Technology, Microbiology, Agrometerology and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. **Land requirement (ha): 7**

4. **Essential Instructional units:**
   - Implement shed, Farm Service Centre, farm implements
   - Green houses (10m × 20m each) – 2 Numbers
   - Drying yard/Processing yard
   - Irrigation: Drainage/Sprinkler/Drip - demonstration
   - Demonstration of different soil types
   - Workshops: 3 big rooms (70 × 35 feet each)
   - Seed drill/fertilizer drill
   - Farm machinery lab
   - Renewable energy setup- solar system/ bio-gas etc.
   - Laboratories and instructional facilities as per V Deans' Committee report.
   - ELP units to be established under skill development or Entrepreneurial mode-0.5 ha

5. **Divisons/Departments/Section:**
   - Department of Farm Machinery and Power Engineering (FMPE)
   - Department of Processing and Food Engineering (PFE)
   - Department of Soil and Water Conservation Engineering (SWCE)
   - Department of Irrigation and Drainage Engineering (IDE)
   - Department of Renewable Energy Engineering (REE)
   - Department of Basic Engineering and Applied Science (BEAS)

6. Non-Teaching Staff:

Sl No.	Dean Office		SWCE	IDE	FMPE	PFE	REE	BEAS	Total
1.	AO/Suptd.	1	-	-	-	-	-	-	1
2.	Clerk	6	1	1	1	1	1	1	12
3.	PA/Steno	2	1	1	1	1	1	1	8
4.	Messenger/Peon	2	1	1	1	1	1	1	8
5.	Laboratory staff								41
6.	Laboratory Assistant	-	2	2	2	2	2	4	14
7.	Workshop Staff/Computer Operator/Driver/Technicians	-	3	3	6	3	3	6	27
	Total	**14**	**8**	**8**	**11**	**8**	**8**	**13**	**111**

7. Floor Space Requirement

a) Offices

Sl. No.	Office	Number	Dimensions (ft)
1.	**Dean/Principal**	**1**	**20 × 30**
2.	**Head of Department**	**6 (one for each department)**	**15 × 20 each**
3.	**Admin. Staff**	**8 (2 for Dean office and one eachfor 6 departments)**	**10 × 15 each**
4.	**Faculty rooms/chambers**	**45**	**10 × 12 each**

b) Labo oratories

Sl. No.	Department	Number	Dimensions (ft)
1.	SWCE	1 + 1 Field Lab	20 × 30 + 1 Acre
2.	IDE	1 + 1 Field Lab	20 × 30 + 1 Acre
3.	FMPE	2	20 × 30 each
4.	PFE	3	20 × 30 each
5.	REE	2	20 × 30 each
6.	BE & AS	8 (1 Physics, 1 Chemistry, 2 Civil, 2 Mechanical,	20 × 30 each
		1 Computer, 1 Electrical & Electronics)	
		1 Drawing hall	40 × 30
		1 Workshop	60 × 30

8. College Building Requirement (Infrastructure)

Sl. No.	Description	Number	Remarks
1.	Class rooms	8	Seating capacity of 60
2.	Examination Hall	1	Seating capacity of 200
3.	Auditorium	1	Seating capacity of 500
4.	Hostels	2	1 for Boys (100 residents)
			1 for Girls (100 residents)
5.	Sports complex	1	Outdoor
		1	Indoor
		1	Gymnasium
6.	Guest house	1	10 rooms
7.	Dispensary	1	

Sl. No.	Description	Number	Remarks
8.	Library	1	
9.	Canteen	1	
10.	Toilets	1 set (1 for Ladies and 1 for Gents)	Every wing of each floor should have 1 set
11.	Parking space	As per requirement	For college and hostels

9. Department wise Laboratories

Sl. No.	Department	Name of the laboratory
1.	Soil & Water Conservation Engineering	• Soil and Water Conservation Lab • Field Lab
2.	Irrigation and Drainage Engineering	• Irrigation and Drainage Lab • Field Lab
3.	Farm Machinery and Power Engineering	• Tractor and Power Lab • Farm Equipment Lab • Field Lab
4.	Processing and Food Engineering	• Process Engineering Lab • Food Engineering Lab • Agricultural Structures and Environmental Control Lab
5.	Renewable Energy Engineering	Renewable Energy Lab
6.	Basic Engineering and Applied Sciences	• Physics Lab
		• Chemistry Lab
		• Civil Engineering Lab (Surveying, Strength of Material, Soil Mechanics)
		• Mechanical Engineering Lab (Engineering Drawing, CAD/CAM, Refrigeration & Air conditioning, Heat Engines, Fluid Mechanics)
		• Workshop (Carpentry, welding, Foundry, Machining, Fitting, Sheet metal)
		• Computer Lab
		• Electrical Engineering Lab
		• Electronics Lab

10. Department wise List of Laboratory Equipment

a) Department of Soil and Water Conservation Engineering Lab

Sl. No.	Name of Equipment	Quantity
Soil & Water Conservation Lab		
1.	Rain Gauges	2
2.	50 kg capacity weighing balance	1
3.	1 kg capacity electronic balance	1
4.	Models of Soil Water Conservation Structures (Drop Spillway, Chute Spillway and Drop Inlet Spillway)	1 each
5.	Stage Recorder	1
6.	Coshocton wheel runoff sampler	1
7.	Multi slot runoff sampler	1
8.	H flume, Hydraulic Flume and Parshall Flume	1 each

Field Lab

1.	**Runoff plots**	-
2.	**Runoff harvesting structures**	-
3.	**Bunds/terraces**	-

b) Department of Irrigation and Drainage Engineering Lab

Sl. No.	Name of Equipment	Quantity
1.	Oven	1
2.	Tensiometer	5
3.	Electrical Conductivity Meter	2
4.	Distillation apparatus	1
5.	Double Ring Infiltrometer	
6.	pH Meter	
7.	Water Quality Testing Kit	2
8.	Moisture Boxes	2
9.	Augers	2
10.	Current meter	50
11.	Darcy Apparatus	4
12.	Porous Cup & Measuring Flask	1
13.	Sieve Shaker	1
14.	Filters & Strainers	5
15.	Cut section of centrifugal pump, submersible pump and Turbine pump	1
16.	Positive displacement pump (Hand Pump)	5
17.	Water level Indicator	1 each
18.	Tachometer	1
19.	Pump Testing Rig	2

Field Lab		
1.	Diesel Engine with Centrifugal Pump	1
2.	Sprinkler Irrigation System (for one acre area)	1
3.	Drip Irrigation System (for One acre area)	1
4.	Submersible Pump	1
5.	Weather Station	1
6.	Irrigation Water Measuring Devices (V-Notch, Parshall Flume, H-Flume, Orifice Plate)	1 each
7.	Hydraulic Ram	1
8.	Underground Pipeline system	1

c) Department of Farm Machinery and Power Engineering Lab

Sl. No.	Name of Equipment	Quantity
Tractor and Power lab		
1.	Tractor – 45 hp	1
2.	Power Tiller	1
3.	Work bench	1
4.	Grinder	1

Sl. No.	Name of Equipment	Quantity
5.	Air compressor	1
6.	Mechanical jacks	2
7.	Tool kits with box (having tools : Ellen key set, Open end spanner set, Pliers, Nose pliers, Circlip pliers)	3 sets
8.	Welding machine	1
9.	• Feeler gauges	1 each
	• Piston ring expander	
	• Piston ring compressor	
	• Plastic mallet	
	• Weighing balances (mechanical and digital)	
	• Oil pans	
	• Grease gun	
	• Bearing puller	
	• Nozzle compression tester	
	• Cylinder pressure gauge	
	• Battery charger	
	• Anvil	
10.	Cut sections of:	1 each
	• Tractor	
	• Single cylinder engine	
	• Multi cylinder engine	
	• Air cleaner	
	• Gear box	
	• Differential	
	• Battery	
	• Fuel injection pump	
11.	Models of:	1 each
	• Electrical system	
	• Lubrication system	
	• Cooling system	
	• Tractor hydraulic system	
12.	Engine for dismantling	1
13.	Display boards:	1 each
	• Fuel feed pumps	
	• Oil pumps	
	• Types of pistons	
	• Fuel injection pumps	
14.	Models of	1 each

Sl. No.	Name of Equipment	Quantity
	• Mould board	
	• Standard disc plough	
	• One way plough	
	• Different types of disc harrows	
	• Different types of agricultural discs	
	• Furrow openers	
	• Seed metering mechanism	
	• Seed drill calibration set-up	
	• Cutter bar cut section	
	• Tangential flow thresher	
	• Axial flow thresher	
	• Knap sack sprayer	
	• Sprayer nozzles	
	• Set of manually operated sprayer and dusters	
15.	Hot air oven	1
16.	Mechanical sieve shaker	1
17.	Cone penetrometer	1
18.	Load cells- various capacitie	

Farm Machinery Lab and Field Lab

1.	Mould board plough	1
2.	Sub soiler	1
3.	Rotary tiller	1
4.	Cultivator	1
5.	Seed-cum fertilizer drill	1
6.	Inclined plate planter	1
7.	Potato planter	1
8.	Sugarcane cutter planter	1
9.	Vertical conveying reaper	1
10.	Wheat thresher	1
11.	Paddy thresher	1
12.	Multi crop thresher	1
13.	Potato digger	1
14.	Laser leveler	1
15.	Hand tools including Khurpis, Sickles, spades, Scythe	As per need
16.	Set of animal drawn implements : disc harrow and cultivator	1 each

d) Department of Processing and Food Engineering Lab

Sl. No.	Name of Equipment	Quantity
Food Engineering Laboratory		3
1.	Weighing Balance	
2.	Texture analyzer	1
3.	Apparatus for angle of repose, coefficient of friction measurement, anemometer, nitrogen analyzer	1

Sl. No.	Name of Equipment	Quantity
4.	Apparatus for measurement of properties of milk and milk products	1
5.	Bod incubator	1
6.	Seed germinator,	1
7.	Autoclave	1
8.	Mini Oil Expeller	1
9.	Refrigeration and freezing tutor	1
10.	Fruit penetrometer	1
11.	Plate heat exchanger	1
12.	Soxhlet apparatus,	1
13.	Boiler	1
Process Engineering Laboratory		3
1.	Moisture meter	
2.	Hammer Mill	1
3.	Bur Mill (Vertical & Horizontal Plate Type)	1
4.	Aspirator Column	1
5.	Vibratory Screen Cleaner With Aspirator	1
6.	V – Mixer	1
7.	Tyler Sieve Set	3
8.	Manual sieve set	2
9.	Ro – Tap Shaking Machine	2
10.	Indented cylinder grader	1
11.	Pneumatic Grader	1
12.	Illuminated Purity Table	1
Agricultural Structures & Environmental Control Laboratory		
1.	Weighing Balance	2
2.	Digital Thermo-hygrometer with data logger	1
3.	Wet & Dry bulb Thermometer	1
4.	Anemometer	1
5.	Luxmeter	1
6.	Solar power meter	1
7.	Muffle Furnace	1
8.	Hot air Oven	1
9.	Thermal conductivity apparatus	1

e) Department of Renewable Energy Engineering Lab

Sl. No.	Name of Equipment	Quantity
Biomass Energy Lab		
1.	Hot air oven	1
2.	Muffle Furnace	1
3.	pH meter	1
4.	Bacteriological Incubator	1

Sl. No.	Name of Equipment	Quantity
5.	Autoclave	1
6.	Atomic Absorption Spectrophotometer	1
7.	High Performance Liquid Chromatograph	1
8.	Portable Gas Analyser	1
9.	Glassware and chemicals	1
10.	Models and cut-section of Fixed Dome and floating drum Type Biogas Plants	1
11.	Biomass Gasifier Model	1
12.	Thermo Gravimetric Analyser	1
13.	Bomb Calorimeter	1
14.	Biomass Pyrolyser	1
15.	Moisture analyser	1
16.	Fuel Cell Model and Testing kit	1
17.	MHD Model	1
18.	Biogas Engine Generator set and Testing Rig	1
19.	Bio-diesel based engine Testing Rig	1
20.	Improved Cook stoves Model and Testing set up	1
Solar and Wind Energy Lab		
1.	Solar Cooker - Box Type and Concentrating type	1
2.	Solar Water Heating System 100-125 lpd - Flat Plate Collector and Evacuated	
Tube Collector Type		1
3.	Natural Convection Solar Dryer - 5 kg capacity	1
4.	Solar Photovoltaic panel	1
5.	Solar PV Testing kit	1
6.	Atomic Absorption Spectrophotometer	1
7.	High Performance Liquid Chromatograph	1
8.	Gas Analyser	1
9.	Glassware and chemicals	1
10.	Solar Data Logger	1
11.	Solar Radiations Measurement Equipments	1
12.	Solar Thermal Testing kit	1
13.	Solar Pump Demonstration Unit	1
14.	Wind Turbine model	1
15.	Cut model of Aero-generator	1
16.	Wind Mapping Software	1
17.	Automatic Weather Station	1

f) Department of Basic Engineering and Applied Sciences Labs

Sl. No.	Name of Equipment	Quantity
Civil Engineering		
Material Testing Lab		
1.	Universal Testing Machine	1
2.	Deflection of Beam Apparatus	1
3.	Torsion Testing Machine	1
4.	Drop Hammer testing apparatus	1
5.	Charpy's Test Apparatus	1

Sl. No.	Name of Equipment	Quantity
6.	Curing Tank (Temperature controlled)	1
7.	Cement Testing Moulds (70.5mm×70.5mm×70.5mm)	1
8.	Cube Moulds (150 mm×150mm×150mm)	1
9.	Concrete Mixer	1
10.	Vibrating Table	1
11.	Cement storing drums	2
12.	Weighing Balance (5 kg.)	1
13.	Weighing Balance (200 kg.)	1
Soil Mechanics Lab		
1.	Pycnometer	5
2.	Core Cutter Apparatus	5
3.	Sand Replacement Apparatus	5
4.	Sieve Set	2
5.	Liquid Limit Apparatus (Cassagrande)	5
6.	Compaction Test Apparatus	5
7.	Direct Shear Test Apparatus (2'× 2')	1
8.	Unconfined Compression Test	1
9.	Constant Head Permeability Apparatus	1
10.	Variable Head Permeability Apparatus	1
11.	Mercury	200 ml
12.	Weighing Balance (100 g)	1
13.	Sieve shaker	1
14.	Oven	1
15.	Sample Containers for moisture content	25
16.	Auger	2
17.	Hammer	2
18.	Split spoon sampler	2
19.	Desiccators	1
20.	Straight edge	4
21.	Trowel	2
22.	Sieve Brush	2
23.	Hydrometer	2
24.	Measuring Cylinders (1000 ml)	4
25.	Thermometer	2
26.	Shrinkage limit Test Kit	4
27.	Sample Box	25
Survey Lab		
1.	Chain (30 m)	5
2.	Metallic Tape (30 m)	7
3.	Arrow	100
4.	Cross-staff	5
5.	Wooden Pegs	100
6.	Wooden Mallet	5

Sl. No.	Name of Equipment	Quantity
7.	Ranging Rods	50
8.	Offset Rod	10
9.	Surveyor's Compass with stand	5
10.	Prismatic Compass with stand	5
11.	Plane table with accessories	5
12.	Theodolite with stand	5
13.	Total survey station	2
14.	Planimeter	5
15.	Dumpy Level with stand	5
16.	Levelling Staff	10
17.	Abney Level	2
18.	Hand Level	2
19.	Ceylon Ghat Tracer	2
20.	Plumb Bob	5

g) Mechanical Engineering

Sl. No.	Name of Equipment	Quantity
Fluid Mechanics Lab		
1.	Venturimeter and an orifice meter setup	1
2.	Bernoulli's Theorem Apparatus	1
3.	Different vanes for measuring impact of water jet	1
4.	Mouthpiece to determine the coefficient of discharge	1
5.	Triangular and rectangular notches arrangement	1
6.	Meta-centric height Apparatus	1
7.	Pipes friction apparatus	1
8.	Current meter	1
Workshops		
1.	Wood Working Machine	1
2.	Bend Saw (Small)	1
3.	Wood Working Lathe	2
4.	Wood Working Bench	5
5.	Black Smith Hearth	3
6.	Power Hammer	1
7.	Work bench	4
8.	Fitter's Table	4
9.	Surface Plate	2
10.	Power Hacksaw	1
11.	Bench Grinder	1
12.	Arc Welding Machines	3
13.	Gas Welding Equipment	1
14.	Resistance Welding Machine	1
15.	Work Table	5
16.	Shear (Manually Operated)	1
17.	Bench Grinder	1

18.	Cupola (Small Size)	1
19.	Crucibles	2
20.	Lathe	2
21.	Shaper	1
22.	Universal Milling Machine	1
23.	Bench Drilling Machine	1
24.	Radial Drilling Machine	1
25.	Bench Grinder	1
26.	Work Bench	1
27.	Surface Plate	1
28.	Power Hacksaw	1

Refrigeration and Air Conditioning Lab		
1.	Set up for determination of the coefficient of performance of vapour compression refrigeration system	1
2.	Set up for determination of the coefficient of performance of vapour absorption (electrolux) refrigeration system	1
3.	Set up for determination of humidifying efficiency	1
4.	Set up for determination of dehumidifying efficiency	1
5.	Set up for determination of the coefficient of performance of a domestic refrigerator 1	
6.	Set up for determination of the coefficient of performance of air conditioning system 1	

Theory of Machine & Machine Design Lab

1.	Epicyclic Gear Train	1
2.	Clutch Models	
	1) Single Plate Clutch	
	2) Multi Plate Clutch	
	3) Cone Clutch	1 each
3.	Models of Knuckle Joint Assembly, Cotter Joint Assembly, Muff Coupling,	
	Flange Coupling, Leaf Spring, Oldham coupling	1 each
4.	Centrifugal and inertia governors working models	1
5.	Model of different types of mechanisms	1 each
6.	Model of different types of key sets	1 each
7.	Different type of gears, pulleys, sprockets, chains, ropes , springs etc	1 each

h) Computer Science and Electrical Engineering

Sl. No.	**Name of Equipment**	**Quantity**
Computer Lab		
1.	Computers	15
2.	MFP-Printer	1
3.	Networking equipment – (Like router, LAN card for each computer)	1
4.	Uninterrupted power supplies	15
5.	Integrated projection system	1

CAD Lab

1.	Computers	16
2.	Server	1
3.	2-D software(AutoCAD)	1
4.	3-D software (Catia/Solid works/Unigraphics/Delcam/ etc)	1
5.	CAM software (Master CAM/Delcam/etc.)	1

i) Electrical and Electronics Engineering Lab

Sl. No.	Name of Equipment	Quantity
1.	Bread Board	10
2.	D.C. Power supply	6
3.	Multi-meters	10
4.	Cathode ray oscilloscopes (Dual Channel)	5
5.	Passive components (Resistors, Inductors, Capacitors)	20 each
6.	Small signal active components	10 each
7.	Various transducers	10 each
8.	Single Phase transformers	Four
9.	DC series motor	One
10.	Energy meter	2
11.	Resistive load box	2
12.	Micro processor kits – 8085	10
13.	Micro controller kits 8051, 89c52	4
14.	DAC AND ADC	4 each
15.	DC series Generator (with DC drive)	1
16.	DC shunt motor	1
17.	Three phase Induction motor (complete set)	1
18.	Single Phase induction motor	1
19.	Slip Ring Induction motor (Three phase)	1
20.	Tachometer	5
21.	Digital multi-meters	5
22.	Digital Power factor meter	2
23.	Wattmeters of various ratings (5A, 10A, 20A, 40A)	2 each
24.	Ammeter (Analog type) (0-10A)	5
25.	Voltmeter (Analog type) (0-300V)	5
26.	Rheostats of various ratings (2.5A, 5A,10A)	2 each
27.	Variac single phase or Dimmer Set (0-250V)	2
28.	Three phase Dimmer Set	2

j) Physics & Chemistry Labs

Sl. No.	Name of Equipment	Quantity
Physics Lab		
1.	Photocell kit	1
2.	Energy Band Gap kit using PN Junction diode	1
3.	Hysteresis curve (BH curve) set-up including CRO	1
4.	Induced emf study (with simple harmonic motion of magnet fitted on semi-circular arc) as a function of velocity	1
5.	Specific charge (e/m) set-up by Helical method	1
6.	Desauty Bridge set-up including oscillator, diode etc	1
7.	Carey Foster Bridge set-up including resistance boxes, resistance coils, galvanometer, jockey, connecting wires etc.	1
8.	Electrical vibrator apparatus including weight box, pulley etc	1
9.	Magnetometer (Stewart & Gee Tangent galvanometer) set-up with battery, reversing key, rheostat etc.	1
10.	Probe kit	4
Sl. No.	**Name of Equipment**	**Quantity**
Chemistry Lab		
1.	Viscometer	1
2.	Stalagomometer	1
3.	Refractrometer	1
4.	Spectrophotometer	1
5.	Polarimeter	1
6.	FT-IR Spectrometer	1
7.	Fuel properties measuring apparatus: bomb calorimeter, gas calorimeter, flash and fire point apparatus, cloud point apparatus, etc	1 each

COMMUNITY SCIENCE

Course Curricula for Undergraduate Programme in Community Science: UG-Certificate (Community Science); UG-Diploma (Community Science); B.Sc. (Hons.) Community Science

INTRODUCTION

Higher education in community science equips students with the knowledge, skills, and mindset necessary to address real-life challenges while instilling a sense of social responsibility. Community Science embraces a multidisciplinary approach by integrating elements from various fields such as science, social science, and technology. It is a comprehensive field that plays a crucial role in fostering human resource development and leadership skills. It empowers individuals to take charge of outreach programs, enhancing national development efforts through grassroots initiatives and sustainable practices. The NEP-2020 layout a well-defined framework at the Undergraduate level providing multiple entry and exit options to students in their whole degree program with more emphasis on Skill enhancement courses, so that if the student exits after completing first-year courses, he/she/ze may be given a UG-Certificate and after exit in the second year, will get UG-Diploma.

The restructured course curriculum for the Undergraduate programmes in Community Science (UG-Certificate, UG-Diploma, and B.Sc. (Hons.) aims at strengthening critical thinking, creativity, communication, and collaboration among the students. Several new initiatives such as categorization of course credits into core, skill and elective, practicals, skill enhancement, and internship Segments have been added to newly refurbished Undergraduate course curricula of the VI Deans' Committee to gradually upskill and imbibe the students with required skills and entrepreneurial capabilities to take up new and challenging roles and become market-ready. The first year of study emphasizes building the fundamental knowledge base of the core domain along with the initiation of a choice-based skill enhancement course module from a bouquet of multiple interesting skill enhancement modules offering a wide arena of opportunities to the students.

The second year, further, reinforces and upskills the proficiency already gained in the first year coupled with a higher level of skill modules, besides enhancing knowledge and understanding in the area of agriculture

informatics and entrepreneurship. The third-year courses put more emphasis on strengthening core aspects of the discipline with more orientation toward theory and practicals. By leveraging diverse perspectives and methodologies, courses in community science addresses complex challenges and promote holistic approaches to societal well-being. The final year focuses on the holistic development of the undergraduates by providing a choice of electives to impart specialized skills in the chosen field of specialization out of the five important domains of community Science with a student READY programme.

Through RAWE and Experiential learning, students engage directly with communities, gaining practical insights and understanding their role in fostering positive change. This not only sharpens their capabilities but also cultivates a deep awareness of their societal impact and encouraging them to contribute meaningfully to the well-being of others. Online learning through digital environments like MOOC/SWAYAM courses will further complement and open new avenues to pursue the passion of the student within the whole span of a four-year degree program. On successful completion of the whole four-year course programme, the degree offered will be an Honours degree named B. Sc. (Hons.) Community Science.

The present document of the VI Deans' Committee report of Community Science is an outcome of the valuable suggestions and recommendations of VI Deans' Committee members after having multistage in-depth ponderings and deliberations in a series of virtual meetings along with meticulous immersion and collective in-depth inputs of eminent Deans', Emeritus Professors and Senior Faculty members representing all the five departments of Community Science, stakeholders pass out from related industries, Government Institutions and also pass-out Undergraduate students of the V Deans' Community Science course program across the Nation. The contribution of each one in giving shape to this valuable document is thankfully acknowledged.

HIGHLIGHTS

- The B.Sc. (Hons.) Community Science programme is designed over 4 years, covering 167 credit hours of coursework. Additionally, students engage in 4 credit hours of non-gradial courses and 10 credit hours of MOOCs/Online courses.
- After the admission of students in the university, the students will register for the *Deeksharambh* (Foundation Course of 2 Week) in the first semester of the degree programme. It will include discussions on operational framework of academic process in University, sessions from alumni, business leaders, University academic and research managers and classes on instilling social awareness, ethics and values, cultural heritage, folk art and craft, Indian Constitution, etc. Steps will be taken to identify the strength and weakness of students, diverse potentialities and to enhance cultural integration of students from diverse backgrounds. It will also create a platform for students to learn from other's life experiences.
- Student will have to do common courses under categories like Multi-disciplinary, Value-added, Ability enhancement courses, NSS/NCC etc.
- The first two years of the course program is dedicated for skill development in Community Science discipline through skill enhancement courses along with basic and fundamental courses. The skill enhancement courses (SEC) of 12 credit hours will be offered during the first and second year of the degree program with flexibility to the student as per NEP-2020 guidelines.

- There are two different SEC modules of 4 credits hours, to be offered one in each semester in a sequential manner, like SEC module-1 in first semester, SEC module-2 in second semester. In second year, other two SEC modules of 2 credit hours each will be offered in third (SEC module-3) and fourth semester (SEC module-4).
- The students will have flexibility and choice in selection of skill development area from a basket of SEC modules to be offered by the parent institute. Each of the SEC module offers five skill development areas of related domains of Community Science for the students. After one-week common orientation on different skill enhancement modules, students will take up one module as per the interest / local needs and gain complete hands-on experience on the selected module. In addition, University /(HAEI) Higher Agricultural Education Institutions may also offer courses in any other areas as identified by it, based on institutional expertise / capabilities/ resources.
- In the first year, after satisfactory completion of courses in first two semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in Community Science on the exit. The students continuing the study further, would not have to attend the internship after first year.
- The second year has been designed with the practical exposure as well as some part of the fundamental courses related to Community Science with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of Community Science. After satisfactory completion of courses in 3rd and 4th Semesters and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Diploma in Community Science on the exit. The students continuing the study further, need not to attend the internship after second year. These students will acquire distinct knowledge, skills, competency and confidence to start his/her/ze own enterprise and can also get good jobs as per their merits.
- The community science courses in the third-year have been designed to impart core knowledge of the subject to the students. There will not be an exit after third year. During the 5th semester, the students will have a study tour of 10-14 days' duration, which will be counted as 2 credits (Non-gradial).
- The fourth-year course program has been meticulously designed not only to impart specialized knowledge to the students in the selected major discipline but also to prepare the students to take up employment or entrepreneurship as their future career.
- Students opting for the degree leading to B.Sc. (Hons.) Community Science will study Electives as major/minor/minors of 20 credits in the 7th semester. HAEI will ensure adequate choice of electives/ specialization courses for the students to opt for. In 8th semester, Student READY programme (Experiential Learning/Hands-on Training/Rural Awareness Work Experience (RAWE)/ In-Plant Training/ Industrial attachment/Internship and Student Project) of 20 credits will be offered. The student will have to take components of Student READY, out of which 10-12 credits of RAWE and 10-12 credits of Internship/Hands-on-training/Student project.
- After satisfactory completion of fourth-year course requirements, the student will become eligible for the award of a Degree in B.Sc. (Hons.) Community Science.
- The Universities will have the flexibility to include more courses as Electives depending on specific needs and situational variations. The objective is to enable the student to acquire deeper understanding in any particular field.
- The students will also have the choice to take 10 credit hours course either preferably MOOC/ SWAYAM/ NPTEL/ mooKIT/ edX or any other portal accepted by the University during the

third and fourth year as a partial requirement for the degree of B.Sc. (Hons.) Community Science. The MOOCs courses may relate to the main discipline or from any other discipline like social science, psychology, anthropology, economics, language, humanity, music, etc. The objective is to allow the students to acquire competency and strengthen their knowledge and competency based on his/her/ze choices.

- These courses will be non-gradial and a separate certificate would be issued by the Institute/ University offering the courses. However, the university/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the successfully completed courses in final transcript issued to the student. These will be added in Academic Bank of Credits of the student.
- The students will register for a maximum of two modules of Skill Enhancement Course (SEC) for Employement and Enterpreneurship Development during each semester in the first year. Thus, the name(s) of modules taken by the student will be reflected in the UG certificate award, such as UG-Certificate (Community Science) in XXX (names of the modules).

Entry and Exit Options

The entry and exit options for the B.Sc. (Hons.) programme in Community Science are shown in the Figure 1 below:

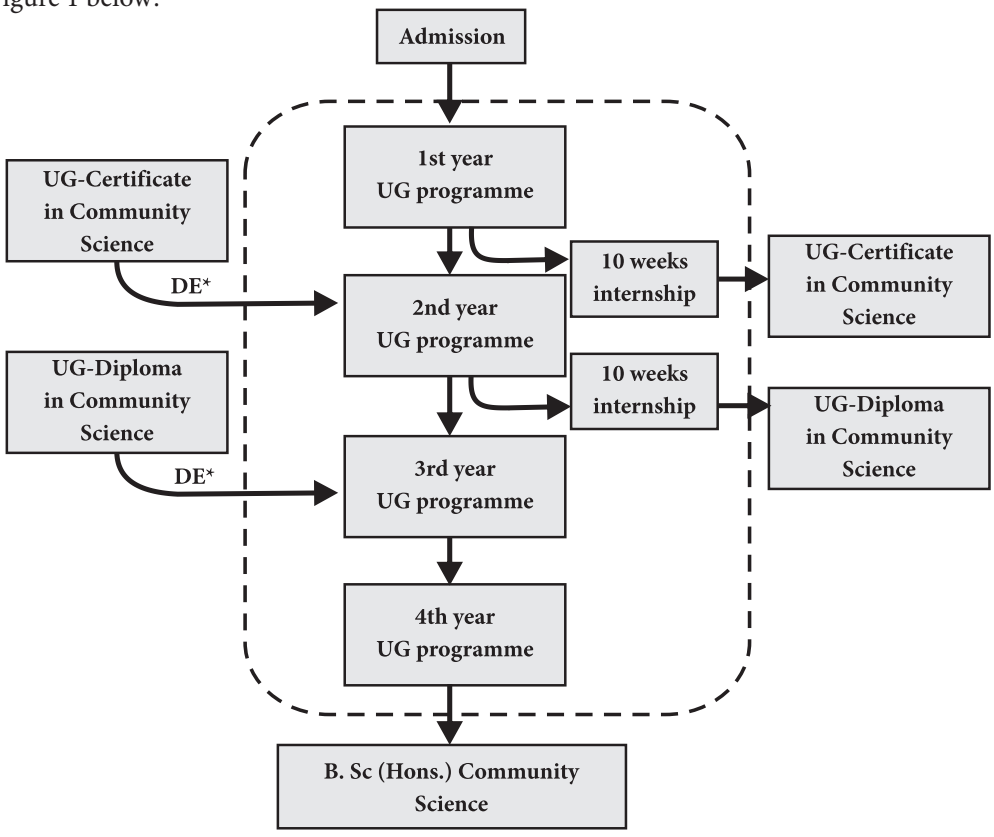


Fig.1. Entry and Exit options for the UG program in Community Science
DE* Direct Entry in the respective year

Exit options

- UG-Certificate in Community Science (Exit after first year and completion of 10 weeks' internship)
- UG-Diploma in Community Science (Exit after second year and completion of 10 weeks' internship)
- B.Sc. (Hons.) Community Science (On successful completion of four-year degree requirements

Admission Eligibility for Entry in to 1st year UG Programmee: 10+2 Science with Biology or Mathematics as one subject/Agriculture from a recognized Central/State Board/University or as per the criteria decided by the ICAR/SAU/ HAEI*.

Note: This Syllabus is meant for all Higher Agricultural Education Institutions including SAUs and ICAR-DUs.

ACADEMIC PROGRAMME

Semester wise course distribution

S. No.	Course Title	Credit Hours	Total credits
	First year		
	Semester I		
1.	*Deeksharambh* (Induction-cum-Foundation Course of 2 weeks)	2 (0+2) Non-gradial	
2.	Food Standard and Quality Control	2 (1+1)	**22 (10+12) (+ 2 NG)**
3.	Textile Science and Fabric Care	3 (2+1)	
4.	Fundamentals of Art and Design	2 (1+1)	
5.	Childhood Development	3 (2+1)	
6.	Communication for Development	2 (1+1)	
7.	Skill Enhancement Course (SEC-I)*	2 (0+2)	
8.	Skill Enhancement Course (SEC-II)*	2 (0+2)	
9.	Farming System Based Livelihood	3 (2+1)	
10.	Communication Skills	2 (1+1)	
11.	National Cadet Corps-I (NCC-I)/ National Service Scheme-I (NSS-I)	1 (0+1)	
*SEC-I and SEC-II to be selected from the list of the basket available under SEC-I module			
	Semester II		
1.	Food Science and Processing	3 (1+2)	**23 (10+13)**
2.	Fundamentals of Clothing Construction	3 (1+2)	
3.	Fundamentals of Ergonomics	2 (1+1)	
4.	Theoretical Approaches to Parenting	2 (2+0)	
5.	Personality Development	2 (1+1)	
6.	Entrepreneurship Development and Business Management	3 (2+1)	
7.	Environmental Studies and Disaster Mmanagement	3 (2+1)	
8.	Skill Enhancement Course* (SEC-III)	2 (0+2)	
9.	Skill Enhancement Course* (SEC-IV)	2 (0+2)	
10.	NCC-II/ NSS-II	1 (0+1)	
*SEC-III and SEC-IV to be selected from the list of the basket available under SEC-II module			

S. No.	Course Title	Credit Hours	Total credits
Post- II Semester Internship (Only for exit option for award of UG-Certificate)			
1.	Internship (10 weeks)		**10 (0+10)***
*Compulsory Internship for students exercising exit option (UG-Diploma) after Ist Year			
Second Year			
Semester III			
1	Food Packaging and labelling	2 (1+1)	20 (9+11)
2	Pattern Making and Draping	3 (1+2)	
3	Computer-aided Interior designing-I	3 (1+2)	
4	Early childhood Education	3 (2+1)	
5	Extension and Rural Development	3 (2+1)	
6	Rural Sociology	2 (2+0)	
7	Physical Education, First Aid, Yoga Practices and Meditation	2 (0+2)	
8	Skill Enhancement Course (SEC-V)*	1 (0+1)	
9	Skill Enhancement Course (SEC-VI)*	1 (0+1)	
*SEC-V and SEC-VI to be selected from the list of the basket available under SEC-III module			
Semester IV			
1.	Institutional Food Service Management	3 (2+1)	20 (10+10)
2.	Retailing and Merchandising	2 (1+1)	
3.	Housing and Space Management	3 (1+2)	
4.	Theories and Practices in Early Childhood Education	2 (2+0)	
5.	Training and Professional Development	2 (0+2)	
6.	Agriculture Marketing and Trade	3 (2+1)	
7.	Agriculture Informatics and Artificial Intelligence	3 (2+1)	
8.	Skill Enhancement Course (SEC-VII)*	1 (0+1)	
9.	Skill Enhancement Course (SEC-VIII)*	1 (0+1)	
*SEC-VII and SEC-VIII to be selected from the list of the basket available under SEC-IV module			
Post- IV Semester Internship (Only for exit option for award of UG- Diploma)			
1.	Internship (10 weeks)		10 (0+10)*
*Compulsory Internship for students exercising exit option (UG-Diploma) after IInd Year			

S. No.	Course Title	Credit Hours	Total credits
	Third Year		
	Semester V		
1.	Human Physiology	3 (2+1)	**21 (10+11)**
2.	Food Hygiene and Sanitation	1 (1+0)	
3.	Techniques of Fabric Construction	3 (1+2)	
4.	Principles of Textile Designing	3 (0+3)	
5.	Consumer Education	3 (1+2)	
6.	Adolescent Development	3 (2+1)	
7.	Adulthood Development	2 (1+1)	
8.	Project Management	3 (2+1)	
	Educational Tour (10-14 days)	2 (0+2) Non-gradial	
	Semester VI		
1.	Nutritional Biochemistry	3 (2+1)	21 (12+9)
2.	Human Nutrition	3 (2+1)	
3.	Traditional Textiles and Costumes of India	3 (2+1)	
4.	Principles of Management	2 (2+0)	
5.	Computer aided Interior designing-II	3 (0+3)	
6.	Marriage and Family Dynamics	3 (2+1)	
7.	Diffusion and Adoption of Innovation	3 (2+1)	
8.	Seminar	1 (0+1)	
	Fourth Year		
	Semester VII		
1.	Research Methodology		3 (2+1)
2.	Statistical methods		2 (1+1)
3	Elective courses from major/ minor (Anyone specialization)		15
	Total		**20**
	Semester VIII		
1.	Student READY RAWE/ Internship/In plant/Industrial Attachment)/ Experiential Learning /Hands on Training/Student Project)		**20**
	Total		**167 + 10* (MOOCs) + 4 NG**

*On- line courses (MOOC);NG- Non-gradial

List of Elective Courses*		
Course Number	**Course**	**Credit Hours**
Elective-1 **Food and Nutrition**		
1.	Food Analysis	3 (1+2)
2.	Normal and Therapeutic Nutrition	3 (2+1)
3.	Food Product Development and Formulations	2 (1+1)
4.	Clinical Nutrition	2 (2+0)
5.	Diet and Nutrition Counselling	1 (0+1)
6.	Sports Nutrition	2 (2+0)
7.	Community Nutrition and Education	2 (1+1)
8.	Research Methodology	3 (2+1)
9.	Statistical Methods	2 (1+1)
Elective-2 **Apparel and Textile Science**		
1.	Advance Draping Technique	3 (0+3)
2.	CAD- Pattern Making and Grading	2 (0+2)
3.	Quality Analysis in Textiles and Apparels	3 (2+1)
4.	Apparel Production Management	3 (3+0)
5.	Agro Textiles	2 (1+1)
6.	Recent Advances in Textiles	2 (2+0)
7.	Research Methodology	3 (2+1)
8.	Statistical Methods	2 (1+1)
Elective-3 **Resource Management and Consumer Science**		
1.	Residential and Commercial Space Design	3 (1+2)
2.	Colour and Lighting in Interiors	3 (2+1)
3.	Tourism and Hospitality Management	3 (1+2)
4.	Financial Management and Consumer Behaviour	3 (2+1)
5.	Work Space and Product Design	3 (1+2)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)

Elective-4 **Human Development and Family Studies**		
1.	Developmental Challenges in Children	3 (2+1)
2.	Methods and Materials for Teaching Young Children	3 (1+2)
3.	Computer application in ECCE	3 (1+2)
4.	Guidance and Counselling	3 (2+1)
5.	Parent Education and Community welfare Programs	3 (2+1)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)
Elective-5 **Extension Education and Communication Management**		
1.	Extension Program Management	3 (1+2)
2.	Extension Training Management	3 (1+2)
3.	Advertising and Social Marketing	3 (1+2)
4.	Public relations and Communication Management	3 (1+2)
5.	Web designing	3 (0+3)
6.	Research Methodology	3 (2+1)
7.	Statistical Methods	2 (1+1)
	TOTAL	**20**

*The institutions may formulate additional elective courses as per specific local needs and facilities/expertise available.

Department/ section wise course breakup

S. No.		Course Title	Credits	Total Credits
Foundation courses				
1.		Deeksharambh (Induction-cum-Foundation Course of 2 weeks)	0+2 (NG)*	4 (0+4) *Credits not included in the total calculated here
2.		Study Tour (10-12 days)	0+2 (NG)* Non-gradial	
Common Courses				
1.	Multidisciplinary courses (MDC) 9 credits	Farming based livelihood systems	3 (2+1)	23 (12 + 11)
2.		Entrepreneurship Development and Business Management	3 (2+1)	
3.		Agriculture Marketing and Trade	3 (2+1)	
4.	Value Added courses + (VAC) 6 credits	Environmental Studies	3 (2+1)	
5.		Agriculture Informatics & Artificial Intelligence	3 (2+1)	
6.	Ability Enhancement Courses (AEC) 8 credits	NSS/ NCC – I	2 (0+2)	
7.		Communication Skills	2 (1+1)	
8.		Personality Development	2 (1+1)	
9.		Physical Education, First Aid Yoga Practices & Meditation	2 (0+2)	

S. No.		Course Title	Credits	Total Credits
Department of Food and Nutrition				
1.	Core courses	Food Standards and Quality Control	2 (1+1)	32 (13+19)
2.		Food Science and Processing	3 (2+1)	
3.		Food Packaging and labelling	2 (1+1)	
4.		Institutional Food Service Management	3 (2+1)	
5.		Human Physiology	3 (2+1)	
6.		Human Nutrition	3 (2+1)	
7.		Nutritional Biochemistry	3 (2+1)	
8.		Food Hygiene and Sanitation	1 (1+0)	
9.	Skill Enhancement Courses (under SEC Modules-12 credits)	Breads and Buns	2 (0+2)	
10.		Biscuits and Cookies	2 (0+2)	
11.		Cakes and Pastries	2 (0+2)	
12.		Chocolate Making	2 (0+2)	
13.		Quantity Cookery	1 (0+1)	
14.		Traditional Indian Foods	1 (0+1)	
15.		Food Preservation and Storage-I	1 (0+1)	
16.		Food Preservation and Storage-II	1 (0+1)	
Department of Apparel and Textile Science				
1.	Core courses	Textile Science and Fabric Care	3 (2+1)	32 (8+24)
2.		Fundamentals of Clothing Construction	3 (1+2)	
3.		Pattern Making and Draping	3 (1+2)	
4.		Retailing and Merchandising	2 (1+1)	
5.		Principles of Textile Designing	3 (0+3)	
6.		Techniques of Fabric Construction	3 (1+2)	
7.		Traditional Textiles and Costumes of India	3 (2+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Textile Dyeing and Printing	2 (0+2)	
9.		Fabric Embellishment	2 (0+2)	
10.		Indian Embroideries	2 (0+2)	
11.		Quilting and Patchwork	2 (0+2)	
12.		Garment Designing	1 (0+1)	
13.		Accessory Designing	1 (0+1)	
14.		Fashion Illustration	1 (0+1)	
15.		Portfolio Development	1 (0+1)	

S. No.		Course Title	Credits	Total Credits
Department of Resource management and Consumer Science				
1.	Core courses	Fundamentals of Art and Design	2 (1+1)	30 (7+23)
2.		Fundamentals of Ergonomics	2 (1+1)	
3.		Computer aided Interior designing- I	3 (1+2)	
4.		Housing and Space Management	3 (1+2)	
5.		Consumer Education	3 (1+2)	
6.		Principles of Management	2 (2+0)	
7.		Computer Aided Interior Designing- II	3 (0+3)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Housekeeping and Service Management- I	2 (0+2)	
9.		Floral Art and Design- I	2 (0+2)	
10.		Housekeeping and Service Management -II	2 (0+2)	
11.		Event Planning and Management	2 (0+2)	
12.		Interior designing and decoration I	1 (0+1)	
13.		Floral Art and Design- II	1 (0+1)	
14.		Interior Accessories and Furnishings	1 (0+1)	
15.		Interior designing and decoration- II	1 (0+1)	
Department of Human Development and Family Studies				
1.	Core courses	Childhood Development	3 (2+1)	30 (13+17)
2.		Theoretical Approaches to Parenting	2 (2+0)	
3.		Early Childhood Education	3 (2+1)	
4.		Theories and Practices in Early Childhood Education	2 (2+0)	
5.		Adolescent Development	3 (2+1)	
6.		Adulthood Development	2 (1+1)	
7.		Marriage and Family Dynamics	3 (2+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)	
9.		Developmental Assessment II (childhood)	2 (0+2)	
10.		Infant Stimulation Practices	2 (0+2)	
11.		Health Practices in Early Childhood	2 (0+2)	
12.		Establishment of ECCE Centers	1 (0+1)	
13.		Program Planning and Execution in ECCE Centres	1 (0+1)	
14.		Management of ECCE Centers	1 (0+1)	
15.		Monitoring and Evaluation of ECCE Centers	1 (0+1)	

S. No.		Course Title	Credits	Total Credits
Department of Extension Education and Communication Management				
1.	Core courses	Communication for Development	2 (1+1)	28 (9+19)
2.		Extension and Rural Development	3 (2+1)	
3.		Rural Sociology	2 (2+0)	
4.		Project Management	3 (2+1)	
5.		Diffusion and Adoption of Innovations	3 (2+1)	
6.		Training and professional Development	2 (0+2)	
7.		Seminar	1 (0+1)	
8.	Skill Enhancement Courses (under SEC Modules-12 credits)	Audio Visual Aids for Communication	2 (0+2)	
9.		Extension Teaching Methods	2 (0+2)	
10.		Computerized Instructional Aids Production	2 (0+2)	
11.		ICT and New Media	2 (0+2)	
12.		Print Journalism	1 (0+1)	
13.		Electronic Journalism	1 (0+1)	
14.		Audio and Video Recording	1 (0+1)	
15.		Instructional Video Production	1 (0+1)	
ELECTIVE COURSES				
1.	Food and Nutrition	Food Analysis Normal and Therapeutic Nutrition	3 (1+2) 3 (2+1)	15 (Anyone elective to be chosen)
2.		Food Product Development and Formulations	2 (1+1)	
3.		Clinical Nutrition	2 (2+0)	
4.		Diet and Nutrition Counselling	1 (0+1)	
5.		Sports Nutrition	2 (2+0)	
6.		Community Nutrition and Education	2 (1+1)	
7.	Apparel and Textile Science	Advance Draping Technique	3 (0+3)	
8.		CAD- Pattern Making and Grading	2 (0+2)	
9.		Quality Analysis in Textiles and Apparels	3 (2+1)	
10.		Apparel Production Management	3 (3+0)	
11.		Agro Textiles	2 (1+1)	
12.		Recent Advances in Textiles	2 (2+0)	
13.	Resource Management and Consumer Science	Residential and Commercial Space Design	3 (1+2)	
14.		Colour and Lighting in Interiors	3 (2+1)	
15.		Tourism and Hospitality Management	3 (1+2)	
16.		Financial Management and Consumer Behaviour	3 (2+1)	
17.		Work Space and Product Design	3 (1+2)	

S. No.		Course Title	Credits	Total Credits
18.	Human development and family Studies	Developmental Challenges in Children	3 (2+1)	30 (12+18)
19.		Methods and Materials for Teaching Young Children	3 (1+2)	
20.		Computer application in ECCE	3 (1+2)	
21.		Guidance and Counseling	3 (2+1)	
22.		Parent Education and Community welfare Programs	3 (2+1)	
23.	Extension Education and Communication Management	Extension Program Management	3 (1+2)	
24.		Extension Training Management	3 (1+2)	
25.		Advertising and Social Marketing	3 (1+2)	
26.		Public relations and Communication Management	3 (1+2)	
27.		Web designing	3 (0+3)	

Table 1. Summary of credit hours for different categories of courses (Credit Hours)

Sem-ester	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses/ MOOC
I	12	3(2)		1(3) + 2(4)	4	-	22	2(1)		
II	10	3(5)	3(6)	1(3) + 2(7)	4	-	23	-	10(12)	
III	16	----		2(8)	2	-	20			
IV	12	3(9)	3 (10)	----	2	-	20	-	10(13)	**10**
V	21	-	-	-	-	-	21	2(11)		
VI	21	-	-	-	-	-	21	-		
VII	20*	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

Note: The credit hours mentioned in the table includes both theory and practical.

(1) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices & Meditation
(9) Agriculture Marketing and Trade
(10) Agricultural Informatics & Artificial Intelligence
(11) Study tour (10-14 days).
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major and minor's)	:	112
Common courses (MDC+VAC+AEC)	:	23
Skill Enhancement Courses (SEC)	:	12
Internship/ Student READY	:	20
**MOOCS/SWAYAM	:	10 non-gradial
Total	:	**167+10****

** Massive open online courses

Community Science is a multi-disciplinary subject and have perfect amalgamation of many disciplines. Hence, choice of skill based and Elective courses will be offered to student from bouquet of Skill Enhancement Course modules to develop required skill competency in both first year and second year for UG Certificate in Community Science or Diploma in Community Science at the first exit or second exit, respectively. The online learning through digital environment like MOOC/ SWAYAM, courses will further complement and open new avenues to pursue the passion of the student within the whole span of four years of the degree program.

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Course)- Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Helpings in cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in University
3. Instilling life and social skills
4. Social awareness, ethics and values, team work, leadership, creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Suggested Readings

1. Pandikattu K. 2024. *Excellence and Integrity: Fostering the Greater Good as Adding Value to the Business of Life*. Written Words, Delhi, India.
2. Pandikattu K. 2023. *Ideas Changing the World: Ideals Shaping Our Lives*. Written Words, Delhi, India.
3. Pandikattu K. 2022. *Business Ethics: Textbook of Concepts and Cases*. Written Words, Delhi, India.
4. Pandikattu K. 2021. *Finding God in Everything: Spiritual Insights into Finding Everything in God*. ISPCK, Delhi, India.

Food Standards and Quality Control 2 (1+1)

Objectives

i. To understand the adverse effects of chemical substances in food on human beings and about food laws and regulations to prevent adulteration in food
ii. To acquire knowledge about quality and safety aspects of food
iii. To induce knowledge regarding national and international food safety standards and regulations

Theory

Food Quality: Meaning and definition of food quality, quality factors in raw and cooked foods, indicators of food quality. Meaning, importance and ways of Food Quality Assessment. Total quality management. Hazard Analysis and Critical Control Points (HACCP). Good Hygienic Practices. Good

Manufacturing Practices - Risk Analysis, Risk Management, Risk Assessment, Risk Communication - Traceability and authentication. Water quality: Methods of assessment, purification. Sensory evaluation, Physiological bases, sensory characteristics of foods, types, selection and training of sensory panel, requirements for sensory evaluation tests, types of tests, analysis and interpretation of sensory evaluation tests; Methods of Sensory Evaluation and Evaluation cards- Ranking and Rating procedures. Different methods of Quantitative descriptive analysis. Determination of Sensory thresholds and taste Interactions. Objective methods for quality evaluation- Introduction and application. Consumer Studies – Types of Consumer studies- Preference Studies Objectives of Consumer Preference Studies-factors affecting consumer acceptance.

Food laws and regulations at National Level and International level: Food Safety and Standards Rules, 2011. FSSAI, AGMARK, BIS, food export and import regulations in India. Codex Alimentarius. Eco-friendly products. ISO and others. Food Adulteration Meaning. Detection of common adulterants. Food packaging material – Potential contaminants from food packaging material. Food toxins and contaminants: Occurrence, types, harmful effects, detection in foods, Toxicological effects, limits and methods of removal. Food hygiene and sanitation.

Practical

Detection of common adulterants in foods. Sensory evaluation of some finished products. Quality evaluation of some products using objective methods. Visit to quality control laboratory/ food processing industries. FSSAI. AGMARK. Food Toxicology laboratory and notes the procedures and parameters used for quality assessment. Market Survey. Collection of food labels and preparation of Scrap Book.

Suggested Readings

1. Khanna R. 2003. *Food Standard and Safety in Globalized World: Impact of WTO and Codex.* 505 p. New Century Publications, Delhi.
2. McWilliams M. 2000. *Foods Experimental Perspectives*. (4th Edn.). 588p. Prentice-Hall, Inc New Jersey.
3. https://www.fssai.gov.in/https://agriexchange.apeda.gov.in/IR_Standards/Import_Regulation/ Food and Agricultural Import Regulations and Standards Report New Delhi India 352019.pdf. Accessed on 13-02-2023.

Textile Science and Fabric Care 3 (2+1)

Objectives

i. To impart knowledge about the basics of textiles and their care
ii. To develop a basic understanding of different textile fibres, yarn and fabrics
iii. To gain knowledge of the processing of natural fibres and manufacturing of man-made fibres
iv. To inculcate an understanding of fibre morphology and physical and chemical properties of fibres
v. To learn about the laundry practices of clothes made of natural and man-made fibres and their care and storage

Theory

Textile: Terminology, forms of textile, importance of textile industry in national economy. Classification of textile fibres. Properties of textile fibres: primary and secondary properties. Molecular

structure of textile fibres: Monomers, polymers and their types, polymerization and its type degree of polymerization and orientation. Cotton: Fibre processing, fibre varieties and their grading, fibre morphology, physical, chemical, biological properties and end-uses. Bast fibres: Flax, jute, hemp. Fibre processing, fibre morphology, physical, chemical and biological properties and end-use. Wool and specialty hair fibres: classification, processing, wool labelling, fibre morphology, physical, chemical, biological properties and end-uses. Silk: Fibre processing, classification, fibre morphology, physical, chemical, biological properties and end-uses. Chemical spinning: Wet, melt and dry. Common properties of man-made fibres. Regenerated cellulosic fibres: Viscose, Cuprammonium and High Wet Modulus rayons: fibre manufacturing, microscopic structure, physical, chemical, biological properties and end-uses. Modified cellulosic fibres. Diacetate and triacetate: fibre manufacturing, fibre microscopic structure, physical, chemical and biological properties and end-uses. Synthetic fibres: Nylon, polyester, acrylic and elastomeric, fibre manufacturing, fibre microscopic structure, physical, chemical, biological properties and end-uses. Mechanical spinning: Ring spinning method, classification of yarn on the basis of structure (simple yarns and different type of novelty yarns), twist direction, twist amount, fibre length and end-uses. Methods of fabric construction: Weaving, knitting, braiding, tufting, net, lace making, crocheting, macramé, stitch through fabrics, quilted fabrics, laminated fabrics, bonded fabrics, felt, nonwoven and films. Laundry: Definition, principles, equipment, laundry methods and dry cleaning. Stain removal: Classification of stains and methods of removing different stains. Laundry agents: Water, soap, and other laundry auxiliaries-stiffening agents, bleaches and blue. Care of textiles: Labelling Act, importance of labelling, labels and tags used in textiles. Storage of clothes: Requirements of short term and long-term storage, folding and packaging of clothes.

Practical

Fibre identification: Visual test, Burning test, Solubility and Microscopic view. Collection and identification of different types of yarns. Collection and identification of fabric samples of different construction. Washing of garments made up of cotton, wool, silk and manmade fibres. Dry cleaning. Removal of different stains from fabric surface. Visit to textile industry.

Suggested Readings

1. Dantyagi S. 2021. *Fundamentals of Textiles and their Care.* (5th Edn.). 378p. Orient Longman Limited, New Delhi.
2. Hall A J. 1969. *A Students' Textbook of Textile Science.* 332p. Allman and Son Ltd, London.
3. Joseph M L. 1986. *Introductory Textile Science.* (5th Edn.). 464p. CBS College Publishing, New York.
4. Potter M D and Corbman B P. 1967. *Textiles: Fibre to Fabric.* 495p. McGraw Hill Co., New York.
5. Rastogi Dand Chopra S. 2017. *Textile Science.* 352p. Orient Blackswan Private Limited.
6. Ryszard K M M T. 2020. *eBook on Natural Fibres: Processing and Applications.* Vol II. 752p. Woodhead Publishing, UK. ISBN:9780128190708.
7. Stout E E. 1970. *Introduction to Textiles.* (3rd Edn.). 448p. John Wiley and Sons, Inc., New York.
8. Tortora P G. 1982. *Understanding Textiles.* 454p. Macmillan Publishing Company, New York.
9. Vatsala R. 2003. *Textbook of Textiles and Clothing.* 448p. ICAR Publication, New Delhi.

10. Vilensky L D and Gohl E P G. 1999.*Textile Science*. (2nd Edn.). 218p. CBS Publishers and Distributors Pvt. Ltd., New Delhi.

11. Wynne A. 1997. *Textiles*. 310p. Macmillan Education Ltd., London.

Fundamentals of Art and Design 2 (1+1)

Objectives

i. To make the students aware of the fundamentals of Art and Design and develop skills in designing functional and decorative interiors.

ii. To help students gain knowledge of-

- Element of Art and principles of Design
- Colour: its importance, characteristics and applications in interior furniture and furniture arrangement
- Types of floor and floor finishes
- Types of windows, functional and decorative window treatments.
- Types and placement of accessories
- Importance and types of home lighting

Theory

Introduction and objectives of interior decoration. Design: Definition, Types, features and requirements. Elements of art and their importance in interior decoration: Line, Form, Colour, Texture, Pattern. Principles of design and their application to enrich the interiors: Harmony, Proportion, Rhythm, Emphasis, Balance. Colour: sources of colour, Colour theories, properties of colour, emotional effect of colour, colour schemes, colour plans for interiors. Furniture: types of furniture, materials and finishes of furniture, factors affecting the selection of furniture, care and maintenance of furniture, furniture arrangement. Walls- Classification, Types of building wall, Exterior and interior wall finishes. Floor: importance, types of floor and floor covering, Selection,care and maintenance of floor covering. Ceilings: types, materials and functions, Doors, windows and ventilators: Importance and types, Functional and decorative window treatments, Curtain and draperies, top treatments of windows- pelmets, valances, swags and tails. Hardware for curtains, blinds. Factors considered in selection of curtain and draperies. Lighting: importance, types of lighting and its application.

Practical

Learning elements of art and principles of design. Development of motif and design through art principles. Colour: colour schemes, values and intensity scale, colour wheel. Furniture: care and arrangement of furniture. Accessories: preparation and placements of accessories. Window treatment: Preparation of soft window treatment. Study of lighting fixtures. Market survey: different types of wall and floor coverings. Types of flower arrangement, learning different types of table setting, napkin folding.

Suggested Readings

1. Dodsworth S. 2019. *The Fundamentals of Interior Design.* 208p. Bloomsbury Publishing PLC.
2. Faulkner and Faulkner. 1975. *Inside Today's Home.* 598p. Holt, Rinehart and Winston, New York.
3. Kasu Ahmed A. 2005. *An introduction to Art, Craft, Science, Technique and Profession of Interior design.* 701p. Ashish Book Center, Mumbai.
4. Parimalam P, Andal A and Premalatha M R . 2008. *A Textbook of Interior Decoration.* 286p. Satish Serial Publishing house, New Delhi.
5. Seetharaman P. 2019. *Interior Design and Decoration.* 729p. CBS Publishers and Distributors, New Delhi.

Childhood Development 3 (2+1)

Objectives

i. To make students aware about the fundamental as well as overall development of the child from conception to late childhood
ii. To understand human development and its significance
iii. To create awareness about the process of human growth and development
iv. To identify the genetic and environmental influences on human life
v. To study the inter-relatedness of physical, cognitive, social, emotional and motor development
vi. To understand the theories of human development

Theory

Concept of human development. Stages of human development. Domains of human development and its characteristics. Definition of growth and development. Determinants of human growth and development. Principles of human growth and development-Concept of heredity and environment. The role of heredity and environment on development–perspectives on development: Naturalism, environmentalism, maturational, need, ecological, ethological, cognitive, psycho-analytical, social (socio-cultural and social learning), language, behaviour, psycho-social intelligence and moral reasoning -Prenatal, peri- natal and postnatal stages- conception, care during pregnancy, labour/ birth. Early Childhood {birth to eight yrs}-Physical, motor, social, emotional, cognitive and language development of infancy, babyhood, preschool and early school yrs. Late childhood (eight to 14 yrs): Physical, motor, social, emotional, cognitive and language development. Guidance to parents for promoting holistic development of children.

Practical

Observational visits to well-baby clinics to observe full term and pre-term babies and observe/ record its characteristics. Visit to Early Childhood Centres, study physical, motor, social, emotional, intellectual, language, moral and personality development at different stages and prepare interpretive reports. Collect and evaluate reports/article/news/other secondary data related to recent issues, trends and challenges of Human development and write an analytical report. Case study of individuals in different stages of development - Infancy, early childhood, and late child hood Critical analysis of case study reports. Preparation of Resource file.

Suggested Readings

1. Bronfenbrenner V. 1979. *The Ecology of Human Development.* 330p. Harvard Univ. Press, Cambridge.

2. Berk E L. 2013. *Exploring Life Span Development.* (3rd Edn.). 696p. McGraw Hill, New York.
3. David M T, Garavan L and Dooley M. 2012. *Fundamentals of Human Resource Development*. 1688p. SAGE Publications Ltd, London.
4. Hall C S and Lindzey, G. 1978. *Theories of Personality*. 622p. John Wiley and Sons, New Jersey.
5. Harris J R and Liebert R M. 1987. *The Child*. 538p. Prentice Hall Inc., New Jersey.
6. Munsinger H. 1975. *Fundamentals of Child Development.* 604p. Holt, Reinhart and Winston, Inc., New York.
7. Papalia D E and Olds SW. 2008. *Human Development.* (11th Edn.). 832p. McGraw Hill, New York.

Communication for Development 2 (1+1)

Objectives

i. To develop competence in effective communication
ii. To develop understanding of various concepts of communication process
iii. To develop competence in oral and written communication

Theory

Communication process – concept, elements, and their characteristics. Principles of Communication. Basic functions of communication. Models of Communication. Barriers of communication. Concepts related to communication: fidelity of communication, empathy credibility, feedback in communication, communication gap and distortion. Forms and types of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication, Digital communication.

Practical

Practice sessions on written communication- Writing official letters, Notices/Circulars, Preparing minutes of meetings. Practice sessions on Oral communication- Planning and delivering an effective talk. Planning for digital communication- Arranging educational programs using digital media.

Suggested Readings

1. Dasgupta S. 1989. *Diffusion Agricultural Innovations in Village India*. 193p. Wiley Eastern Ltd, New Delhi.
2. Jalihal K A and Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. 312p. Concept Publication Company, New Delhi.
3. Ray G L. 2005. *Extension Communication and Management*. 358p. Kalyani Publication, Ludhiyana.
4. Reddy A A .1987. *Extension Education*. 344p. Shree Lakshmi Press, Bapatla. Guntur, AP.
5. Somani L L. 2012. *Extension Methodologies for Transfer of Agricultural Technology*. 432p. Image Print Media, Udaipur
6. Supe S V. 2009. *Textbook of Extension Education*. 288p. Agrotech Publishing Academy Udaipur.

Farming-based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming-based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states. Income of farmers and rural people in India. Livelihood-Definition, concept and livelihood pattern in urban and rural areas. Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework. Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/farming-based livelihood systems- Crops and cropping systems, Livestock (dairy, piggery, goatry, poultry, ducky etc.). Horticultural crops, Agro- forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc. Small, medium, and large enterprises including value chains and secondary enterprises as livelihood components for farmers. Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones. Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country. Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems. Schemes and programmes by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. *Towards Green Villages: A Strategy for Environmentally, Sound and Participatory Rural Development*. Center for Science and Environment, New Delhi, India.

2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience*; Department for International Development: London, UK, Vol. 7.

3. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa*. Consultation Document, FAO, Rome, Italy.

4. Dixon J, Gulliver A and Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO & World Bank, Rome, Italy & Washington, DC, USA.

5. Evenson R E. 2000. *Agricultural Productivity and Production in Developing Countries*. FAO, Rome, Italy.

6. Panwar A S, Ravisankar N, Prusty A K, Shamim M, Singh R, Bhaskar S, Malik S K, Tomar R K, Arunachalam A and Alagusundaram K. 2019. *Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment*. ICAR, New Delhi, India.

7. Reddy S R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi, India.

8. Singh J P, Ravisankar N, Prusty A K, Sikka A K and Gangwar B. 2016. *Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series 1)*. IIFSR Bulletin No. 2016-1, AICRP on Integrated Farming Systems, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, pp. 1-88.

9. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.

10. Chavan K. 2024. *Farming Based Livelihood Systems*. Pustakmarket Publication.

11. Mounika Leena C H, Chaithanya L K, Saurav S K and Sajjan R. 2024. *Agriculture Based Livelihood Systems in Drylands: Challenges and Strategies*. International Journal of Agriculture Environment and Biotechnology, 17(3):645-652.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills. Precis writing/ Abstracting/Summarizing. Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals, phrases and clauses. Case: subjective case, possessive case. Ojective case. Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles. Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking. Writing skills: precis writing, summarizing and abstracting. Reading and comprehension (written and oral) of general and technical articles. Micro-presentations and Impromptu Presentations: Feedback on presentations. Stage manners: grooming, body language, voice modulation, speed. Group discussions. Public speaking exercises. Vocabulary building exercises. Interview Techniques. Organization of events.

Suggested Readings

1. Brown Michele and Gyles Brandreth. 1986. *How to Interview and be Interviewed*, 146p. Sheldon Press, London.
2. Carnegie Dale. 2018. *The Quick and Easy Way to Effective Speaking*. Finger Print Publishing.
3. Francis Peter S J. 2012. *Soft Skills and Professional Communication*. 154p. Tata McGraw Hill, New Delhi.
4. Kumar S and Pushpa Lata. 2011. *Communication Skills*. 656p. Oxford University Press, India.
5. Napoleon Hill. 2014. *Think and Grow Rich.* Finger Print Publishing.
6. Neuliep James W. 2003. *Intercultural Communication - A Contextual Approach*. 520p. Houghton Mifflin Company, Boston.
7. Pease Allan .1998. *Body Language*. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. *Business Communication*. 640p. Oxford University Press, England.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. 392p. Oxford University Press, England.
10. Shital Kakkar Mehra. 2020. *Executive Presence*. Harper Business.

National Cadet Corps (NCC-I) 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the Nation.

Practical/ Awareness Programmes

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline. Drill- aim, general words of command, attention, stands at ease, stand easy and turning. Sizing, numbering, forming in three ranks, open and close order march, and dressing. Saluting at the halt, getting on parade, dismissing, and falling out. Marching, length of pace, and time of marching in quick/ slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. Marking time, forward march, and halt. Changing step, formation of squad and squad drill. Command and control, organization, badges of rank, honors, and awards. Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values

and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme (NSS-I) 1 (0+1)

Objectives

i. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work,

ii. To be skillful in executing democratic leadership, developing skill in programme,

iii. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness Programmes

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS;

Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.

NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth and opportunities for youth who is agent of the social change.

Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture. Identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.

Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.

Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Skill Enhancement Courses (SEC-I module) 4 (0+4)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-certificate, they can work with bakery/confectionary shops/ units, textile

dyeing units/ embroidery shops/housekeeping job services, event planning units, development counselling service providers, AV Aids making units/shops, etc. or can go for self-employment.

Indicative modules for SEC- I *(any one module to be selected)*

Module	Course	Credit Hours
Bakery and Confectionary Management- I	Breads and Buns	2 (0+2)
	Biscuits and Cookies	2 (0+2)
Textile Design and Embellishment- I	Textile Dyeing and Printing	2 (0+2)
	Fabric Embellishment	2 (0+2)
Event Management and Housekeeping- I	Housekeeping and Service Management-I	2 (0+2)
	Floral Art and Design-I	2 (0+2)
Childhood Development and Assessment- I	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)
	Developmental Assessment II (Childhood)	2 (0+2)
Extension Education for Community Development- I	Audio Visual Aids for Communication	2 (0+2)
	Extension Teaching Methods	2 (0+2)

In addition to the above modules, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the above modules.

Module on Bakery and Confectionary Management-I

Breads and Buns 2 (0+2)

Objectives

i. To enable students to learn the basics of producing breads and buns
ii. To acquaint the students with newer technologies and machineries used in product development
iii. To develop skills of students in making of breads and buns at professional level
iv. To impart knowledge about commercialization of breads and buns
v. To build confidence among students to start a new career in bakery

Practical

Role of ingredients in breads and buns. Characteristic features of ingredients of bread and buns. Quality assessment of raw ingredients used in bread and buns. Breads and buns– role of ingredients – various types of breads and buns– basic procedure in production. Type of bread and bun- multigrain bread, pita bread, rye bread, sour dough, whole wheat bread, bread stick, banana bread. Bread and bun packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of bread and buns. Storage of breads and buns– slightly cool, dry, dark place. Visit to breads and buns industry. Project planning for financial assistance for a small-scale industry on breads and buns making and writing report.

Suggested Readings

1. Arora A K. 2007. *Food Service and Catering Management*. 350p. APH Publishing Corporation, New Delhi.
2. Chakrabarty M M. 2003. *Chemistry and Technology of Oil and Fats*. 750p. Prentice Hall.

3. Dendy D A V and Dobraszczyk B J. 2001. *Cereal and Cereal Products*. 429p. Aspen Publishers, Boston, MA, US.
4. Parvinder S B. 2018. *Theory of Bakery*. 264p. Oxford Publishing.

Biscuits and Cookies 2 (0+2)

Objectives

i. To enable students to learn the basics of producing biscuit and cookies
ii. To acquaint the students with newer technologies and machineries used in product development
iii. To impart knowledge about commercialization of biscuit and cookies
iv. To build confidence among students to start a new career in bakery.

Practical

Biscuits and cookies–role of ingredients–various types of biscuits and–basic procedure in production. Role of ingredients in biscuits and cookies, Characteristic features of ingredients of cookies. Quality assessment of raw ingredients used in cookies. Type of cookies Sheeted type cookies making Bar type cookies making Piped type cookies making, dropped type cookies making, rolled type cookies making. Type of biscuits- digestive biscuit, custard cream, short bread, chocolate biscuit, rolled biscuits drop biscuit. Biscuits and cookies packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of biscuits and cookies. Storage of biscuits and cookies– slightly cool, dry, dark place. Project planning for financial assistance for a small-scale industry on biscuit and cookie making and writing report.

Suggested Readings

1. Arepally D, Reddy R S, Goswami T K and Datta AK. 2020. *Biscuit Baking: A review, LWT - Food Science and Technology* ***131****(2):109726.*, doi: https://doi.org/10.1016/j.lwt.2020.109726.
2. Arora AK. 2007. *Food Service and Catering Management*. 350p. APH Publishing Corporation, New Delhi.
3. Bali Parvinder S. 2018. *Theory of Bakery*. 264p. Oxford University Press, India.
4. Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats*. (1st Edn.). 760p. Allied Publishers Pvt. Ltd.; India.
5. Dendy D A V and Dobraszczyk B J. 2001. *Cereal and Cereal Products*. 429p. Aspen Publishers, Boston, MA, US.
6. https://en.m.wikipedia.org/wiki/Biscuit. Accessed on 13 January 2025.
7. Martins Z E. 2017. *Trends in Food Science and Technology.* pp106-128.
8. Mathuravalli S M D. 2021. *Handbook of Bakery and Confectionery*. 186p. Narendra Publishing House, Delhi.

Module on Textile Design and Embellishment- I

Textile Dyeing and Printing 2 (0+2)

Objectives

i. To impart skills in dyeing of cotton fabric with different dyes and designing of fabric through tie and dye and batik techniques

ii. To develop competence in printing by using block, screen, and stencil

iii. To give hands on experience in fabric surface enrichment through dyeing and printing techniques.

Practical

Introduction to dyeing and printing (Classification of dyes and their suitability to different fibres. Different styles of printing: Resist, direct and discharge. Different methods of printing: Stencil, block, screen and heat transfer printing). Preparation of fabric for dyeing and printing: De-sizing, scouring and bleaching of cotton fabric. Dyeing of cotton fabric with direct dyes, reactive dyes and naphthol dyes and preparation of shade card with different dye concentrations. Dyeing of Textiles with natural dyes and application of mordants. Sample designing through different techniques of tie and dye: pleating (diagonal and straight), fold and tie, object tying, ruching, stitching, marbling, tied circles. Sample designing through different techniques of batik with wax resist: Painting, scratching, sprinkling and marbling. Dyeing with naphthol dyes, washing and dewaxing. Preparation of printing paste and printing of cotton fabric using: (Block printing, Screen printing: Preparation of screen and printing on fabric, Stencil printing: Preparation of stencil and negative and positive stencil printing with painting and spraying method). Preparation of one article using any of the above techniques or combination of them.

Suggested Readings

1. Gahlot M and Rani A. 2016. *A Laboratory Manual on Textile Designing and Basic Finishing*. Published by Govind Ballabh Pant University of Agriculture and Technology, Pantnagar.
2. Gopal Krishnan D and Karthik T. 2016. *Basics of Textile Chemical Processing*. 117p. Daya Publishing House, Astral International Pvt. Ltd., New Delhi.
3. Hall A J.1955. *Handbook of Textile Dyeing and Printing*. 202p. The National Trade Press ltd., London.
4. Mahapatra NN. 2016. *Textile Dyes*. 230p. Woodhead Publishing series in Textiles, Elsevier.
5. Matthew C. 2011. *Handbook of Textile and Industrial Dyeing: Vol.1: Principles, Processes and Types of Dyes*. 680p. Woodhead Publishing Series in Textiles, Elsevier.
6. Matthew C. 2011. *Handbook of Textile and Industrial Dyeing: Vol. 2: Applications of dyes*.344p. Woodhead Publishing Series in Textiles, Elsevier.
7. Prayag R.S. 1989. *Technology of Textile Printing*. 239p. Sri J. Printers
8. Shenai V A. 1985.T*echnology of Printing, Technology of Textile Processing*. Vol. IV. 484p. Sevak Publications, Mumbai.
9. Shenai V A.1996.*Technology of Dyeing. Vol.VI*. 459p. Sevak Publications, Mumbai.
10. Story J.1974.*The Thames and Hudson Manual of Textile Printing*. 188p. Thames and Hudson, London.

Fabric Embellishment 2 (0+2)

Objectives

i. To develop awareness among students about fabric embellishment

ii. To develop skills in various embellishment techniques

Practical

Fabric embellishment/Fancy Construction Methods: An orientation, Survey of Embellishment material available in the market. Introduction about Embroidery tools. Basic hand embroidery stitches- Stem, chain, lazy dazy, buttonhole, herringbone, satin, bullion, long and short, French knot, feather, fly, spider stitch, Other fancy embroidery stitches, Machine Embroidery -Introduction and sample preparation - Motif embroidery machine and border embroidery machine, Metal Thread Embroidery-Ari, Zardosi, Gota patti, Danka and sample preparation, Bead work, Mirror work - sample preparation.

Suggested Readings

1. Carr H and Latham B. 1992. *Fashion Design and Product Development*. 192p. Blackwell Science, UK.
2. Gahlot M and Rani A. 2016. *Textile Designing and Basic Finishing*. 86p. University Press. G.B. Pant University of Agriculture and Technology, Pantnagar.
3. Tyles D J. 1991.*Materials Management in Clothing Production*. 176p. John Wiley & Sons.
4. Withers Sara. 2005. *Bead-Work*. 160p. Chartwell Books.

Module on Event Management and Housekeeping- I

Housekeeping and Service Management I 2 (0+2)

Objectives

i. To provide an overview of the key issues of housekeeping and maintenance management
ii. To understand the theoretical and practical knowledge that constitutes the work of housekeeping
iii. To illustrate the complexities and demands of working in the industry through the scope of housekeeping
iv. Provide the student with the competencies to function professionally within the housekeeping department

Practical

Types of lodging establishments. Organizational chart – duties and responsibilities of housekeeping employees. Communication techniques and skill. Handling of clients. Handling complaints and emergencies – Accommodation operation of co-ordination between Front Office, Maintenance and Security departments. Setting and different types of Bed making. Napkins Folding. Table etiquettes. Cleaning equipment. Selection and care of equipment. Use and care material required by the House Keeping Department. Cleaning methods. Placement of flower arrangements and other decorative items. Pest control and eradication. Reporting accidents Safety procedures at the workplace. Use protective equipment.

Suggested Readings

1. Casado M.2000. *Housekeeping Management*. 282p. John Wiley and Sons, Inc. New York.
2. Kappa M, Nitschke A and Schappert P. 1995. *Housekeeping Management*. 488p. Educational Institute of the American Hotel and Motel Association, New York.

3. Martin R. 1998. *Professional Management of Housekeeping Operations.* (3rd Edn.). John Wiley and Sons, Inc., New York .
4. Robinson M. 2004. *Housekeeping.* 219p. Picador USA.

Floral Art and Design - I 2 (0+2)

Objectives

i. Understand how to use fundamental techniques for creating floral designs
ii. Develop floral designs according to the occasion - weddings, birthdays, parties, funerals etc., - each having specific flower arrangement patterns
iii. Create popular forms of flower art such as flower carpet and stage decoration, flower painting, garlands, bouquets and flower show, drying flowers, Driftwood Craft, Potpourri
iv. Get awareness about Ikebana flower arrangements, indoor plants and Bonsai Culture to convey through symbolism on how nature and art relate to daily living
v. Study and analyze floral art creations

Practical

Practice on applying elements and principles of design in floral art. Selection and preparation of plant and other material for floral art. Practicing techniques and tools, Rules, Styles and Colour schemes in flower arrangement and floral craft. Creating theme or idea in floral art. Applying preservation techniques of flowers/foliage. Developing basic shapes and practicing different styles of flower arrangements. Developing theme boards, designing backgrounds and floral décor suitable to the occasion. Developing designs for Garland, flower bouquet, Potpourri, flower painting and carpets etc. Preparation of permanent/dry floral arrangement/Driftwood Craft. Visit to shows and gardens to acquire basic knowledge about Bonsai techniques and Indoor gardening. Visit to a florist store to understand the basic procedures for selection and care of flower and plant materials. Developing theme boards for stage decoration. Visit to different occasions to evaluate commercial stage decoration ideas. Organizing shows/exhibitions for sale of flower craft.

Suggested Readings

1. Akinseye A and Akisanya S. 2016. *The Art of Floral and Event Design.* 261p. Kesh Luxury Group, Chicago.
2. Benzakein E and Chai J. 2020. *Floret Farm's - A Year in Flowers: Designing Gorgeous Arrangements for Every Season.* 122p. Chronicle Books LLC, San Francisco.
3. Caballero R and Reyes E V. 2017. *Decorating with Flowers: A Stunning Ideas Book for all Occasions.* 240p. Tuttle Publishing, United States.
4. Dupon O. 2014. *Art Flowers: Contemporary Floral Designs and Installations.* 288p. Potter Style Publishers, Australia.
5. Jan H and Sarah W. 1994. *The Art of Flower Arranging.* 192p. Smithmark Publishers.
6. Judith B. 2016. *Buying and Arranging Cut Flowers - The Essential A - Z Guide.* 199p. Flower Press; Spl. Edition, United Kingdom.
7. Putnam D and Putnam M. 2021. *Flower Colour Theory.* 484p. Phaidon Press Ltd., London, United Kingdom.
8. Rachel S. 2017. *The Flower Book: Let the Beauty of Each Bloom Speak for Itself.* 244p. Dorling Kindersley Limited, London, United Kingdom.
9. Shinichi N. 2021. *Modern Japanese Ikebana: Elegant Flower Arrangements for Your Home.* 128p. Tuttle Publishing, United Kingdom.

10. Sonya P E. 2022. *The Modern Gardener: A practical guide to houseplants, herbs and container gardening.* 224p. Harper Collins Publishers, New York.

Module on Childhood Development and Assessment- I

Developmental Assessment I (Infancy and Toddlerhood) 2 (0+2)

Objectives

i. To learn about the various standard tools and techniques for assessing development of Infants and toddlers

ii. To learn to administer the standard tools to assess the development of new born, infants and toddlers

iii. To learn about the ethical issues in assessing children on various areas of development

iv. To create awareness about challenges in developmental assessment of young children

Practical

Orientation on screening and developmental assessment of children for various developments through different tools and techniques. Exploring existing areas. Purpose of use of tests and techniques and classification. Criteria for selection and use of test–reliability and validity and wide acceptability. Approaches and tools in developmental screening. Trends and challenges in developmental assessment of young children. Advantages and abuses of testing and tests. Orientation on formal and informal measures in assessment, special considerations and ethical issues in assessing various areas of developments of New born, Infants, Toddlers. Conducting tests and report writing for each test Neonatal assessment–APGAR* and Gestational age, Neonatal Behavioural Assessment Scale (BNBAS), Infant and Toddler hood assessment. Anthropometric measurements* and national and international standards. Developmental Screening Test. Bayley's Scale of Infant. Pramila Pathak's Mental and Motor Growth of Indian babies. Vineland social Maturity scale.

Suggested Readings

1. Anastasi A. 1997. *Psychological Testing. (*7th Edn.). 750p. Pearson publishers, London.

2. Losardo A, Notari-Syverson A and Bricker D B. 2011. *Alternative Approaches to Assessing Young Children.* (2nd Edn.). *248p.* Brooker publishing, Baltimore.

3. Gayle Mindes and Lee Ann Jung Minds L. 2014. *Assessing Young Children.* (5th Edn.). 352p. Pearson publication, London.

4. Development (BSID)/latest version Bayley N. 2006. *Bayley Scales of Infant and Toddler Development Technical Manual.* (3rd Edn.). 163p. United States: Pearson Clinical Assessment.

Developmental Assessment II (Childhood) 2 (0+2)

Objectives

i1. To learn about the various standard tools and techniques for assessing development of children

ii. To learn to administer the standard tools to assess the development of children

iii. To learn about the ethical issues in assessing children on various areas of development

iv. To create awareness about challenges in developmental assessment of children

Practical

Special considerations and ethical issues in assessing various areas of developments of Pre- schoolers, Pre-Primary school children, Primary School Children Middle School Children and Secondary / Higher Secondary School Children, conducting tests and report writing for each test: Screening and assessment of preschool and Pre-primary school children- Stanford Binet Intelligence Scale*, Wechsler Scale of Intelligence for Preschool and Primary School Children*, Vineland Adaptive Behavior Scale, DAS II, Pea body Picture Vocabulary test or similar test, Ecological assessment of Preschool and Pre-primary school children- HOME Inventory, Screening and assessment of Primary School Children- Parent child relationship Scale- latest test, Wechsler Intelligence Scale of for children, Learning disability tests: Diagnostic test of reading disorder-, Screening and assessment of Middle School Children- Children's self concept scale-, Anxiety scale, Thematic Apperception Test (TAT)*, Children's Apperception Test (CAT)*, General well being scale-, Screening and assessment of Secondary /Higher Secondary School Children - Emotional Intelligence scale- /Emotional Maturity Scale, Case studies, Presentation of reports. Counselling parents on developmental deviations observed

Note: The test marked with * are compulsory. Latest tests with concurrent validity for each area of assessment should be taught.

Suggested Readings

1. Anastasi A and Urbina S. 1997. *Psychological Testing. (*7th Edn.). 721p. Prentice Hallpublishers, London.
2. Losardo A, Notari-Syverson A and Bricker B D. 2011. *Alternative Approaches to Assessing Young Children.* (2ndEdn.). 248p. Brooker publishing, Baltimore.
3. Mindes G, Jung L N and Minds L. 2014. *Assessing Young Children.* (5th Edn.). 352p. Pearson publication, London.
4. Manuals of the respective tests.

Module on Extension Education for Community Development- I

Audio Visual Aids for Communication 2 (0+2)

Objectives

i. To equip with practical skills in planning and preparation of various audio-visual aids

ii. To provide hands-on experience in the use and presentation of various audio-visual aids

Practical

Planning, designing and preparation of posters. Planning, designing and preparation of bars, flow charts, striptease charts and line charts, Flip and overlay charts. Planning, designing and development of 2D and 3D models. Planning, designing and preparation of flash cards. Collection of samples and specimens. Preparation of various types of puppets and presentation of puppetry, slides and flannel graphs. Planning, recording and presentation of simple audio messages. Organization of exhibition with audio visual aids.

Suggested Readings

1. Chauhan J. 2016. *Communication and Extension Management*. (2nd Edn.). Kushal Publications and Distributors.

2. Dahama O P and Bhatnagar O P. 2012. *Education and Communication for Development*. (2nd Edn.). 734p. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Dubey V K and Bishnoi Indira. 2009. *Extension Education and Communication*. 508p. New Age International Publishers, New Delhi.
4. Grover I, Yadav L, Kaushik S and Varma S K. 2002. *Communication and Instructional Technology*. Agrotech Publishing Academy, Udaipur.
5. Lal H, Bhushan S and Kumar M. 2018. *Audio-Visual Aids to Educational Technology*.
6. Ray G L. 2017. *Extension Communication and Management*. (8th Edn.). 358p. Kalyani Publishers, Ludhiana.
7. Reddy A. 2007. *Extension Education*. (7th Edn.). 344p. Sree Lakshmi Press, Guntur.
8. Sandhu A S and Sandhu A S. 2019. *Textbook on Agricultural Communication (Process and Methods)*. 228p. CBS Publishers and Distributors Pvt. Ltd.

Extension Teaching Methods 2 (0+2)

Objectives

i. To enhance the extension teaching skills for development communication
ii. To develop an understanding about the group specific extension teaching methods for dissemination of information
iii. To provide hands on experience for application of extension teaching methods

Practical

Orientation to various extension teaching methods. Planning and use of selected extension teaching methods - familiarization with individual methods – farm and home visit, field trip, office calls, personal letters, and telephone calls. Group methods- method demonstration, group meeting, focuses group discussion, role play, drama, puppet show, small group teaching method. Mass media methods – farm publications, circular letters, campaigns, exhibitions, posters, banners, radio, TV, and social networking sites. Selection and use of suitable audio-visual aids for effective extension teaching. E-extension- internet, radio and teleconferencing. Mobile phone- applications. Computer based instruction- teaching/learning platforms. Preparation and presentation of a lesson plan using conventional methods.

Suggested Readings

1. Ray G L. 2017. *Extension Communication and Management*. (8th Edn.). 358p. Kalyani Publishers, Ludhiana.
2. Reddy A. 2007. *Extension Education*. (7th Edn.). 344p. Sree Lakshmi Press, Guntur.
3. Dahama O P and Bhatnagar O P. 2012. *Education and Communication for Development*. 734 p. (2nd Edn.). Oxford and IBH Publishing Co. Pvt. Ltd.
4. Dubey V K and Bishnoi Indira. 2009. *Extension Education and Communication*. (1st Edn.). 508 p. New Age International Publishers, New Delhi.

Semester II

Food Science and Processing 3 (1+2)

Objectives

i. To develop the skills for understanding structural, compositional and nutritional importance of various foods and their processed products

ii. To develop the skills on the properties of food and various food groups and their role in food products

Theory

Food groups, food guide pyramid and MyPlate- importance, Objectives of cooking, processing, preservation, methods of cooking and processing with their merits and demerits. Nutritive value of foods during cooking and processing. Cereals and millets - Structure, composition, processing techniques, effect of heat and acid, functions of starch in the cookery. Legumes, nuts and oil seeds- Composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - Types, composition, pigments, changes caused by heat, acid and alkali. Techniques of processing of fruits and vegetables. Milk and milk products – Composition, types, products, effect of acid on milk cookery, uses and functions. Milk processing – products. Egg - Structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish- Types, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Processed meat, poultry and fish products. Sugars- Types, composition, manufacturing process, effect of heat and acid, functions in cookery. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats. Brief overview of beverages. Condiments and spices, importance in daily life. Processed spice products.

Practical

Laboratory conduct and responsibilities. Knowledge of different food stuffs in English, Hindi and local language. Terms used in cookery, weights and measures. Identification and use of different kitchen items and equipment. Identification and listing of various food groups. Market survey of processed and preserved foods. Cereal cookery. Cereal processing – extrusion, puffing, flaking, germination and baking. Pulse processing – germination, puffing, convenience mixes. Preparation of cereal and pulse combined products and other regional preparations. Nuts and oilseeds. Oil extraction, Preparation of chikki, til, ladoos, thandai. Milk cookery-processed milk products. Egg cookery- Quality evaluation of egg, preparation of boiled egg, scrambled egg, poached egg. Meat and fish cookery. Preparation of meat and fish-based products. Fruits and vegetables cookery. Processed fruits and vegetables products - Preparation of sauces, pickles, squash, RTS, jam, jelly and chips. Curry and salad. Sugar cookery - Stages and products. Crystaline and Non-crystaline candies. Fats and oils. Preparation puris, cakes and biscuits. Appetizers. Visit to food industries.

Suggested Readings

1. Jood S and Khetarpaul N. 2002. *Food Preservation*. 263p. Geeta Somani Agrotech Publishing Academy, Udaipur.

2. Kalia M and Sood S. 2010. *Food Preservation and Processing*. (Revised Edn.). 492p. Kalyani Publishers, New Delhi.

3. Khader V. 1999. *Textbook of Food, Storage and Preservation*. Kalyani Publishers, New Delhi.

4. Potter N N. 1996. *Food Science*. 608p. The AVI Publishing Company, Inc., Westport, Connecticut.
5. Sehgal S, Grewal R B, Kawatra A and Kaur Y. 1997. *Practical Aspects of Food Preservation*. Directorate of Publications, Haryana Agricultural University, Hisar.
6. Sivasankar B. 2002. *Food Processing and Preservation*. 372p. Prentice Hall India Learning Pvt. Ltd., Delhi.

Fundamentals of Clothing Construction 3 (1+2)

Objectives

i. To educate students regarding importance and requirement of clothing in human life
ii. To provide primary knowledge about different aspects of clothing construction
iii. To develop basic stitching skills of the students

Theory

Terminology related to clothing construction. Sewing tools and supplies, their selection and maintenance-tools required for measuring, drafting, cutting and stitching. Different sewing supplies used in clothing construction. Sewing machine: Its parts and their function, operation and maintenance, Solving common machine problems. Types of sewing machines. Different methods of making paper pattern their advantages and disadvantages. Selection of fabric for different clothing used for different purposes. Preparation of fabric for cutting, and layout of paper pattern on different fabrics patterns including plain, print, lines, plaid and check. Implications of clothing in human life, different functions of clothing. Social, physical, economical and psychological factors affecting clothing selection. Clothing for infant, toddler, pre-schooler, school age children, teenager, adult and senior citizen. Elements and principles of design applied to apparel designing.

Practical

Use and maintenance of different sewing tools, equipment and supplies used for clothing construction. Sewing machine–Its operation and care, identifying and solving machine problems. Hand stitches and their types–basting, hemming, back stitch, overcast stitch, blanket stitch, buttonhole stitch, cross stitch, slip stitch etc. Attaching different fasteners-Button and button hole, hook and eyes, snap, tape, fasteners. Different types of smocking stitches-Cable, chain, diamond, honey comb, lattice. Seams and seam finishes- Plain, French, Flat-fell, Double-topstitched, Welt and different seam finishing methods. Creating fullness through different types of pleats, gathers, tucks, dart, shirring. Edge finishing–Straight edge finishing, curve edge finishing, decorative edge finishing. Plackets opening and finishing-One piece, two-piece, binding. Taking body measurements for different garments. Preparation of fabric for paper pattern layout, marking, cutting and stitching. Making basic block of bodice, sleeve and skirt and their adaptation. Drafting, cutting and stitching of – Apron, Panty, Bib, Romper, A line frock, Sari Petticoat.

Suggested Readings

1. Armstrong H J.2013.*Pattern Making for Fashion Design*. (5th Edn.). Pearson Education, India.
2. Cooklin G. 1996.*Introduction to Clothing Manufacture.* 178p. Blackwell Scientific Publications
3. Horn M J and Lois M G. 1981.*Second Skin: An Interdisciplinary Study of Clothing*. 514p. Hounghton Muffin, London.
4. Labanya M and Vastala R. 2004.*Textbook of Fundamentals of Clothing Construction.* 173p. ICAR, New Delhi.
5. Lewis V S. 1976.*Comparative Clothing Construction Techniques*. 393p. Burgess Publication company.
6. Kefgen M and Phyllis T S. 1971.*Individuality in Clothing Selection and Personal Appearance.* 429p. The Macmillan Company, New York.
7. Reader's Digest Association. 1978. "Reader's Digest" Complete Guide to Sewing'. Reader's Digest.
8. Thomas A J. 1993.*The Art of Sewing*. 206p. UBS Publishers, Bombay.
9. http://www.stitchrippers.com/forum/Topic/sewing-terminology.

Fundamentals of Ergonomics 2 (1+1)

Objectives

i. To acquaint the students with the fundaments of ergonomics

ii. To acquaint the students in gaining knowledge on importance of Ergonomics and learn how the body is used while performing different activities

iii. To develop skill among students in onsite evaluation of ill effects of ergonomics risk factors

Theory

Introduction of Ergonomics - Definition, History of Ergonomics, Significance and Scope of Ergonomics. Domains of Ergonomics. Work physiology and fatigue. Systems of Human body-muscle system, neuromuscular system, muscle contraction and muscle movement. Human compatibility factors - Anthropometry and anthropometric data, principles in the application of anthropometric data. Physical fitness. Work Posture - Fatigue - major body weights. MMS (Man-Machine-System), Manual Material Handling (MMH). Work related Health Problems- accidents, injuries, musculoskeletal problems, terminologies (RSI, WMSD, CTD, etc.).

Practical

Study of Anthropometric measurements- understanding different anthropometric data and terminologies and its usages. on-site postural studies. Determination of physical fitness.

Suggested Readings

1. Bridger R S. 2003. *Introduction to Ergonomics.* 568p.CRC Press, London.
2. Dalela S and Saurabh. 2009. *Textbook of Work Study and Ergonomics*. 492p. Standard Publishers.
3. Grandjean E. 1978. *Ergonomics of the Home.* 343p. Taylor and Francis, London.
4. Galer I.A.R. 1987. *Applied Ergonomics Handbook.* 223p. Butterworths and Co.
5. Panero J and Zelnik M. 1979. *Human Dimension and Interior Space.* 320p. Watson-Guptill.

6. Singh S.2007. *Ergonomics Interventions for Health and Productivity.* 243p. Himanshu Publications, New Delhi.

Theoretical Approaches to Parenting 2 (2+0)

Objectives

i. To know the parenting roles and practices
ii. To know positive and maladaptive parenting
iii. To know the effects of parenting style and practices on child developmental outcomes

Theory

Positive Psychology, Parenting Style, Parenting Practices and Parenting Roles parent-child transactions, influential factors, family orchestrated child experiences, information needs, Biological, social and Psychological theories, Attachment Theory approach, Behavioristic approach Social Learning approach, Ecological systems approach, Parental role theory approach, Disciplinary theory, Scaffolding approach (Vygotsky), Self-determination approach, Family systems theory approach etc.

Suggested Readings

1. Charney D S. 2004. Psychobiological Mechanisms of Resilience and Vulnerability. *Focus: The Journal of Life long Journey and Psychiatry* **2**(3): 368-391.
2. Carbonell D M, Reinherz H Z, Giaconia R M, Stashwicks C A, Paradis A D, Beardslee W J M and Klien D M. 2008.*Family Theories.* (3rd Edn.). 360p. Sage publications, London.
3. Damon W, Sigel I E and Renninger A. 1998. *Handbook of Child Psychology.* (5th Edn.). 1232p. John Wiley and Sons, Inc., New York.
4. Shonkoff J P and Meisels S J. 2009.*Handbook of Early Childhood Intervention.* (2nd Edn.). 758p. Cambridge University Press, New York.

Personality Development 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition. Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory. Shaping of personality. Determinants of personality. Myers-Briggs Typology Indicator. Locus of control and performance. Type A and Type B Behaviours. Personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior. Models of individual behavior. Perception and attributes and factors affecting perception. Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning. Learning and organizational behavior. Learning and training. Learning feedback. Attitude and values. Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies. Motivational needs. Firo-B. Interpersonal Communication. Teamwork and team building. Group Dynamics. Win-win game. Conflict Management. Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Readings

1. Abdaal A. 2023. *Feel-Good Productivity: How to Do More of What Matters to You*. Penguin Life, London, UK.
2. Andrews S. 1988. *How to Succeed at Interviews.* (21st Reprint). 212p.Tata McGraw-Hill, New Delhi.
3. Heller R. 2002. *Effective Leadership. Essential Manager series*. 72p. D K Publishing, London.
4. Hindle T. 2002. *Reducing Stress. Essential Manager series*. 72p. D K Publishing, London.
5. Kumar P. 2005. *All about Self- Motivation*. 144p. Goodwill Publishing House, New Delhi.
6. Lucas S. 2001. *Art of Public Speaking*. 474p. Tata-Mc-Graw Hill, New Delhi.
7. Mile D J. 2004. *Power of Positive Thinking.* Rohan Book Company, New Delhi, India.
8. Smith B. 2004. *Body Language*. 165p. Rohan Book Company, Dehli.
9. Shaffer D R. 2009. *Social and Personality Development.* (6th Edn.). 622p. Wadsworth, Belmont CA.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide student an insight into the concept and scope of entrepreneurship
ii. To expose the student to various aspects of establishment and management of a small business unit
iii. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product/service – starting a project. Factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development. Role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership. Registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project. Project report preparation. Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing,

inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management/accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practicals

Visit to small scale industries/agro-industries. Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises*. 494p. Pearson Publications, New Delhi.
2. Desai, V. 1997. *Small Scale Industries and Entrepreneurship*. 470p. Himalaya Publication House.
3. Desai V. 2015. *Entrepreneurship: Development and Management*. 292p. Himalaya Publishing House.
4. Grover I . 2008. *Handbook on Empowerment and Entrepreneurship*. 192p. Agrotech Public Academy.
5. Gupta CB. 2001. *Management Theory and Practice*. 896p. Sultan Chand and Sons.
6. Kala S. 2024. *Entrepreneurship Development, Innovation and Business Management*. AGPH Books.
7. Khanka S S. 1999. *Entrepreneurial Development*. 793p. Sultan Chand and Sons
8. Mehra P. 2016. *Business Communication for Managers*. 401p. Pearson India, New Delhi.
9. Pandey M and Tewari D. 2010. *The Agribusiness Book*. 844p. IBDC Publishers, Lucknow.
10. Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publications.
11. Singhal R K. 2013. *Entrepreneurship Development and Management*. 325p. Katson Books.
12. Tripathi P C and Reddy P N. 1991. *Principles of Management*. 74p. Tata McGraw Hill.

Environmental Studies and Disaster Management 3 (2+1)

Objectives

i. To expose and acquire knowledge on the environment.
ii. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its

conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (g) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework. Financial arrangements. Role of NGOs, community-based organizations and media in disaster management. Centre, State, District and Local administration in disaster control. Armed forces in disaster response. Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill/hydro power/solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site. Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. Barucha E. 2004. *Textbook for Environmental Studies*. University Grants Commission, New Delhi.
2. De A K. 2010. *Environmental chemistry*. 384p. New Age International Publishers, New Delhi, India. ISBN:13–978 81 224 2617 5.
3. Dhar Chakrabarti P G. 2011. *Disaster management - India's risk management policy frameworks and key challenges*. 36p. Centre for Social Markets (India), Bangalore.
4. Dubey A K, Malviya S J and Kushwaha P. 2022. *Environmental Studies and Disaster Management*. Astral International Pvt. Ltd., New Delhi, India.
5. Parthiban K T, Vennila S, Prasanthrajan M, Umesh Kanna S. 2023. *Forest, Environment, Biodiversity and Sustainable Development.* Narendra Publishing House, New Delhi, India.

6. Prasanthrajan M, and Mahendran P P. 2008. *A textbook on Ecology and Environmental Science*. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur.
7. Prasanthrajan M. 2018. *Objective environmental studies and disaster management*. ISBN 9789387893825, Scientific Publishers, Jodhpur.
8. Shameem S A, Yatoo S A, Kangroo I N and Ganai N A. 2024. *Environmental Studies and Disaster Management.* AGPH Books.
9. Sharma P D. 2009. *Ecology and Environment*. Rastogi Publications, Meerut.
10. Tyler M and Scot S. 2009. *Living in the Environment (Concepts, Connections, and Solutions).* Cengage Learning Publication, Belmont, USA.
11. Vitnor S S, Bharade V M and Chavan E D. 2024. *Environmental Studies and Disaster Management.* AkiNik Publications, New Delhi, India.

National Cadet Corps (NCC-II) 1(0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical/ Awareness Programmes

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs;
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS-II) 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

Importance and role of youth leadership; Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies; Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs; Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations; Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Skill Enhancement Courses (SEC-II module) 4 (0+4)

Objective

To enable the students to acquire basic skills in different domains of Community Science so that in case they exit with UG-certificate, they can work with cakes and pastries shops/ units, patchwork and quilting units, home textile units, housekeeping job services, event management units, childhood clinics, audio-visual aids production units/shops, ICT service providers, etc. or can go for self-employment.

Indicative options for SEC-II *(any one module to be selected)*

Module	Course	Credit Hours
Bakery and Confectionary Management- II	Cakes and Pastries	2 (0+2)
	Chocolate Making	2 (0+2)
Textile Design and Embellishment- II	Indian Embroideries	2 (0+2)
	Quilting and Patchwork	2 (0+2)
Event Management and Housekeeping- II	Housekeeping and Service Management II	2 (0+2)
	Event Planning and Management	2 (0+2)
Childhood Development and Assessment- II	Infant Stimulation Practices	2 (0+2)
	Health Practices in Early Childhood	2 (0+2)
Extension Education for Community Development- II	Computerized Instructional Aids Production	2 (0+2)
	ICT and New Media	2 (0+2)

Module on Bakery and Confectionary Management- II

Cakes and Pastries 2 (0+2)

Objectives

i. To enable students to learn the basics of producing cake and pastry techniques
ii. To acquaint the students with newer technologies and machinery used in product development
iii. To impart knowledge about commercialization of cake and pastry

Practical

Cake and Pastry – Role of ingredients, cake and making Method's, Cake and pastry Mixing Method's Characteristics of cake and pastry, Role of ingredients in sponge goods. Type of cake - Eggless sponge making, Fruit making, Pound making, Ganache making, marbled making, Swiss roll making. Cake and pastry packaging, Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of cake and pastry. Storage of cake and pastry – slightly cool, dry, dark place. Visit to a cake and pastry industry. Project planning for financial assistance for a small-scale industry on cake and pastry making and writing report.

Suggested Readings

1. Arora A K. 2007. *Food Service and Catering Management*. 350p. APH Publishing Corporation, New Delhi.
2. Parvinder S B. 2018. *Theory of Bakery*. 264p. Oxford Publishing.
3. Stanley P C and Linda S Y. 2007. *Technology of Bread Making*. 354p. Springer.
4. Chakrabarty M M. 2003. *Chemistry and Technology of Oil and Fats*. 760p. Prentice Hall.
5. Dendy D A V and Dobraszczyk B J. 2001. *Cereal and Cereal Products*. 429p. Aspen publishing.
6. Edwards W P. 2007. *Science of bakery products*. 259p. Royal Society of Chemistry, UK.
7. Samuel A M. 1992. *Bakery Technology and Engineering*. (3rd Edn.). 853p. Chapman and Hall, London.

Chocolate Making 2 (0+2)

Objectives

i. To enable students to learn the basics of producing chocolate making and packaging
ii. To acquaint the students with newer technologies and machineries used in product development
iii. To important knowledge about commercialization of chocolates

Practical

Chocolate – basic formulation, preparation of types of chocolate like - basic chocolate, liquid filled chocolate, semi-sweet chocolate, bittersweet chocolate, dark chocolate. Chocolate packaging, Labelling, Packaging material - plastic material, paper material, aluminium material. Packaging type- banding, foil packing, sleeve packing, twist packing. Technique use in chocolate packaging process- foil wrapping, fold wrapping, coin wrapping, bar wrapping. Sensory evaluation direct method - appearance, odor, flavor, taste, and texture Indirect method – single sample test, triangle test, 9-point hedonic scale and the paired comparison test. Consumer

validation. Costing and financial management, Licensing, Marketing (open and digital) and Commercialization of chocolate. Storage of chocolate – slightly cool, dry, dark place. Shelf life of chocolate - parameters of shelf life, type of deterioration, Shelf-life dating. Method to determine shelf life of chocolate – direct method, challenge test, accelerate shelf-life test. Visit to chocolate industry. Project planning for financial assistance for a small-scale industry on chocolate making and report writing.

Suggested Readings

1. Baptista I. 2021. *International Journal of Gastronomy and Food Science* **24**, 100340.
2. Edwards W P. 2007. *Science of Bakery Products*. 259p. The Royal Society of Chemistry, UK.
3. Jackson E B. 1995. *Sugar Confectionery manufacture*. (2nd Edn.). 400p. Blackie Academic and professional, Glasgow.
4. Maricel E P. 2009. *The New Taste of Chocolate: A Cultural and Natural History of Cacao with Recipes*. (Revised Edition). 246p. Ten Speed Press.

Module on
Textile Design and Embellishment- II

Indian Embroideries — 2 (0+2)

Objectives

i. To learn the characteristic features/designs of the traditional embroideries of different states of the India
ii. To develop an understanding of the methods and materials used in different traditional embroideries
iii. To develop an understanding of the techniques of traditional embroideries of India

Practical

Historic perspective, classification and importance of traditional Indian Embroideries Documentation of motifs of traditional Indian embroideries of different States of India- and sample preparation of traditional Indian embroideries -Kashida of Kashmir, Chamba Rumal, Phulkari and Bagh of Punjab, Embroideries of Gujarat, Chikankari and Zari work of Uttar Pradesh, Kanthas of Bengal, Toda Embroidery of Tamil nadu, Kasuti of Karnataka, Patchwork of Bihar and Orissa and Folk embroidery of Rajasthan. Creative projects: Preparation of one article by adapting traditional motifs and embroidery in contemporary textiles. Visit to National craft museum and exhibition/art galleries.

Suggested Readings

1. A Compendium of Indian Handicrafts and Handlooms covered under Geographical Indications (GI), 204p. Development Commissioner (Handloom), Ministry of Textiles, Govt. of India, New Delhi.
2. Kale Smita. 2012. *Kashmir to Kanyakumari Indian Embroidery: State. State Embroidery of India.* 180p. Illustrated edition. Author House.

3. Naik S D. 2012. *Traditional Embroideries of India*. 149p. APH Publishing Corporation, New Delhi.
4. Naik S D. 1997. *Folk Embroidery and Traditional Handloom Weaving*. 208p. APH Publishing Corporation, New Delhi.
5. Pauline B. 2016. *Encyclopedia of Embroidery Techniques, A Unique Visual Directory of all the Major Embroidery Techniques, Plus Inspirational Examples of Traditional and Innovative Finished Work*. 176p. Headline book publishing.
6. Rai I. 2008. *Indian Embroidery and Textiles*. (1st Edn.). 115p. Books Treasure, Jodhpur.

Quilting and Patchwork 2 (0+2)

Objectives

i. To develop awareness among students about Quilting techniques
ii. To develop skills in various designs of Quilting and Patchwork

Practical

Patch Work: Definition. Different styles of Patchwork Techniques- Pieced Patchwork, Shell Patchwork, Suffolk Puffs, Crazy Patchwork, Log Cabin Patchwork, Strip Patchwork, Seminole Patchwork, Folded Star Patchwork, Mayflower Patchwork and Pleated Patchwork. Applique: Definition, Various Styles of Applique Techniques, Standard applique, Applique Perse, Reverse applique, Padded applique, folded applique, Shadow applique, Lace appliqué. Quilting: Definition, Various Styles of Quilting, Wadded Quilting, Padded Quilting, Corded Quilting, Shadow Quilting, Preparation of two commercially viable article using above techniques.

Suggested Readings

1. Allen W H. 1985. *Mc-calls Big Book of Quilts and other Treasures*. 256p. London Fall Cheryl.
2. Fall C. 1996. *Happy Quilts*. 144p. Sterling Publisher, New York.
3. David and Villasenor J. 1983.*Indian Designs*. 50p. Naturegraph Publication.

Module on Event Management and Housekeeping- II

Housekeeping and Service Management-II 2 (0+2)

Objectives

i. To understand role and responsibility of housekeeping department
ii. To discuss relationship of housekeeping with other departments
iii. To demonstrate an understanding of housekeeping basic planning activity and its organization
iv. To understand and analyze housekeeping standards together with safety and security aspects
v. To demonstrate the creativity on housekeeping standards and trends

Practical

Understanding the role of housekeeping and its relationship with other departments. Housekeeping department and its role and responsibility. Housekeeping organization chart. Positions and job descriptions in housekeeping department. Developing a schedule outlining the

housekeeping department and their roles and responsibility in various types of organizations. Developing a housekeeping organization chart with positions and job descriptions in housekeeping department in various types of organizations. Different types and importance of keys- section key, master key, floor key and grand master key. Key of executive officers and public areas and computerized key. Understanding the role of housekeeping and its relationship with other departments - Front office. Food and beverage. Engineering departments. Planning and organizing housekeeping department. Planning the work in housekeeping department- Area inventory. Frequency schedule. Performance standard. Productivity standard, Supply and equipment inventory level. Housekeeping standards/trends. Housekeeping standard building. Standard set up. Human resource and training employees in housekeeping. Staffing and training employees. Motivating employees.

Suggested Readings

1. Casado M. 2000. *Housekeeping Management.* 288p. New York: John Wiley and Sons, Inc.
2. Martin R .1992. *Professional Management of Housekeeping Operations*. 528p. John Wiley and Sons, Inc., New York.
3. Kappa M, Nitschke A and Schappert P. 1995. *Housekeeping Management*. 488p. Educational Institute of the American Hotel and Motel Association. New York.

Event Planning and Management 2 (0+2)

Objectives

i. To understand event planning and management, its scope and significance
ii. To know about the stages and domains of event management
iii. To understand the process of planning and management

Practical

Developing a SWOT analysis of identifying and conducting an event. Identify various corporate events. Identifying and develop a schedule for any one event for a college event, themed celebration, festival. Develop a plan for budget/sponsors/fundraising/marketing strategies for the identified events. Listing of fundamentals of corporate hospitality. Study event specifications of Celebrity events and Award Ceremonies. Destination weddings. Establish a plan for risk assessment and management within the Event Laws and Administration and Health and Safety Requirements. Plan an event for themed celebration, Festival, Record outcome of events and evaluate the event through SWOT analysis, report on the success and weakness of the events.

Suggested Readings

1. Berridge G. 2006. *Event Design and Experience.* 320p. Oxford: Butterworth – Heinemann, London.
2. Bowdin G, McDonnell I, Allen J and O'Toole W. 2010. *Events Management*. (3rd Edn.). 774p. Oxford: Butterworth - Heinemann.
3. GeraV. 2012. *Event Management and Planning.* 252p. Atlantic Publishers and Distributors.
4. Getz D. 2007. *Event Studies: Theory, Research and Policy for Planned Events.* 442p. Oxford: Butterworth - Heinemann.

5. Goldblatt J. 2010. *Special Events: A New Generation and the Next Frontier.* 576p. New York: Wiley.
6. Judy A. 2009. *Event Planning Ethics and Etiquette: A Principled Approach to the Business of Special Event Management*. 256p. Wiley (first published 2003).

Module on Childhood Development and Assessment- II

Infant Stimulation Practices 2 (0+2)

Objectives

i. To understand the need for providing stimulation to infants
ii. To learn the skills of providing stimulation

Practical

Stimulation for Growth and development of neonate - Sensation and perception for Newborns at risk-Preterm, Low birth weight, Respiratory distress syndrome. Stimulation for Physical Development during Toddlerhood, Muscle Control, motor skills. Stimulatory learning environments at home and early childhood child care and education centers. Current and conventional practices of stimulatory learning. Innovative ideas for planning and execution of customized Programs/ activities for infants.

Suggested Readings

1. Boyd D and Bee H. 2011. *Lifespan Development*. 624p. Pearson, London.
2. Kail R V and Cavaraugh J C. 2018. *Human Development-A Life Span View*. 720p. Cengage Learning, Noida.
3. Santrock J W. 2006. *Life Span Development*. 800p. McGraw Hill, New Dehli.
4. Santrock J W. 2017. *Lifespan Development*. 800p. McGraw Hill, New Dehli.
5. Steinberg L, Bornstein M H, Vandell D L and Rook K S. 2011. *Lifespan Development*. 625p. Wadsworth, USA.

Health Practices in Early Childhood 2 (0+2)

Objectives

i. To learn about the importance of health and factors affecting health
ii. To promote health and hygiene in children
iii. To reduce and prevent the incidence of underdevelopment and diseases in young children
iv. To plan need-based programs to address health issues during early childhood
v. To educate parents/caregivers/ ECE Teachers on good health practices

Practical

Importance of child's health - factors affecting child health. Important child health indicators- NMR, IMR, CMR (under 5 years). Health care practices during neonatal stage, infancy and childhood period. Nutrition and health; Health assessment techniques in children. ECE Centres and Child's health. Integration of Health care with educational and social services. Identification of

common health problems in children. Planning and organizing parent/community health education Program. Review of health Programs and policy, Digital addiction and child health. Eating disorders and child health. Health care practices in rural /urban/tribal families. Case study of preschool child. Studying health care practices in children. Report writing and presentation. Recommendation to parents/caregivers/health care professionals and ECE educators.

Suggested Readings

1. Dutt S. 1998. *Understanding Children*. 420p. Anmol Publications Pvt.ltd, New Delhi.
2. Hurlock E B. 1978. *Child Development.* (6th Edn.). 570p. Tata Mcgraw Hill Education, India.
3. Nandha V K. 2002. *Principles of Child Development*. 331p. Anmol Publications. Pvt. Ltd, New Delhi.
4. Mazar J E. 2017. *Learning and Behaviour. (*8thEdn.). 412 p. Routledge Publications, New York.
5. Papalia D E and Olds SW. 2008. *Human development*. (9th Edn.). 827p McGraw Hill, New Delhi.
6. Santrock J W. 2006. *Life Span Development.* 800p. McGraw Hill, New Delhi.
7. https://childcareta.acf.hhs.gov.
8. https://www.who.int/health-Topic/child-health.
9. www.ruralhealthinfo.org/toolkits/child-health/1/overview.www.ashaweb.org/wp-content/uploads/2014/08/Childhood-Obesity-Prevention-Strategies-for-Rural-Communities.pdf

Module on Extension Education for Community Development- II

Computerized Instructional Aids Production 2 (0+2)

Objectives

i. To develop an understanding about the software used for production of computerized information material

ii. To build competency in application of different software tools for production of instructional aids

Practical

Familiarization with the parts of computer. Software for creation of instructional materials: MS Word 2020/latest version – Getting started, editing documents, proofing tools, text formatting, formatting document, using templates, creating tables and charts. Using reference and review option in word and WPS for smartphones and creating Google forms. MS PowerPoint 2020/latest version – Getting started, working with text in slides, working with charts, printing, animating custom shows and adding hyperlinks. Recording PPT's screen capture recordings and e-presentations. MS-Excel 2020/latest version - Getting started, using workbooks, entering data, editing data, formatting worksheet, working with range of cells, creating formulas and functions, working with charts, object linking and embedding. Importance of colours in designing of visual aids. Illustrator/ latest designing software – Familiarization and working with software, Planning and production of selected instructional aids, Familiarization of menus required for designing various publications and print material. Planning and designing of Visiting Card, Customized cards for gift hampers, Leaflet, Folder, Poster, Brochure, Booklet, Newsletter, and Magazine.

Suggested Readings

1. Jain S, Geetha M and Kratika. 2012. *Computer Course Windows 7 with MS Office 2010*. (1st Edn.). 655p. BPB Publications, New Delhi – 110 001.
2. Murthy G R K Reddy K M Ramarao D, Rao V K J and Kumar V V S. 2012. *Resource Material on Innovative Approaches to E- Learning*. National Academy of Agricultural Research Management, Rajendranagar, Hyderabad.
3. Rajaraman V. 2001. *Fundamentals of computers*. (3rd Edn.). 495p. Prentice-Hall of India Private limited, New Delhi.
4. Sarvanan R, Nesa Rani P M, Madhava Rao V and Rao V K J. 2015. AEM -204 *Information and Communication Technology in Agriculture*. National Institute of Agricultural Extension Management, Rajendranagar, Hyderabad .
5. Simonson M. 2014 (b) *37th Annual Proceedings* - Jacksonville: *Practice of Educational Communications and Technology*. Vol. I & II. 302p. Nova Southeastern University, North Miami Beach, Florida.
6. Simonson M. 2015 (b) *38th Annual Proceedings, Indianapolis: Practice of Educational Communications and Technology*. Vol. I & II. 2344p. Nova Southeastern University, North Miami Beach, Florida.
7. https://www.renderforest.com
8. https://www.socrative.com

ICT and New Media 2 (0+2)

Objectives

i. To provide hands-on experience on application of ICT tools and devices

ii. To develop an understanding about the e-learning tools

iii. To build competency in usage of different digital platforms for dissemination of information

Practical

e-Learning Systems – learning objects development. e-Learning Systems – fundamental characteristics of learning objects, typical components of learning objects. e-Learning Systems – typical components of learning objects. Role of Internet in e-Learning – computer networking, domain names and URL, ISP, types of internet protocols. Social media for e-Learning under Web 2. Platform – YouTube, Blogs, Vlogs, Virtual Classrooms. Social Networking Sites – Facebook, LinkedIn, WhatsApp. Open access resources – e-books, e-Journals and e- newspapers. Open access resources – e-magazines, Web portals. Important online technologies for creation of computerized learning materials, Screen capture, Render Forest. Lucid Charts, Kids inspiration, Sketch Up, Classtools.net. Mind42, Slide share. Socrative, Testmoz, Quiz Star; Photoshop CS5 – Getting started, working with selections, painting and editing, layers, channels, masks and animation, Web site designing concept, HTML, interactive.

Suggested Readings

1. Reinhard R and Dowd S. 2004. *Macromedia Flash Mx*. 1318p. Bible. Wiley.
2. Vaghan T. 2002. *Multimedia- Making it Work*. (5th Edn.). Tata McGrawHill.

Post-II Semester

Internship (only for exit option for award of UG-Certificate) **10 (0+10)**

Objectives

i. To integrate theory and practice
ii. To assess interests and abilities in their field of study
iii. To develop work habits and attitudes necessary for job success
iv. To develop competency and confidence during hands on experience

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as experiential learning units, prototype production facilities, etc.) or in related cottage industries, local artisans/craftsmen, handicraft units, bakery shops, fruits and vegetable processing and preservations centre, or related organisations involved in the activities of the respective domain. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester III

Food Packaging and labelling **2 (1+1)**

Objectives

i. To impart knowledge of various areas related to food processing and packaging
ii. To develop skills required in various industries, research labs and in the field of food and human health
iii. To enable the students to understand packaging materials and effective packaging processes

Theory

Introduction, Importance and Role of packaging in extending shelf life of foods, packaging materials: Use of paper, glass, metals and plastics as a packaging material, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics,

Foils and laminates, retort pouches. Different forms of packaging, Rigid, semi-rigid, flexible forms of packaging, Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods, beverages, microwave food products. Printing of packages, Barcodes and other marking. Legal requirements of packaging materials and product information. Properties of packaging materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, methods of testing and evaluation. Barrier properties of packaging materials. Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate and its measurement, water vapor transmission rate and its measurement. Testing of package performance, Transport worthiness tests, Safety aspects/ assessment of food packaging materials. Aseptic packaging of foods: sterilization of packaging material, food contact surfaces and aseptic packaging systems. Modern Packaging Techniques-Vacuum Packaging, Modified Atmosphere Packaging (MAP), Eco-friendly packaging, Active food packaging – definition, scope, physical and chemical principles involved, Edible films and coatings. Microbiological aspects of packaging materials. Regulation related to Hazardous Packaging. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food. Standard packages - package laws and regulation – general guidelines on giving declarations – FSSAI. Packaging equipment and machinery- Vacuum packaging machine, CA and AMP. MA packaging machine, Gas packaging machine, Seal and shrink-packaging machine. Form and amp. Fill sealing machine, Aseptic packaging systems, Retort pouches, bottling machines, Carton making machines, Basic Concept of Printing on Packaging, Package printing machines.

Practical

Familiarization of different types of packaging material. Testing of packaging materials like thickness, GSM, grease resistance, bursting strength, tearing resistance, Water vapour transmission rate (WVTR), puncture resistance. Vacuum packaging and determination of storage life Testing the compression strength of the boxes. Packaging of food material in seal and shrink-packaging machine and study its shelf life, testing of strength of glass containers by thermal shock test, testing of strength of filled pouches by drop tester. Packaging of powder foods and estimation of shelf-life Visit to a food packaging plant.

Suggested Readings

1. Robertson G L. 2016. *Food Packaging: Principles and Practice*. (3rd Edn.). 733p. CRC Press.
2. Robertson G L. 2009. *Food Packaging and Shelf Life: A Practical Guide*. 404p. Tailor and Francis Group, CRC Press.
3. Ruben J H, Susan E M S and John D C. 2004. *Plastics Packaging: Properties, Processing, Applications, and Regulations by FSSAI.* 448p. Hanser publications.
4. Rui M S C. 2019. *Food Packaging: Innovations and Shelf-life.* 288p. CRC Press.

Pattern Making and Draping **3 (1+2)**

Objectives

i. To enable students to develop patterns for designer garments

ii. To develop understanding about basics of pattern making and draping

iii. To upgrade skills for commercialized apparel manufacturing using advance patternmaking techniques

iv. To develop skills in obtaining perfect fit and create harmony between the fabric and garment design

Theory

Flat pattern: Terminology, tools, applications and limitations. Anthropometric measurements: Importance, standardization and standard measurement charts of children and adults. Pattern development process: Design analysis, plotting, alteration of basic patterns and development of production patterns for fabric layout. Principles of patternmaking: Dart manipulation, added fullness and contouring. Patternmaking techniques: Slash-spread and pivot-transfer. Draping: Terminology, tools, applications and limitations. Basic draping techniques for bodice front and back, skirt front and back. Application of dart manipulation, added fullness and contouring principles in draping. Factors affecting patternmaking and apparel construction using special fabrics: Stretch fabrics, knits, checks, plaids, velvet and lace etc. Fitting: Principles of fitting, standards for good fit, common fitting problems and their remedies. Pattern grading: Importance, terminology and techniques.

Practical

Taking measurements: Circumference, horizontal and vertical measurements. Preparation of basic pattern set- bodice front and back, skirt front and back and sleeve. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through slash-spread and pivot-transfer techniques to design patterns having single-dart series, two-dart series, tuck-darts, graduated, radiating and parallel darts, pleats, flare, gathers, princess stylelines. Development of design patterns through flat patternmaking technique: Design analysis, adaptation of basic patterns through added fullness in different forms and at various locations. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through contouring to empire, surplice, off-shoulder and halter designs. Preparation of paper patterns for different yokes, collars, necklines, sleeves and skirts. Development of design patterns through flat patternmaking technique for six garments incorporating various style features- two of each principle of patternmaking. Construction of three garments using developed design patterns- one each of dart manipulation, added fullness and contouring. Preparation of muslin for draping, development of foundation block for upper and lower garments. Designing of different garments through draping using dart manipulation. Designing of different garments through draping with added fullness. Designing of different garments through draping using contouring. Designing upper garments with different yokes, collars, built-up necklines and cowls through draping. Development of design paper patterns of six garments of draped patterns incorporating various style features - two of each principle of patternmaking. Construction of three garments using developed design patterns of draped patterns- one each of dart manipulation, added fullness and contouring for casual, formal and party wear. Assessment of constructed garments for fitting. Pattern grading: Grading of basic blocks through draft grade and track grade systems of grading, pattern grading using different zero points. Projection of work. Visit to apparel manufacturing units and fashion institutes.

Taking measurements: Circumference, horizontal and vertical measurements. Preparation of basic pattern set- bodice front and back, skirt front and back and sleeve. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns

through slash-spread and pivot-transfer techniques to design patterns having single-dart series, two-dart series, tuck-darts, graduated, radiating and parallel darts, pleats, flare, gathers, princess style lines. Development of design patterns through flat patternmaking technique: Design analysis, adaptation of basic patterns through added fullness in different forms and at various locations. Development of design patterns through flat patternmaking technique: Designs analysis, adaptation of basic patterns through contouring to empire, surplice, off-shoulder and halter designs. Preparation of paper patterns for different yokes, collars, necklines, sleeves and skirts. Development of design patterns through flat patternmaking technique for six garments incorporating various style features (two each of dart manipulation, added fullness and contouring). Construction of three garments using developed design patterns (one each of dart manipulation, added fullness and contouring) and assessment of their fitting. Preparation of muslin for draping, development of foundation block for upper and lower garments. Designing of different patterns through draping using dart manipulation. Designing of different patterns through draping with added fullness. Designing of different patterns through draping using contouring. Designing upper garment patterns with different yokes, collars, built-up necklines and cowls through draping. Designing and Construction of three garments using developed design patterns of draped patterns (one each of dart manipulation, added fullness and contouring for casual, formal and party wear) and assessment of their fitting. Grading of garment pattern (any one of the constructed garments).

Suggested Readings

1. Amaden-Crawford C. 2018. *The Art of Fashion Draping*. 464p. Bloomsbury Publishing Inc. USA.
2. Bane A. 1996. *Creative Clothing Construction*. 448p. McGraw-Hill Publication, USA.
3. Bane A. 1972. *Flat Pattern Design*. 262p. McGraw-Hill Publication, USA.
4. Bray N. 2003. *Dress Fitting: Basic Principles and Practice*. (Classic Edn.). 128p. Blackwell Publishing.
5. Cooklin G. 1991. *Pattern Grading for Women's Clothes*. 400p. lackwell Publishing.
6. Goulbourn M. 1971. *Introducing Pattern Cutting, Grading and Modelling*. 96p. B T Batsford Ltd., UK.
7. Handford J. 2003. *Professional Pattern Grading for Women's, Men's and Children's Apparel*. 264p. Fairchild Books, New York.
8. Kiisel K. 2020. *Draping: The Complete Course*. 368p. Laurence King Publishing.
9. Mee J and Purdy M. 1987. *Modeling on the Dress Stand*. 192p. BSP Professional Books.
10. Tate S L. 2003. *Inside Fashion Design*. (5th Edn.). 480p. Prentice Hall Publishing Co.
11. Taylor P J and Shoben M M. 1990. *Grading for the Fashion Industry- The Theory and Practice*. 288p. Stanely Thornes Ltd., England.
12. Winfred A. 2015. *Metric Pattern Cutting for Women's Wear*. 256p. Wiley.

Computer Aided Interior Designing – I 3 (1+2)

Objectives

i. To get oriented with use of AUTOCAD software

ii. To understand various draw and edit commands in AUTOCAD software
iii. To draw the furniture templates through AUTOCAD
iv. To draw the structural building features through AUTOCAD
v. To develop conceptual drawings through AUTOCAD

Theory

Introduction to AUTOCAD: Drawing templates, dialogue boxes - Toolbar, Difference between Paper drawing and CAD drawing - AutoCAD co-ordinate system - Absolute and Relative, Methods of using tools in AutoCAD - Introduction to 2D drawing tools - line, polyline, polygon, rectangle, Ellipse - Introduction to modify tools- Copy, mirror, offset, Array, Move, Rotate, Scale, stretch, extend, Trim, Break, Chamfer, Fillet - Adding Text to drawings, text styles, Dimension tools and styles, Methods of adding dimensions to drawings - Blocks and inserts: Methods of inserting drawings.

Practical

Orientation about Auto CAD software through demo mode. Opening the software, Opening the document and setting up to start drawing. Use of Auto CAD Co-ordinate system – Relative and Absolute. Demo of using basic drawing tools - Line, polyline, polygon, rectangle, ellipse. Demo of use of modify tools – Copy, mirror, offset, rotate, trim, extend, chamfer, filter, array, move, break. Developing different 2-D features in drawings through AUTOCAD- Door, windows, furniture templates, stairs - Adding Text to drawings, text styles.

Suggested Readings

1. Fiorello A and Joseph A. 2009. *CAD for Interiors Basics.* 220p. John Wiley and Sons Inc.
2. Kirkpatrick B L and Kirkpatrick J M. 2000. *Auto CAD for Interior Design and Space Planning using Auto CAD.* 512p. Peach pit press.
3. Moss E. 2019. *Auto CAD 2020 Fundamentals.* 586p. SDC publications.
4. Muccio D. 2020. *Auto CAD 2021 for the Interior Designer.* 430p. SDC publications.
5. Shrock C R and Heather S. 2019. *Auto CAD Pocket Reference.* (8th Edn.). 360p. Best Seller Publication.
6. Zeid I and Sivasubramanyan R. 2009. *CAD/CAM: Theory and Practice (Special Indian Edition).* 828p. McGraw Hill Education

Early Childhood Education 3 (2+1)

Objectives

i. To orient the students about significance of ECE for accelerating holistic development of children
ii. To enhance knowledge and skills of the students for planning program and its execution in ECE centres
iii. To sensitize students about significance of inclusive Early Childhood Care and Education (ECCE) and also about involving parents and community in ECCE program

Theory

Early Childhood Education - Meaning, characteristics and significance of early childhood education. History of its evolution, abroad and in India, -National ECCE policy 2020 - application of Western and Indian educational philosophies to early childhood education - Recent trends and challenges in Early Childhood Education - Concept of learning- definition, essential features, types of learning, laws of learning, principles of learning ; sensations, perception, imagination, attention and memory, remembering and forgetting, Intelligence-reasoning and thinking, effortful control, problem solving, information processing and learning environment- Motivation- definition, types, modes of motivation, relationship of motivation with learning and performance - Performance evaluation – meaning of evaluation/ testing, evaluation of student's performance - Types of tests used in classroom evaluation - program planning in ECE- Theory of play, Development of play stages, Importance of play, Steps and types of program planning, Significance of Play way method in ECE, Activities to promote all round development of children in early childhood- cognitive, language, socio-emotional and motor development, Developing key characters in children: Empathy, Adaptation, Boldness, Creativity, Diligence, Patience, Responsibility, Self-reliance, Resilience, Resourcefulness, Positive Self-esteem, Integrity, Humility, Tolerance, punctuality etc., role, qualities and responsibilities of an early childhood personnel, maintenance of registers and records; promotion of inclusive ECCE; involvement of parents and community in ECCE. Guidance to parents on activities to promote child's learning / early identification of learning problems.

Practical

Observation and recording of activities in ECE center. Analyzing effect of reinforcement, motivation, discipline on learning. Developing and conducting activities to promote all round development- Gross and fine motor skills, cognitive skills, language skills, creativity and socio emotional skills. Preparation of suitable creative/innovative teaching learning material used for preschool children. Application of theories of classroom teaching. Application of different methods of evaluating performance and interpretation.

Suggested Readings

1. Snow C E and Van Hemel S B (Eds). 2008. *Early Childhood Assessment: Why, What, and How by the National Research Council*. 500p. The National Academies Press, Washington, DC.
2. National Education Policy. 2020. *Early Childhood Care and Education (ECCE): Foundations of Learning.* NCERT, New Delhi
3. Early Childhood Care and Education, Senior Secondary Course, 376, National Institute of Open Schooling ISO9001:2000 Certified (An autonomous organisation under MHRD, Govt. of India) NOIDA. https://www.nios.ac.in/online-course-material/sr-secondary-courses/early-childhood-care-and-education-376.aspx
4. Eliason C and Jenkins L. 1990. *A Practical Guide to Early Childhood Curriculum. (4th Edn.).* 580p. London: Merrill Publishing Company.
5. Aggarwal J C. 2000. *Methods and Materials of Nursery Education.* (4th Edn.). Doaba House, Book Sellers and Publishers, Delhi.
6. Grewal J S. 1984. *Early Childhood Education, Foundations and Practice*. 363p. National Psychological Corporation, Modern Printers, Agra.

7. Human Development and Family Studies, Unit III, NCERT, New Delhi. http://ncert.nic.in/textbook/pdf/lehe107.pdf
8. Kostelnik M J, Soderman A K and Whiren A P. 2007. *Developmentally Appropriate Curriculum, Best Practces in Early Childhood Education.* (4th Edn.). 552. Pearson, Merrill Printice Hall, New Jersey.
9. Mohanty J and Mohanty B. 2000. *Early Childhood Care and Education*. 230p. Deep and Deep, New Delhi.
10. National Early Childhood Care and Education (ECCE), Curriculum framework. 2019.The Preschool Curriculum, NCERT. New Delhi. http://ecoursesonline.iasri.res.in/course/index.php?categoryid=100
11. Sinclair H. 2004. *Standards for Early Childhood Programmes in Centre based Child Care*. Govt. of New Found Land and Labrador. Dept. of Health and Community Services.UG Courses-Home Science - e-KrishiShiksha, Early Childhood Development and Education. http://ecoursesonline.iasri.res.in/course/index.php?categoryid
12. https://www.nios.ac.in/online-course-material/sr-secondary-courses/early-childhood-care-and-education-376.aspx

Extension and Rural development 3 (2+1)

Objectives

i. To develop understanding regarding the extension support system
ii. To impart knowledge on rural development programmes
iii. To make them understand the role of extension agencies in rural development
iv. To develop competency in working with the village people in line with the local and national rural development programmes

Theory

Extension Education: Concept and importance. Philosophy, principles and objectives. Evolution of extension education: Glimpses of pre- -independence era. Post-independence era. Community: Meaning and definition. Types of communities. Community mobilisation: - Meaning and importance. Leadership Development. Community development programmes: Concept, objectives, organization, activities. Strategies, achievement and failures. Community Science: Concept, significance and evolution of Community Science. Rural development: Concept, need, meaning, aim and functions. Role of Extension Agencies in Rural development. Panchayati Raj Institutions-Concept, power, role and responsibilities. Five-year Plans: Concept of Five-year plans (FYP). Planning Commission and NITI Aayog. Sustainable Development Goal (SDG). Rural Development programmes/ Organisations: SGSY (1999), NRLM (2011) - DDU-AY (Deen Dayal Antyodaya Yojana (DAY), IAY (1985)- Pradhan Matri Awas Yajana Gramin (PMAY-G), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Integrated Child Development Service Scheme (ICDS). Pradhan Mantri Social Security Schemes-Social Welfare and Social Safety Programme. Poshan Abhiyaan, National Health Mission (NHM), Swach Bharat Mission, Pradhan Mantri Kaushol Bikash Yojana (PMKBY). Din Dayal Upadhyaya Gramin Kausholya Yojana (DDUGKY)- Skill Development Programme, Sansad Adarsh Gram Yojana (SAGY), National Rurban Mission (NRuM). Atma Nirbhar Bharat Abhiyaan, District Water Management Agency

(DWMA), Agricultural Technology Management Agency (ATMA). Role of International/National Organization: United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), Food and Agriculture Organization (FAO), Bill of Melinda Gates foundations Trust(BMGF). National Organization and State level organization: Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Integrated Tribal Development Project/Area (ITDA/ITDP). District Agricultural Advisory and transfer of Technology Centres (DAATTCs), District Rural Development Agency (DRDA), Farmer Producer Organization/Company (FPO/FPC), Self Help Groups (SHGs) in rural development. Evolution of Extension as broad-based extension with multiple stakeholders' i.e. govt/private/NGO/CSR funds.

Practical

Studying the village profile by visiting village: Establishing rapport with rural families and leaders. Use of Survey method: Identification of needs of rural mothers and Agriculture workers. Exploring Income Generating Activities. Collecting information regarding the role of existing rural development program in operation with village area. Prepare a village profile based on collected information. Presentation of Report. Exposure Visit to: KVK. Exposure Visit to: PHC (for collecting information on health service specially to women and children). Exposure Visit to: DRDA. Exposure Visit to: AWCs. Exposure Visit to: Mahila Mandals/SHGs/Youth Club. Exposure Visit to: Cooperatives to make interaction programs with Extension Professionals of the Institutions.

Suggested Readings

1. Azeez N P Abdul and Akhtar Jawed S M. 2016. *Rural Development in India*. 409p. Kalpaz Publications.
2. Chamola S D and Bharati Anirudha. 2018. *Agriculture and Rural Development in India*. 334p. Global Vision Publishing House.
3. Ganesan R, Mohamed Iqbal I and Anandaraja N. 2019. *Reaching the Unreached*. 389p. Associated Publishing Company, A division of Astral International Pvt. Ltd., Ansari Road, Darya Ganj, New Delhi.
4. Mondal, S. 2018. *Textbook of Agricultural Extension with Global Innovations*. 325p. Kalyani Publishers, NOIDA, New Delhi.
5. Mondal S. 2017. *Fundamentals of Agricultural Extension Education*. (A complete Textbook for U.G. Students of Agriculture, Horticulture, Forestry, Fishery, Home Science and Dairy Faculties). 359p. Kalyani Publishers, Rajinder Nagar, Ludhiana.
6. Ray G L and Mondal Sagar. 2016. *Rural Development*, Kalyani. Publishers, New Delhi
7. Supe S V. 2017. *A Textbook of Extension Education*. (3rd Edn.). Agrotech Publishing Academy, Udaipur

Rural Sociology 2 (2+0)

Objectives

i. To develop understanding about sociological concepts with special reference to rural community
ii. To understand approaches to rural planning and status of rural women

Theory

Sociology and Rural sociology- Meaning and significance. Difference between rural, urban and tribal community. Indian rural social stratification: Caste and Class- Concept, Characteristics and difference. Changes in social stratification and implementation of constitutional provisions. Indian rural institutions- Social- Family and marriage (Nature, forms and changes), Economic, Political. Rural poverty: Meaning and causes. Religion: Functional significance of beliefs, traditions and customs. Rural social change: Concept, process and factors of transformation. Planned social change - Approaches to rural planning, improvement and transformation. Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

1. Chitambar J B. 1973. *Introductory rural sociology*. 369p. New York, John Wiley and Sons.
2. Desai A R. 1978. *Rural sociology in India*. 968p. Popular Prakashan, Bombay.
3. Doshi S L. 2007. *Rural sociology*. 365p. Rawat Publishers, Delhi.
4. Jayapalan N. 2002. *Rural sociology*. 348p. Atlantic Publishers, New Delhi.
5. Sharma K.L. 1997. *Rural Society in India*. 308p. Rawat Publishers, Delhi.

Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices

ii. To disseminate the knowledge and skill how to perform physical training, perform first-aid and increase stamina and general wellbeing through yoga

Practical

Physical education. Training and Coaching - Meaning and Concept. Methods of Training; aerobic and aerobic exercises. Calisthenics, weight training, circuit training, interval training, Fartlek training. Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems. Balanced Diet and Nutrition: Effects of Diet on Performance. Physiological changes due to ageing and role of regular exercise on ageing process. Personality, its dimensions and types. Role of sports in personality development. Motivation and Achievements in Sports. Learning and Theories of learning. Adolescent Problems and its Management. Posture. Postural Deformities. Exercises for good posture.

Yoga. History of Yoga, Types of Yoga, Introduction to Yoga:-

- Asanas (Definition and Importance) Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari

- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports.
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games. Governance of sports in India. Important national sporting events. Awards in Sports. History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of First Aid. First Aid equipment and upkeep. First Aid Techniques, first aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Skill Enhancement Courses (SEC-III module) 2 (0+2)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-Diploma, they can work with food service provider, catering units, fashion design units, interior design shops, accessory designing units, ECCD centres, etc., etc. or can go for self-employment.

Indicative options for SEC-III module *(any one module to be selected)*

Module	Course	Credit Hours
Food Service Management - I	Quantity Cookery	1 (0+1)
	Traditional Indian Foods	1 (0+1)
Fashion Designing- I	Garment Designing	1 (0+1)
	Accessory Designing	1 (0+1)
Interior Design and Decoration - I	Interior Designing and Decoration I	1 (0+1)
	Floral Art and Design II	1 (0+1)
Early Childhood Care and Education - I	Establishment of ECCE centers	1 (0+1)
	Program Planning and Execution in ECCE centers	1 (0+1)
Communication Technology and Journalism - I	Print Journalism	1 (0+1)
	Electronic Journalism	1 (0+1)

Module on Food Service Management - I

Quantity Cookery 1 (0+1)

Objectives

i. Students will learn to produce various food items in quantity, food safety, and hygiene

ii. Students will be able to learn menu planning, standardized recipes to be served to a large group of people, organizations

Practical

Equipment and Kitchen tools used in quantity cookery. Receiving and storage of equipment. Production Equipment. Service equipment. Cleaning equipment. Kitchen organization. Selection of raw material for quantity cookery. Regional foods for festivals. Snacks. Sweets. Gravies. Menus planning and quantity production. Food costing. Food safety. Food Handling. Hygiene. Food waste management.

Suggested Readings

1. Arora K. 2011. *Theory of Cookery*. 356p. Frank Brothers and Co. Pvt. Ltd., New Delhi.
2. Bali P S. 2009. *Food Production Operations*. (1st & 2nd Edn.). 604p. Oxford Publication.
3. Bali P S. 2011. *Quantity Food Production Operation*. 414p. Oxford Publication.
4. Bali P S. 2012. *Food Production Management*. 600p. Oxford Publication.

Traditional Indian Foods 1 (0+1)

Objectives

i. To know the traditional food preparations of different regions of India

ii. To know the nutritive / therapeutic value of traditional Indian diets

Practical

Survey of region specific traditional food products having therapeutic/medicinal values. Calculation of nutritive value of traditional recipes and meals of the state. Planning and preparation of characteristic recipes of different states. Standardization of common recipes of North, East, South and West-Zone of the country. Preparation of nutritionally significant foods for physiological conditions in India. Preparation of festive food of the country.

Suggested Readings

1. Crusius V C. 1984. *Quantity Food Management: Principles and Management*. 186p. Minneapolis, Minn. : Burgess.
2. Peckham G C. 1995. *Foundations of Food Preparations*. 768p. Prentice Hall, New Jersey.
3. West B B, Wood L H V F and Shugart G S. 1997. *Food Services in Institutions*. 710p. John Wiley and Sons, New Delhi.

Module on Fashion Designing – I

Garment Designing 1 (0+1)

Objectives

i. To develop awareness among students about garment designing

ii. To develop skills in various fabric construction techniques

Practical

Selection of figure template for children, women and men. Designing of garments for children using different construction features: Yoke, gather, pleats, tucks, shirring, smocking, trimmings. Designing of garments for women using different construction features: collar, sleeve, and neckline. Designing of garments for men using different construction features: shoulder yoke, collar, sleeve, and cuff. Drafting and construction of the following garments for women, men and children (Fancy frock, Salwar/ pyjama/pyjama, Kurta (gents)/kameez (ladies) and Night dress/ gown).

Suggested Readings

1. Chuter A J. 1995.*Introduction to Clothing Production Management*. 208p. Wiley-Blackwell Science.
2. Tyles D J. 1991. *Materials Management in Clothing Production*. 176p. John Wiley & Sons.
3. Gerry C. 2006. *Introduction to Clothing Manufacture*. 208p. Wiley-Blackwell Science.
4. Harold C and Barbara L.2008. *The Technology of Clothing Manufacture*. 344p. Blackwell Science.

Accessory Designing 1 (0+1)

Objectives

i. To develop awareness among students about Accessory designing

ii. To develop skills in construction of various accessories

Practical

Accessories: introduction and classification. Footwear, hand bags, belt, jewellery, gloves, hats, scarves and umbrella. Designing of accessories for children, women and men. Selection of designs for construction of accessories; Accessories Construction for Children, Women, Men.

Suggested Readings

1. Harold C and Barbara L. 1993. *Fashion Design and Product Development*. 192p. Wiley-Blackwell Science.
2. Mike E. 2008. *Fashion Marketing*. 276p. Wiley-Blackwell Science
3. Peacock J. 2000. *Fashion Accessories- The Complete 20th Century Source Book*. 192p. Thames and Hudson, London.
4. Meadows C S. 2003. *Know your Fashion Accessories*. 464p. Fairchild Books, New York.

Module on Interior Design and Decoration – I

Interior Design and Decoration I 1 (0+1)

Objectives

i. To understand the concept of elements and principles of design
ii. To understand basic principles of illumination and application of natural lighting in interiors
iii. To impart knowledge on working and managing of interior design as professional practice

Practical

Application of elements and of principles of design. Colour concept: colour schemes and its cost estimation. Colour scheme for problematic area. Curtains and draperies. Types of curtain material and hardware's and its costing. Lighting, types of light fixture. Use of lights and lamps. Lighting plan for problematic areas. Floor treatments and its type. Wall treatment and its types. Accessories for interiors. Materials used for interior designing and decoration. Indoor landscaping. Flower arrangements. Auto CAD for interiors. Visit to any residential and commercial building to study about materials used for interior designing and decoration.

Suggested Readings

1. Ch'ing, Francis D K and Binggeli Cork. 2004. *Interior Design Illustrated.* 318p. Wiley Publications, New Jersey.
2. Dechiara J, Panero J and Zelnik M. 2011. *Time Saver Standards for Interior design and Space Planning.* 1689p. McGraw Hill, London,
3. Dechiara J and Panero J. 2011. *Standards for Interior Design and Space Planning.* 1744p. McGraw Hill Professional,
4. Diane P and Tap S. 2000. *Curtains, Draperies and Shades.* 400p. Lane, Menlo Park, California.
5. Faulkner S and Faulkner R N. 1968. *Inside Today's Home.* 592p. Holt, Rinehart and amp; Winston.
6. Gordon G. 2015. *Interior Lighting for Designers.* (5th Edn.). Wiley Publishers.
7. Keeping M and Shiers D. 2017. *Sustainable Building Design: Principles and Practice.* (1st Edn.). 200p. Wiley Blackwell.
8. Mitton M and Nystuen C. 2016. *Residential Interior Design - A Guide to Planning Spaces.* (3rd Edn.). 288p. Wiley Publication.
9. Piotrowski C M. 2016. *Designing Commercial Interiors.* (3rd Edn.). 576p. John Willey Publishers.
10. Pratap R M. 2012. *Interior Design Principles and Practice.* 121p. Standard Publications, Delhi.
11. Seetharam P and Pannu P. 2009. *Interior Design and Decoration.* (1st Edn.). 703p. CBS, New Delhi.
12. Singh G. 2017. *Building materials.* 959p. Standard Publishers Distributors, Delhi.

Floral Art and Design II 1 (0+1)

Objectives

i. To get oriented with modern and world over most popular techniques of floral craft
ii. To understand aesthetics of Ikebana, Driftwood and Bonsai culture
iii. To develop conceptual indoor landscaping designs for official, industrial, commercial and residential areas
iv. To study dry flower technologies for developing long lasting floral craft
v. Get awareness about Ikebana flower arrangements, indoor plants and Bonsai Culture to convey through symbolism on how nature and art relate to daily living

Practical

Learning basic Ikebana techniques - Practice on concept and styles of classic ikebana flower arrangements such as Rikka, Nageire Bana, Seika, Moribana, Jiyūka. Study of various Indoor landscaping. Plant scaping or interior scaping, greener y ideas to reimagine a professional space. Office/ hotel, retail, hospital or lobby, Indoor plan maintenance work study. Designing various types of indoor landscape gardening such as Living Walls/Vertical Gardens, Table garden Dish or bowl garden, Green Garden, Stone Scaping, Holy Scape, Floating, Indoor Landscaping, Water Scapes. Cost estimation of indoor garden designing. Dry Flower Technology: Method of drying Flowers and Foliage, Freeze Drying, Glycerin Drying (Glycerining), Microwave/ Oven Drying, Water Drying, Embedding Oven Drying, Air Drying, Sun drying, Press Drying, Skeletonizing, Potpourri, Sulphuring and Bleaching techniques. Cost estimation of dry flower techniques - Learning Styling techniques of bonsai, Bonsai aesthetics, Bonsai, Care and Culture of Miniature Trees - Designing useful and decorative Driftwood articles. Indian traditional ideas of floral decoration for floor, wall, windows and doors. Elements and colour theory in floral designing.

Suggested Readings

1. Adams P D. 1981. *The Art of Bonsai.* 175p. Ward, Lock and Co., London.
2. Averill M. 1913. *Japanese Flower Arrangement.* 222p. ohn Lane Company, New York.
3. Conder J. 1899. *The Floral Art of Japan.* 142p. Kelly and Walsh Ltd., Tokyo.
4. Douthitt J. 2001. *Bonsai: The Art of Living Sculpture.* 144p. Rizzoli International Publications Inc., New York.
5. Gaines R L. 1977. *Interior Plant scaping.* 176p. Architectural Record Books, New York.
6. Kubo K. 2006. *Keiko's Ikebana: A Contemporary Approach to the Traditional Japanese Art of Flower Arranging.* 128p. North Clarendon: Tuttle Publishing, North Clarendon, USA.
7. Lesniewicz P. 1996. *Bonsai in Your Home.* 207p. Sterling Publishing Company, New York.
8. Scrivens S. 1980. *Interior Planting in Large Buildings.* 129p. The Architectural Press, London.
9. Shofunotomo. 1982. *The Essentials of Bonsai*. 108p. Timber Press, Oregon.
10. Steere W C. 1972. *Flower Arrangement: The Ikebana Way*. 286p. Madison Square Press, Chicago, USA.

Module on Early Childhood Care and Education – I

Establishment of ECCE Centres 1 (0+1)

Objectives

i. To gain practical experience in establishing different early childhood care and education centres

ii. To learn about registration of ECCE centres

Practical

Concept, need, characteristics, functions and types of project planning. Ethical considerations in project planning. Types of child care and education programs. Objectives and services of different programs. Need assessment. Method and significance of need assessment. Funding agencies. Budget planning and accounts. Short term and long-term budget planning. Staffing and supervision. Legal and regulatory processes at national and international level. Registration and licensing. Infrastructure development- location, indoor and outdoor space requirements. Setting up the physical environment and facilities. Physical facilities ECCE centers- basic requirements. Class room arrangements, care facilities- facilities for different budgets. Format for submission of proposal for physical facilities. Setting the learning environment. Classroom arrangements, equipment procurements. Short term and long term programs planning and evaluation. Preparing a project proposal. Need assessment in different settings for various programs, selection of locale and clientele. Layout planning for different programs in rural and urban settings. Manpower, finance, infrastructure facilities and cost benefit analysis as input sources. Visit to various funding agencies like banks, cooperatives and other agencies and reporting about schemes and facilities offered by these agencies. Exploring current government programs to support self employment under various schemes. Report writing.

Suggested Readings

1. Sue D, Leonie A, Sue F, Bronwyn B and Deat E. 2017. *Programming and Planning in Early Childhood Settings*. 480p. Cengage Settings, Australia.

2. Mohanty J and Mohanty B. 2000. *Early Childhood Care and Education*. 230p. Deep and Deep Publications Pvt. Ltd., New Delhi

3. Murlidharan R and Banerji V. 1969. *A Guide for Nursery School Teachers*. 99p. National Council of Education Research and Training, New Delhi.

4. NAEYC (National Association for the Education of Young Children). 2021. *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth Through Age 8.* (4th Edn.). 400p. NAEYC, Washington, DC.

5. Jaipaul R and Johnson J E. 2009. *Approaches to Early Childhood Education*. (5th Edn.). 420p. Pearson India.

Programme Planning and Execution in ECCE Centres 1 (0+1)

Objectives

i. To gain practical experience of the planning of all aspects of different early childhood care and education centres

ii. To develop skills for understanding developmental needs of young children belonging to early childhood years

iii. To develop skills for planning and management of early childhood care and education programs

iv. To provide practical experience in operating an early childhood education centre in urban and rural areas

Practical

Understanding principles of program planning. Planning long and short-term programs for various early childhood care and education centres. Issues and goals of curriculum planning. Principles of effective program planning. Importance of developmentally appropriate planning. Observing and recording developmental characteristics of children in various early childhood care and education settings. Preparing developmentally appropriate activities for physical development, fine and large muscle coordination. Developmentally appropriate activities for cognitive stimulation. Activities for creative expression, language development. Activities for socio-emotional interaction. Pre reading and pre writing activities. Foundations for numeracy. Activities for environmental awareness. Science experiences. Activities for body movements. Developing self-care, care of surroundings activities. Effective use of material, mapping of material. Developing classroom teaching learning accessories. Activities for parent and community involvement. Execution of all activities through practice teaching different age groups of children. Conducting activities with parents and community- submitting records of observation of children's activities. Parent and community activities.

Suggested Readings

1. Chowdhury A and Chowdhury R. 2016. *Development Care and Education of Pre-School Children*. 276p. Discovery Publishing House, New Delhi

2. Brophy J E, Good T I and Nedler S E. 1975. *Teaching in the Preschool*. 388p. Harper Row publisher, New York

3. Day B. 1983. *Early Childhood Education: Creative learning activities*. 447p. Macmillan Publishing Co. Inc., New York.

4. Lan F J and Kissinger J B. 1976. *The Young Child and the Educative Process*. 390p. Holt, Rinehart and Winston, New York

5. Christopher G. 2010. *Beyond Toddlerdom*. 128p. Permilion, Landon

6. Grewal J S. 1984. *Early Childhood Education: Foundations and Practice*. 363p. National Psychological Corporation, Agra.

7. Leeper S H, Skipper D S and Witherspoon R L. 1979. *Good Schools for Young Children*. 588p. Macmillan Publishing Co., Inc., New York.

8. Morrison GS. 1997. *Early Childhood Education Today.* (7th Edn.). 672p. Merril, an imprint of Prentice Hall, New Jersey Columbus, Ohio.
9. Kail R V. 2019. *Children and their Development*. 588p. Pearson India Education Services Pvt. Ltd, Uttar Pradesh, India.
10. Sararwathi T S, Menon S and Madan A. 2021. *Childhood in India*. 474p. Routledge Taylar and Francis Group, New York.
11. Swaminathan M and Daniel P. 2022. *Play Activities for Child development*. 214p. National Book Trust, India

Module on Communication Technology and Journalism - I

Print Journalism 1 (0+1)

Objectives

i. To equip with necessary knowledge about various print journalism
ii. To impart skills in development and use of various print media
iii. To develop comprehensive skill in writing and editing of an article

Practical

Identification and discussion on various types of print material. Planning and production of news - news gathering by using direct and indirect methods. News gathering by using interview techniques. Different forms of news reports and writing news- curtain raiser, spot news/live report, investigative report/interpretative, in-depth report/advocacy report, cultural events, civil and social events reporting, crime and sports reporting. Specialized reporting – environment and ecology, agriculture, health/nutrition issues, women and children's issues, human interest stories, travelogues, humor writing and types of column writing. Editing of news. Planning for article writing and its production. Editing of article-rewriting, integrating, updating, referencing and proof reading. Planning for feature writing and its production. Editing of feature. Planning, production and editing of advertisements. Exposure visits and hands on experience on printing technology, visit to university press to understand the production process and equipment.

Suggested Readings

1. Ajay D. 2011. *Basic Concepts of Journalism*. 295p. Discovery Publishing House, New Delhi.
2. Ahuja B N and Chabra S S. 2004. *Principles and Techniques of Journalism.* (3rd Edn.). 373p. Surjeet Publications, New Delhi.
3. Bhatnagar R. 2001. *Print Media and Broadcast Journalism*. Indian Publisher Distributors, New Delhi.
4. Bisht M S. 2007. *Journalism Techniques and Practices.* (1st Edn.). 69p. Cybertech Publications: New Delhi.
5. Kamath M V. *The journalist's handbook*. 320p. Vikas Publishing Pvt Ltd., Noida.
6. Rangaswami P. 1984. *Basic journalism*. 195p. Macmillan India Limited.

Electronic Journalism 1 (0+1)

Objectives

i. To equip with necessary knowledge about various electronic media
ii. To impart skills in development and usage of various electronic media formats
iii. To impart skill in planning and developing of script
iv. To develop skills in production technology of TV and radio programs

Practical

Visit to Radio station. Doordarshan/local television channel. Formats of Radio Programs – features, discussions, news bulletins, drama, talk. Writing and editing script for Radio program. Rehearsal, recording and editing with computer-based editing software and presentation for Radio script. Application of photographic principles. Formats of Television Programs. Screening and TV cultural news programs. Screening of TV political and sports news programs. Screening of developmental TV programs. Video script -basic production script. Different types of video scripts– storyboard script. Planning script for video program–1 minute program. Writing and editing script for program. Script writing for documentary and drama. Script writing for educational program. Planning script for advertisements– storyboard. Practice news reading. Anchoring for Radio program. Presenting Radio and TV news. Rehearsal recording and editing with computer- based editing software and presentation.

Suggested Readings

1. Bhatt S C. *Broadcast Journalism, Basic Principles*. 230p. Har Anand Publisher. Delhi.
2. Millerson G and Owens J. 2008. *A Handbook of Video Production*. 352p. Butterworth-Heinemann, oxford.
3. Millerson G and Owens J. 2008. *Television Production*. 424p. Focal Press London.
4. Hedgecoe J. 1997. *The Photographer's Handbook: A Complete Reference Manual of Photographic Techniques, Procedures and Equipment*.
5. Kimberly A, Neuendorf. 2017. *The Content Analysis Guidebook*. 438p. Online Publication. DOI: https://dx.doi.org/10.4135/9781071802878
6. Ray G L. 2004. *Communication and Management*. 213p. Kalyani Publishers, New Delhi.
7. Sandhu A S. 1993. *Textbook on Agricultural Communication: Process and Methods*, Oxford and IBH Publishing Pvt. Ltd., New Delhi.
8. Waters A. 2018. *Confident Digital Content : master the fundamentals of online video, design, writing and social media to surcharge your career.* https://books.google.co.in/books/about/Confident_Digital_Content.html.

Semester IV

Institutional Food Service Management 3 (2+1)

Objectives

i. To enable them in planning, execution and control of the management of institutes with ease and profit

ii. To provide practical knowledge about keeping inventory of stocks, tool management and cost calculation

iii. To Proclaim work study, work simplification and its improvement in day to day life

Theory

Introduction- Classification of food service institutions, function, profit oriented, public health facility oriented. Processing method- Conventional system, fast food service systems. Service of food- Self-service, tray service, waiter-waitress service, floor planning and layout. Characteristics of typical food service facilities. Floor planning and layout for catering establishment. Catering Equipment- Introduction. Classification. Factors involved in selection of equipment. Factor involved in purchasing of equipment. Use and care of major equipment. Food preparation- Introduction, Principles of food preparation. Characteristics of food. Principles of food purchasing. Methods of food purchasing. Storages of foods. Menu planning- Definition of menu planning. Principles of menu planning. Types of menus. Standardization of recipe- Definition of standardization of recipe. Standard portion sizes. Portioning equipment. Portion control. Use of left over foods. Management- Definition Principles of management. Steps in effective management. Techniques of effective management Tools of management. Organization chart. Work study. Work simplification. Work improvement financial management. Introduction. Principles. Costing. Budgeting. Accounting. Food cost control methods. Factors affecting food cost, labor cost, operating cost and overhead cost. Personal management Introduction. Personal management concepts. Staff employment. Employee benefit. Methods of selection. Orientation. Training and development. Supervision. Motivation of employees.

Practical

Standardization of at least 2 recipes in each of the following category: cereal and cereal products vegetables fruits. Meat, Chicken and other fleshy foods. Sugar and Jaggery. Milk and its products. Pulses, Nuts and Oil seeds. Sweet and Savory dishes, snacks, traditional recipes. Planning and preparation of menu for various occasions and to calculate amount of each food ingredients. Birth day menu. Holy function menu. New year special menu. Wedding menu. Lhori special menu. Christmas special menu. Calculate food cost labor cost operating cost and overhead cost of a home- made dish Calculate gross profit percentage of establishment welfare/commercial/transport catering. Calculate break-even point any establishment welfare/ commercial / transport catering. Table setting. Maintenance of accounts and record keeping. Visit to various food service institutions and observation of physical facilities menu cards serving style table setting number of personnel and their work schedule hygiene and sanitary conditions safety measures etc. Report writing and presentation.

Suggested Readings

1. Arora R S. 2012. *Banquet and Catering Management*. 300p. Abhijeet Publications.
2. Beckley J H, Herzog L J and Foley M M. 2017. *Accelerating New Food Product Design and Development*. (2nd Edn.). 400p. John Wiley and Sons Inc., Hoboken, New Jersey.
3. Bhajwani M. 2007. *Food Service Management: Principles and Practice*. 282p. Rajat Publications, New Delhi.
4. Bhat H. 2008. *Hotel Management*. 124p. Crescent Publishing Corporation.

5. Carpenter R P, Lyon D H and Hasdell T A. 2002. *Guidelines for Sensory Analysis in Food Product Development and Quality Control*. (2nd Edn.). 210p. Aspen Publishers Inc., New York.
6. Earle M and Earle R L. 2008. *Case Studies in Food Product Development*. 440p. Woodhead Publishing Limited and CRC Press, New York.
7. Moskowitz H R, Straus T and Saguy S. 2009. *An Integrated Approach to New Food Products Development*. 504p. CRC Press, Boca Raton, Florida.
8. Nancy L S. 2007. *Catering Management.* 304p. John Wiley and Sons.
9. Puckett R P. 2012. *Good Service Manual for Health Care Institutions*. (4th Edn.). 592p. John Wiley and Sons Inc., Hoboken, New Jersey.
10. Sethi M. 2018. *Catering Management- An Integral Approach*. (3rd Edn.).496p. New Age International, New Delhi.
11. Vaclavik V A, Amy C H and Marjorie M D. 2018. *Dimensions of Food*. (8th Edn.). 344p. CRC Press.
12. https://www.ferrerofoodsservice.com. Accessed on 13-02-2025.
13. https://www.foodservicedirector.com. Accessed on 13-02-2025.

Retailing and Merchandizing 2 (1+1)

Objectives

i. To learn about retailing and various formats of retailing
ii. To understand the organizational structure of the retail firms
iii. To know about the merchandising division in an apparel firm
iv. To gain knowledge of the sales promotion techniques used in the industry
v. To become familiar with the export and import procedures and organizations in export promotion

Theory

Retailing - Introduction to textile and apparel industry, nature, scope, importance of retailing and merchandising. Retailing concept and principles, retail life cycle, market segmentation, key players at domestic, national and global level. Retailing and merchandising in India – status, evolution and trends. Classification of retail formats – store or onsite retailers, non-store or off-site retailers, e-tailing and online/virtual sales and promotions. Organizational set up- on site retailers and off-site retailers. Merchandising – concepts, terminology of merchandising, factors affecting buying function, merchandising plan, buying plan, fashion calendar and merchandising planner. Merchandising –functions of buying for store, chain store, buying house, studios, export houses, catalogue sales. Merchandising – categories, textile, apparel and fashion merchandising, retail merchandising. Roles and responsibilities of merchandiser, merchandising team. Factors affecting Merchandising-Franchising, trade promotions, supply chain management, logistics management, physical distribution. Sales promotion techniques, fashion advertising and promotion – media, trends and methods. Visual merchandising – introduction, functions, elements, interior display, exterior display, planogram, trends, mall designing and visual display planning for commercial spaces. Export and import procedure in India: primary and ancillary documents. Export Promotion Councils and their roles.

Practical

Introduction to retail markets. Developing questionnaire and survey to assess the retail / wholesale scenario in Apparel and textiles. Analysis of textile and apparel market -visit to wholesale sectors. Analysis of textile and apparel market -visit to retail and exclusive showrooms. Analysis of textile and apparel market -visit to chain stores and reporting. Analysis of textile and apparel market -visit to factory outlets. Analysis of textile and apparel market -value addition techniques and products. Analysis of textile and apparel market reports in view of selected product category for business development. Developing and presentation of the visual display techniques –textiles / apparel. Planning promotion techniques for textile, apparel and fashion items. (Design and Product development, textile and apparel categories, fashion direction, Forecasting, Product Specification, Sample/ Prototype Development, range planning, product assortment and their significance in product planning, pricing of the products) * Textile, apparel and fashion promotion event planning and organization.

**Can utilize the products developed in other courses also.*

Suggested Readings

1. Berman B and Evans J R. 1979. *Retail Management-A Strategic Approach*. 647p. Macmillan, NY.
2. Bell J. 2006.*Silent Selling*, (3rd Edn.). 399p. Fairchild Publications, NY.
3. Bellenger D N and Goldstucker J L. 1983. *Retailing Basics*. 770p. Richard D. Irwin Inc.
4. Bickle C. 2010.*Fashion Marketing – Theory, Principles and Practice Marianne*. 352p. Fairchild Publications, NY.
5. Diamond E. 2006. *Fashion Retailing*. 411p. Pearson Publications.
6. Donnellan J. 2013. *Merchandise Buying and Management*. 448p. A and C Black, Fairchild Publications, NY.
7. Easey M. 2008. *Fashion Marketing*, (3rd Edn.). 276p. Wiley- Blackwell Publications.
8. Fiore A M and Kinkle P A. 1996.*Understanding Aesthetics for the Merchandising And Design Professional*. Bloomsbury Academic Publications, NY.
9. Gini S F. 1999.*Fashion from Concept to Consumer*. 376p. Prentice Hall, USA.
10. Jackson T and Shaw D. 2001. *Mastering Fashion Buying and Merchandising Management*. 204p. Palgrave publication.
11. Kincade D H. and Gibson. 2011.*Merchandising of Fashion Products*. 655p. Pearson Education.
12. Kumar M K.2010.*Apparel Merchandising*. 221p. Abhishek Publications.
13. Poloian L G. 2003.*Retailing Principles – A Global Outlook*. 608p. Fairchild Publications.
14. Pradhan S. 2008.*Retailing and Merchandising – Text and Cases*. 496p. Fairchild Publications.
15. Rabolt N and Miller J. 2008. *Concepts and Cases in Retail and Merchandise Management*. 496p. Bloomsbury publishing.
16. Levy M and Weitz B A. 2003. *Retailing and Merchandising Management*. (5th Edn.). 735p. Mc Graw Hill Co.

17. Rosenau J A and Wilson D L. 2014. *Apparel Merchandising – the line starts here,* (2nd Edn.). 512p. Fairchild Publications, NY.
18. Pachiyappan, K.M., Mahalakshmi, V., Sundaresan, S. & Ariharasudhan, S. 2023. *Apparel Marketing & Merchandising*. Royal Book Publishing, Salem, Tamil Nadu.
19. Stone E. 1985.*Fashion Merchandising.* (4th Edn.). 438p. Mc Graw Hill Co. NY, USA.
20. Stone E. 2007. *Fashion*. 416p. Fairchild Publications, NY.
21. Stone E. 2007.*In Fashion – Fun, Fame, Fortune.* 368p. Fairchild Publications, NY.
22. http://ecoursesonline.iasri.res.in/course/view.php?id=233.
23. C K Kothari. 2021. *E-Book on Research Methodology*.
24. Mark Piginton. *e-Book on Retail recovery*.
25. e-Book on *The Effects of E-Commerce on Retail Supply Chains*.
26. https://bookauthority.org/book/The-Effects-of-E-Commerce-on-Retail-Supply-Chains/B098CWD6JB.
27. Dimitri Koumbis (2021 Ed). e-Book on *An Introduction to Fashion Retailing from Managing to Merchandising*
28. https://bookauthority.org/book/An-Introduction-to-Fashion-Retailing/1350098272.

Housing and Space Management 3 (1+2)

Objectives

i. Recognize a family's needs in relation to housing and gain knowledge on housing issues and building services.
ii. Gain practical knowledge in designing space for different family needs
iii. Learn the basics of architectural symbols and plans
iv. Learn about the efficient arrangement of space in interiors
v. Learn to develop the house plans including furniture

Theory

Housing – importance, characteristics and effects of insufficient housing. Housing needs at different stages of family life cycle. Housing problems in India. Rural and urban housing. Housing legislation and regulations in India. Building Codes, Floor Space Index (FSI/FAR). Factors to be considered in the selection of family housing. Selection of site. Advantages and disadvantages of renting and owning a house. Types of house plans - floor plan, site plan, cross sectional plan, perspective plan, elevation plan and landscape plan. Principles of house planning. Orientation and aspect, privacy, grouping, roominess, prospect, flexibility, circulation, sanitation, furniture requirement and practical considerations. Space management based on functional areas. Space management and Interior types based on functional needs. Interiors for youth/ elderly / other special needs. Building Services. Electrical layout and wiring, plumbing and sanitation. Construction Techniques for safety- damp proofing, fire proofing, termite Proofing, sound proofing, security features. Housing standards. Technology in housing. Advanced technology in housing construction. Low-cost building technologies. Low-cost building materials.

Practical

Learning and comprehending architectural symbols. Lettering design and techniques. Planning Space arrangement for different room/areas in the home. Different types of Kitchens. Designing for special needs. Planning Space saving storage solutions for various rooms/uses. Drawing of House plans. EWS, LIG, MIG, HIG, Rural. Plans, electrical wiring and fixtures, plumbing and water supply. House plan for renovation according to needs of residents. Market survey to study the available building materials in the local market.

Suggested Readings

1. Tessie A. 1960. *The House: Its Plan and Use.* 706p. Oxford and IBH Publishing Co., New Delhi.
2. Agarwala S C. 2008. *Architecture and Town Planning.* 415p. Dhanpat Rai and Co, N. Delhi
3. Arora and Bindra. 2013. *Building Construction.* 950p. Dhanpat Rai Publications.
4. Cherunilam F and Heggade O .1987. *Housing in India.* 168p. Himalaya PublishingMumbai.
5. Kness D M, Szekely L, Dorothy S D, Darlene K and Kathryn C L. 1980. *Introduction to Interior Design. 560p.* Macmillan Publishing Co., Inc, New York.
6. Dutt D R. 2002. *How Best to Plan and Build Your Home.* 198p. Pustak Mahal, Delhi
7. Faulkner R and Faulkner S .1975. *Inside Today's Home.* 598p. New York: Rinehart and Winston.
8. Mathur G C. 1993. *Low-Cost Housing in Developing Countries.* 142p. Mohan Primlani, Oxford and IBH, New Delhi.
9. Punmia B C. 1993. *Building Construction.* 846p. Laxmi Publications, New Delhi.

Theories and Practices in Early Childhood Education 2 (2+0)

Objectives

i. To understand the various theories of Early Childhood Education
ii. To learn scientific practices in Early Childhood Education

Theory

Importance of theoretical perspectives in early childhood care and education. Early childhood education practices. Play–based, Montessori, Waldorf, Reggio- Emilia, Religious schools, High Scope, Direct instruction, Bank Street approach. Attachment theory of Bowlby and Ainsworth. Ecological systems theory of Bronfenbrenner. Theories of Learning. Classical conditioning. Operant conditioning of Skinner. Trial and Error learning by Thorndyke. Social learning theory of Bandura. Cognitive theory of Maria Montessori. Cognitive development theory Jean Piaget. Socio- cultural theory of Lev Vygotsky. Multiple intelligences theory of Howard Gardner – Erickson's Psycho Social development theory. Disciplining children's theories. Parenting styles, Hoffman's disciplinary techniques. Application of theories in classroom. Challenging aspects of practice of theories in early childhood care and education.

Suggested Readings

1. Soni R. 2015. *Theme Based Early Childhood Care and Education Programme– A Resource Book*, 296p. NCERT, New Delhi.

2. Wiltshire M. 2011. *Understanding the High Scope Approach, Early Years Education in Practice.* 155p. Rutledge, NY.
3. Deiner P L. 2009. *Inclusive Early Childhood Education*. 696p. Cengage Learning Press, Belmonte, USA.
4. Kaul V. 1997. *Early Childhood Education Programmes*. 306p. NCERT, Delhi.
5. Jaipaul R and James E J. 2009. *Approaches to Early Childhood Education*. 420p. Pearson Education, Atlantic.

Training and Professional Development 2 (0+2)

Objectives

i. To impart basic knowledge on types and techniques of training for professional development
ii. To develop the skill on designing and conducting a training program
iii. To develop an understanding of the various techniques like team building, group discussion and brain storming for professional development

Practical

Learning Theories-Basic concepts of learning theories. Principles of learning, learning patterns, characteristics of learning process. Theories of learning - Behaviourism, Cognitivism, Social learning theory, Social constructivism, Multiple intelligences, Brain-based learning. Purpose of learning theories in training and professional development. Advantages and limitations. Interaction with trainees and training officials and find out the method and apply the same for professionals. Training Approach-Basic concept of training approach. Purpose of training approach.

Types of training approach. Steps involved in training approach. Advantages and limitations. Preparation of training, content and procedures (methods and materials). Types of Training. Meaning of training for professional development. Purpose of training for professional development. Pre-service training. In service training and staff development. Evaluation and assessment of training. Detect and predict defects in the procedural design of a training activities.

Phases of Training. Planning Phase. Setting the goals and objectives of an organization, analyzing –the human resources, efficiency indices and organizational climate. Implementation Phase - publicity, develop training brochures, annual calendar of learning opportunities, time about their teaching plans. Evaluation Phase - reaction, behavior and result.

Types of Evaluation– evaluation for planning, process of evaluation, terminal evaluation and impact evaluation. Key elements of the training activities are systematically monitored, problems are to be identified and attempts are to be made to rectify.

Designing training program - Gain attention, inform learner and objectives, stimulate recall of prior learning, Present stimulus material, provide learner guidance, elicit performance, provide feedback, assess performance, enhance retention transfer, interact with trainers and learn the practical requirements.

Suggested Readings

1. Bahal R, Swanson B E and Farner B J. 1992. *Human Resources in Agricultural Extension: A Worldwide Analysis.* 9p. Indian Journal of Extension Education

2. Bhattacharyya D K. 2015. *Training and Development*. 348p. Sage Publication Limited, New Delhi.
3. Dahama O P. 1979. *Extension and Rural Welfare,* Ram Parsad and Sons, New Delhi.
4. Elam S. 1971. *Performance Based Teacher Education: What is the state-of-the-art Washington*. 37p. DC: AACTE.
5. Flippo E B. 1961. *Principles of Personnel Management*. 620p. McGraw Hill, New York.
6. Kirkpatrick D. 1976. *Training and Development Handbook*. 85p. McGraw Hill, New York.
7. Lynton R P and Pareek U. 1990. *Training for Development*. 361p. Kumarian Press, West Hartford, CT.
8. McGhee W and Thayer P W .1961. *Training in Business and Industry*. 305p. John Wiley and Sons, New York:

Agriculture Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade
ii. To analyze the factors influencing supply and demand in agricultural markets
iii. To explore different marketing channels and strategies in agriculture
iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing. Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities. Nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities. Study of relationship between market arrivals and prices of some selected commodities. Computation of marketable and marketed surplus of important commodities. Study of price behaviour over time for some selected commodities. Construction of index numbers. Visit to a local market to study various marketing functions performed by different agencies. Identification of marketing channels for selected commodity. Collection of data regarding marketing costs, margins and price spread and presentation of report in the class. Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2006. *Agricultural Marketing in India*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, India.
2. Chinna S S. 2005. *Agricultural Economics and Indian Agriculture*. Kalyani Publications, New Delhi, India.
3. Food and Agriculture Organization of the United Nations (FAO). 2024. *The State of Agricultural Commodity Markets 2024: Trade and Nutrition—Policy Coherence for Healthy Diets*. FAO, Rome, Italy.
4. Kohls R L and Uhl J N. 2002. *Marketing of Agricultural Products*. Prentice-Hall of India Private Ltd., New Delhi, India.
5. Kotler and Armstrong. 2005. *Principles of Marketing*, Pearson Prentice-Hall.
6. Lekhi R K and Singh J. 2006. *Agricultural Economics*. Kalyani Publishers, New Delhi, India.
7. Memoria C B, Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India*. Kitab Mahal, New Delhi, India.
8. Pandey M and Tewari D. 2004. *Rural and Agricultural Marketing*. International Book Distributing Co. Ltd, New Delhi, India.
9. Rout R K. 2024. *A Text Book of Agricultural Marketing, Trade and Prices*. Kalyani Publishers, New Delhi, India.
10. Salvator D. 2008. *Microeconomics: Theory and Applications*. New York: Oxford University Press.
11. Sharma R. 2005. *Export Management*. Laxmi Narain Agarwal, Agra.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.

ii. To provide basic knowledge of computer with applications in agriculture

iii. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers. Anatomy of Computers. Memory Concepts. Units of Memory. Operating System: Definition and types. Applications of MS-Office for creating. Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database. Uses of DBMS in Agriculture. Internet and World Wide Web (WWW). Concepts and components. Computer programming. General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. Concepts and standard input/ output operations. E-Agriculture: Concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation. IT applications for computation of water and nutrient requirement of crops. Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice. Market price, postharvest management etc.. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System. Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence. Background and Applications. Turing test. Control strategies. Breadth-first search. Depth-first search. Heuristics search techniques: Best-first search, Algorithm, IoT and Big Data. Use of AI in agriculture for autonomous crop management and health. Monitoring livestock health. Intelligent pesticide application. Yield mapping and predictive analysis. Automatic weeding and harvesting. Sorting of produce and other food processing applications. Concepts of smart agriculture. Use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands. Introduction of different operating systems such as Windows, Unix/ Linux. Creating files and folders. File Management. Use of MS-WoRD and MS Power-point for creating, editing and presenting a scientific document. MS- EXCEL - Creating a spreadsheet. Use of statistical tools. Writing expressions. Creating graphs. Analysis of scientific data. Handling macros. MS-ACCESS: Creating Database, preparing queries and reports. Demonstration of Agri- information system. Introduction to World Wide Web (WWW) and its components. Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++. Hands on practice on Crop Simulation Models (CSM). DSSAT/Crop-Info/Crop Syst/ Wofost. Preparation of inputs file for CSM and study of model outputs. Computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology. Hands on practice on preparation of Decision Support System. Preparation of contingent crop planning. India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Date C J. 2007. *An introduction to Database Systems*. Addison-Wesley.

2. Dhabal P S and Manoranjan P. 2017. *Concepts and Techniques of Programming in C*. I. K. International Publishing House Pvt. Limited.
3. Fatima F and Parveen S. 2024. *A Textbook on Agri-Informatics*. Kalyani Publishers, New Delhi, India.
4. ITL Education Solutions Ltd. 2006. *Introduction to Information Technology*. PEARSON Education.
5. Mahapatra S K. Mishra P and Pradhan J. 2022. *Introductory Agri Informatics*. Jain Brothers.
6. Raj P, Gayathri N and Kathrine G J W. 2024. *Artificial Intelligence for Precision Agriculture*. CRC Press, Boca Raton, FL, USA.
7. Rajaroman V and Adabala N. 2015. *Fundamentals of Computer*. PHI Learning Private Ltd, New Delhi, India.

Skill Enhancement Courses (SEC-IV Modules) 2 (0+2)

Objective

To enable the students to acquire basic skills in different domains of community Science so that in case they exit with UG-Diploma, they can work with food preservation units, fashion design units, portfolio development studios, interior design /decoration units/shops, furnishing houses, ECCD centres, audio recording/video making studios, etc. or can go for self-employment.

Indicative options for SEC-IV module *(any one module to be selected)*

Module	Course	Credit Hours
Food Service Management - II	Food Preservation and Storage-I	1 (0+1)
	Food Preservation and Storage-II	1 (0+1)
Fashion Designing- II	Fashion Illustration	1 (0+1)
	Portfolio Development	1 (0+1)
Interior Design and Decoration - II	Interior Accessories and Furnishings	1 (0+1)
	Interior designing and decoration II	1 (0+1)
Early Childhood Care and Education - II	Management of ECCE centre	1 (0+1)
	Monitoring and evaluation of ECCE centre	1 (0+1)
Communication Technology and Journalism - II	Audio and Video Recording	1 (0+1)
	Instructional Video Production	1 (0+1)

Module on Food Service Management - II

Food Preservation and Storage –I 1 (0+1)

Objectives

i. To learn different methods of preservation and storage of various foods
ii. To know the factors affecting shelf life of preserved foods

Practical

Market survey of raw and preserved foods. Selection, purchase and storage of perishable, non -perishable and semi perishable foods for preservation. Preservation by bacteriostatic methods - drying, dehydration, use of high temperature, sterilization, blanching, pasteurization, canning, ultra-heating. Preparation of products cereals and starches. Papads: wheat, maize or other cereal

grain, sago papad and other regional preparations. Fryums, rolls and other snack items. Preservation of products using pulses: Papads: mung dal, chana dal, urad dalor other pulses, badi, mungodi etc. andother regional preparation. Drying of fruits and vegetables: Leafy vegetables: spinach, fenugreek leaves, coriander, bathua, Other vegetables: peas, beans, tomatoes, lady fingers, cluster beans, bitter gourd etc., Roots and tubers: potato chips, onion flakes. Fruits: ber, grapes, raw mangoes, banana powder. Sterilization, bottling, corking, blanching. Preparation of products using natural preservatives: Sugar, squashes - lemon, orange, grapes, guava, custard apple, amla, ber, jamun, mix fruits etc. Sugar syrups: Lemon, orange, grapes, guava, rose, kewda etc. with use of low temperature, chilling, freezing, other recent methods in preservation. Preparation of products using natural preservatives Sugar –Squash, Cordial, Syrups, candies, Jam, Jellies, Preserves Murabba, Oil and Salt, Vinegar - pickles with and without oil, Chutneys, other chemical preservatives – Sauces, purees. Storage of perishable, semi perishable and non -perishable foods. Antimicrobial agents, Biological agents, nonionizing and ionizing radiations in preservation of foods. Hurdle technology. Packaging and packaging material, Labelling and costing of the products. Visit of storage go downs –FCI and others.

Suggested Readings

1. Jood S and Khetarpaul N. 2002. *Food Preservation*. 263p. Geeta Somani Agrotech Publishing Academy, Udaipur.
2. Kalia M and Sood S. 2010. *Food Preservation and Processing*. (Revised Edn.). 429p. Kalyani Publishers, New Delhi.
3. Potter N N. 1996. *Food Science*. 608p. The AVI Publishing Company, Inc., Westport, Connecticut.
4. Sehgal S, Grewal R B, Kawatra A and Kaur Y. 1997. *Practical Aspects of Food Preservation*. Directorate of Publications, Haryana Agricultural University, Hisar.
5. Sivasankar B. 2002. *Food Processing and Preservation*. 372p. PHI Learning Pvt. Ltd., Delhi.
6. Vijay K. 1999. *Text book of Food, Storage and Preservation*. 768p. Kalyani Publishers, New Delhi.

Food Preservation and Storage -II 1 (0+1)

Objectives

i. To learn the techniques of preservation and storage of fruit and vegetables
ii. To learn the prevention of contamination of food from damaging agents

Practical

Preparation of Jam, Jellies, Preserves, Murabba, Candies, Marmalades. Preservation by using Oil, Salt and Vinegar. Pickles with and without oil – Mango, amla, lemon, green chilli, mix vegetables, fresh turmeric, garlic, gonda, carrot. Pickles using other chemical preservatives – Chutneys, purees. Fermented pickles. Ketchups and sauces. Freezing of fruits and vegetables. Concentration of fruit juices. Hurdle technology. Use of anti -microbial agents, food additives and preservatives. Methods of storing preserved foods, prevention of food spoilage. Packaging and packaging material. Labeling and costing of the product. Demonstration on bottling, pasteurization, canning, ultra- heating. Demonstration on ionizing and non- ionizing Irradiation in foods, ohmic heating. Visit to food processing plant.

Suggested Readings

1. Jay J M , Loessner M J and Golden D A. 2006. *Modern Food Microbiology*. (7th Edn.). 782p. Food Science Text Series. Springer-Verlag New York Inc.
2. Jood S and Khetarpaul N. 2002. *Food Preservation*. 263p. Geeta Somani Agrotech Publishing Academy, Udaipur.
3. Kalia M and Sood S. 2010. *Food Preservation and Processing*. (Revised Edn.). 429p. Kalyani Publishers, New Delhi.
4. Kyzlink V. 2003. *Principal of food preservation*. (2nd Edn.). 598p. Elsevier press.
5. Potter N N. 1996. *Food Science*. 608p. The AVI Publishing Company, Inc., Westport, Connecticut.
6. Sehgal S, Grewal R B, Kawatra A and Kaur Y. 1997. *Practical Aspects of Food Preservation*. Directorate of Publications, Haryana Agricultural University, Hisar.
7. Sivasankar B. 2002. *Food Processing and Preservation*. 372p. PHI Learning Pvt. Ltd., Delhi.
8. Vijay K. 1999. *Text book of Food, Storage and Preservation*. 768p. Kalyani Publishers, New Delh

Module on Fashion Designing - II

Fashion Illustration 1 (0+1)

Objective

To gain knowledge on fashion illustration and development of design studio

Practical

Human Body and body proportion theory. Preparation of fashion figure. Drawing 10 and 12 headed fashion figure using geometric body shape. Figures in different poses. Drawing of facial features- eyes, nose and lips. Proportion of body parts- head, face, hand and feet according to different age group. Sketching figures of different age group based on head theory. Sketching of garment features minimum three: collars, neckline, fasteners, sleeves, pockets, cuffs and hemline.

Sketching of added fullness: frills, flounce, gather and pleats. Sketching of accessories: hats, shoes, boots, belts and purses. Designing of garments for adult and child -Male and Female. Illustration of fabric design and texture using different media -water colour, pencil colour, collage, poster colour and crayon colour. Theme based Portfolio development through CAD.

Suggested Readings

1. Allen and Seaman. 1994. *Fashion drawing- The Basic Principles*. 112p. B. T. Batsford, London.
2. Berthoud F. 2011. *Francois Berthoud Studio: The Art of Fashion Illustration*. (Bilingual Edn.). 240p. Hatje Cantz.
3. Bina A. 2012. *Fashion Sketchbook*. (4thEdn.). 440p. New York. Fairchild books.
4. Brambatti M. 2017. *Fashion Illustration and Design: Methods and Techniques for Achieving Professional Results*. 240p. Promo press publishing.
5. Hart C. 2013. *Fashion Design Studio: Learn to Draw Figures, Fashion, Hairstyles and More (Creative Girls Draw)*. 128p. Illustrated Edition. Sterling.

6. Ireland P J. 1970. *Fashion Design Drawing*. 128p. B.T. Batsford Ltd. London.
7. Ireland P J. 1980. *Basic Fashion Design*. 128p. B.T. Batsford Ltd. London.
8. Ireland P J. 1974. *Fashion Drawing for Advertising*. 128p. B.T. Batsford Ltd. London.
9. Kathryn K C and Munslow J. 1997. *Illustrating Fashion*. 272p. Blackwell Science, Oxford.
10. Kiper A. 2011. *Fashion Illustration: Inspiration and Technique*. 144p. David and Charles publishing.
11. Riegelman N. 2012. *9 heads: A Guide to Drawing Fashion*. 492p. Nine heads media. 2006.

Portfolio Development 1 (0+1)

Objectives

i. To impart practical skills for developing theme based portfolio
ii. To make students understand the importance and significance of Portfolio Development through CAD

Practical

Introduction to CAD. Different advanced software used in fashion industry. Portfolio preparation- Definition, types and importance. Contents of portfolio. Different portfolio presentation, skills and material management. Experimenting and creating a story board. Steps to do forecasting, Mood board, client board and colour board, swatch board, Illustrations and Flat sketches. Production of Spec sheet and costing. Development of Logo, Hang tags, Concept board. Role of fashion illustrator and career opportunities. Theme based Portfolio development through CAD.

Suggested Readings

1. Barrett J C. 2012.*Designing Your Fashion Portfolio: From Concept to Presentation. (*Nil Edn.). 400p. Bloomsbury Publishing India Private Limited;
2. Drake and Ireland P J. 1996. *Fashion Design Drawing and Presentation.* 120p. B. T. Batsford, London.
3. Greenwood M and Murphy M F. 1978.*Fashion Innovation and Marketing*. 312p. Macmillan Publishing Company, New York.
4. Hart C. 2013.*Fashion Design Studio: Learn to Draw Figures, Fashion, Hairstyles and More (Creative Girls Draw)*. 128p. Illustrated edition. Sterling.
5. Stone E and Sample J A. 1985.*Fashion merchandising- An Introduction*. (4th Edn.). 438p. MacGraw-Hill Book Company, New York.
6. Tate S L and Edwards M S. 2006. *Inside Fashion Design*. 476p. Pearson Education India.

Module on Interior Design and Decoration – II

Interior Accessories and Furnishings 1 (0+1)

Objectives

i. Design and develop furnishings for different areas in the interiors
ii. Design and develop accessories used for decorating interiors

iii. Identify different types of accessories and furnishings used in interiors, along with their use and features

iv. Understand how accessory and furnishing designing can be taken up as an entrepreneurial activity

Practical

Identifying different accessories, their use, placement, and features. Market Survey to study the design features and financial aspects of different interior accessories. Understanding the application of art elements and design principles for designing accessories. Exploring and selecting different art media for designing and developing a functional/decorative accessory: mud/ clay/ paper/ glass/ fabric/ wood/ MDF/ painting/ printing. Designing and preparation of accessories suitable for different types of staircases, table decoration, floor decoration. Interior landscaping: Exploring its importance and different plants used in interiors. Applying Vastu Shastra in selection and placement of accessories. Identifying different furnishings, their use, placement, suitable materials and features. Market Survey to study the design features and financial aspects of different interior furnishings. Understanding the application of art elements and design principles for designing furnishings for residential and commercial spaces. Exploring Indian handicrafts, paintings, embroideries, printing techniques etc. and application of feasible techniques in designing accessories and furnishings. Cost estimation, Sale of products and Self. Evaluation.

Suggested Readings

1. Chopra T. 2006. *Exotic Indian Interiors.* 216p. Prakash Books India Pvt. Ltd, New Delhi, India.
2. Gates E T. 2014. *Elements of Style: Designing a Home and a Life.* 336p. Simon and Schuster, New York, USA.
3. Jaity J. 2012. *Crafts Atlas of India: Special Edition*. 464p. Niyogi books, New Delhi, India.
4. Massey A. 2020. *Interior Design Since 1900.* (4th Edn.). 256p. Thames and Hudson, London, UK.
5. Wilson H. 2001. *India: Decoration - Interior - Design.* 160p. Watson-Guptill Publishers, New York, USA.

Interior Design and Decoration II 1 (0+1)

Objectives

i. To understand the concept of wall and floor treatment

ii. To understand basic principles of acoustical insulation to interior spaces

iii. To impart knowledge on working and managing of interior design as professional practice

Practical

Application of elements and of principles of design. Colour concept: colour schemes and its cost estimation, colour scheme for problematic area. Curtains and draperies. Types of curtain material and hardware's, and it's costing. Lighting. Types of light fixture, use of lights and lamps, lighting plan for problematic area. Floor treatments and its type. Wall treatment and its types. Accessories for interiors. Materials used for interior designing and decoration. Indoor landscaping.

Flower arrangements. Auto CAD for interiors. Visit to any residential and commercial building to study about materials used for interior designing and decoration.

Suggested Readings

1. Ch'ing, Francis D K, Binggeli, Cork. 2004. *Interior Design Illustrated.* 336p. Wiley Publications, New Jersey.
2. Claffey B. 2017. *Indoor Green: Living with Plants.* (1st Edn.). 206p. Thames and Hudson.
3. Cremer L. 2016. *Principles and Application of Room Acoustics.* 670p. Peninsula Publishing.
4. Drpic I D. 1988. *Sketching and Rendering of Interior Space.* 176p. Watson – Guptill.
5. Dechiara J, Panero J and Zelnik M. 2011. *Time Saver Standards for Interior design and Space Planning.* 1689p. McGraw Hill, London.
6. Dechiara Joseph and Panero Julius. 2001. *Standards for Interior Design and Space Planning.* 1689p. McGraw Hill Professional.
7. Faulkner S and Faulkner R N. 1968. *Inside Today's Home.* 592p. Holt, Rinehart and amp; Winston.
8. Maureen M and Courtney N. 2016. *Residential Interior Design - A Guide to Planning Spaces.* (3rd Edn.). 288p. Wiley Publication.
9. Keeping M and Shiers D. 2017. *Sustainable Building Design: Principles and Practice.* (3rd Edn.). 200p. Wiley Blackwell.
10. Piotrowski C M. 2016. *Designing Commercial Interiors.* (3rd Edn.). 576p. John Willey Publishers.
11. Pratap R M. 2012. *Interior Design Principles and Practice.* 121p. Standard Publications, Delhi.
12. Seetharam P and Pannu P. 2009. *Interior Design and Decoration.* (3rd Edn.). 703p. CBS, New Delhi.

Module on Early Childhood Care and Education – II

Management of ECCE Centres 1 (0+1)

Objectives

i. To gain practical experience in monitoring the different early childhood care and education centres

ii. To develop skills for management of early childhood care and education program

iii. To provide practical experience in monitoring an early childhood education centre in urban and rural areas

Practical

Principles of management – Theories of management. Benefits of using management theories. The seven theories. Scientific management theory. Principles of administrative management theory. Bureaucratic management theory, human relations theory, systems management theory, contingency management theory and theory of X (authoritarian) and Y (participative). Motivation. Maslow's theory, McClleland theory, McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory - Goal setting. Locke and Latham Goal setting principles, essential elements in goal setting. Framing administrative policies for ECCE center: elements in administrative policies. Conducting mock

interviews for selection of various staff members, and framing criteria for their selection. Budget provisions for various ECCE centres. Short term and long budget term planning, cost of operation, expenditure on equipment, salaries and other benefits to staff, maintenance of daily, weekly and monthly accounts. Preparing a plan to meet emergencies.

Suggested Readings

1. Brophy J E, Good T I and Nedler S E. 1975. *Teaching in the Preschool*. Harper Row publisher, New York.
2. Day B. 1983. *Early Childhood Education: Creative Learning Activities*. 447p. Macmillan Publishing Co., Inc, New York.
3. Lan F J and Kissinger J B. 1976. *The Young Child and The Educative Process. 390p.* Holt, Rinehart and Winston, New York.
4. Grewal J S. 1984. *Early Childhood Education: Foundations and Practice*. 363p. National Psychological Corporation, Agra.
5. Kuppuswamy B. 1990. *Child Behaviour and Development*. 265p. Konark Publishers Pvt. Ltd., New Delhi.
6. Leeper S H, Skipper D S and Witherspoon R L. 1979. *Good Schools for Young Children*. 528p. Macmillan Publishing Co. Inc., New York.
7. Morrison G S. 1998. *Early Childhood Education Today.* (7th Edn.). 596p. Merril, an imprint of Prentice Hall, Upper Saddle River, New Jersey Columbus, Ohio.
8. Murlidharan R and Banerji V. 1991. *A Guide for Nursery School Teachers*. 99p. National Council of Educational Research and Training, New Delhi.
9. Mohanty J and Mohanty B. 2007. *Early Childhood Care and Education*. 230p. Deep and Deep Publications Pvt. Ltd., New Delhi.
10. Sinha A.2005. *Manual of Early Childhood Education*. Print Palace, Agra.
11. Taraporevala R and Chhugani N. 2002. *Early Childhood Years- Handbook for Parents and Teachers.* English Edition Publishers, Mumbai.
12. Singh B. 1997. *Preschool Education*. 249p. APH Publishing Corporation, New Delhi.
13. Swaminathan M. 1991.*Play Activities for Young Children.* 214p. P.S. Press Service, Pvt. Ltd, New Delhi.
14. Seefeldt C and Barbour N. 1994. *Early Childhood Education – An introduction*. 614p. Maxwell Macmillan, Canada.

Monitoring and Evaluation of ECCE Centres 1 (0+1)

Objectives

i. To learn to monitor the ECCE programme

ii. To learn about the regulations of standards for Quality of ECCE centre

Practical

Concept of quality and minimum regulations in early childhood education. Important factors to consider in quality. The four dimensions are: those of society, the child, the teacher and the learning context. Four dimensions in quality assessment such as the society, the child, the teacher and the learning context. Concept of evaluation and monitoring. Defining the concepts. Monitoring and evaluation of budget distribution for ECCE activities. Monitoring admissions of children. Monitoring and evaluation of lesson plans. Monitoring and evaluation of classroom practices. Monitoring and evaluation of children's assessment. Monitoring and evaluation of staff supervision and performance. Characteristics of ideal child care supervisors and teachers, their qualifications and training. Monitoring and evaluation of adult and child spaces and their arrangements and utilization. Monitoring and evaluation of service activities such as cleanliness, feeding, health care. Monitoring, use and evaluation of teaching. Learning equipment and material. Monitoring and evaluation of record keeping. Awareness of national and international organisations working for ECCE.

Suggested Readings

1. Mohanty J and Mohanty B. 2000. *Early Childhood Care and Education*. 230p. Deep and Deep Publications Pvt. Ltd., New Delhi.
2. Murlidharan R and Banerji V. 1969. *A Guide for Nursery School Teachers*. 99p. National Council of Education Research and Training, New Delhi.
3. NAEYC (National Association for the Education of Young Children). 2022. *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth Through Age 8*. (4th Edn.). 400p. NAEYC, Washington, DC.
4. Jaipaul R and Johnson J E. 2015, *Approaches to Early Childhood Education*. (5th Edn.). 448p. Pearson India.
5. Sue D, Leone A, Sue F, Bronwyn B and Deth E. 2017. *Programming and Planning in Early Childhood Setting*. 448p. Cengage Australia.

Module on Communication Technology and Journalism - II

Audio and Video Recording 1 (0+1)

Objectives

i. To impart skills in handling video camera and camera support systems
ii. To provide technical exposure to shooting
iii. To build competency in planning, writing and shooting basic video production script, story board and camera script
iv. To impart skill in audio and video recording, editing and mixing

Practical

Visit to NAARM /Electronic wing of university. Exposure to different types of cameras. Care and maintenance of cameras. Familiarization of video camera and parts of video camera. Familiarization with other accessories of video camera. Changing and loading battery pack. Handling of camera support systems. Handling of video camera –home video camera and Practicing video camera with white balance. Handling compositions of video camera. Handling of VHS camera and

advanced professional cameras. Practical exercise on focusing. Zooming and shooting. Planning of different camera positions - long shot, medium shot, close up, zoom. Tilting and panning. Lighting Techniques and moods. Familiarization of drone camera and its parts. Handling and operation of drone cameras. Practical exercise on different types of video scripts. Basic production script, story board script, camera script. Planning script for video program - one minute program. Planning script for documentary production and drama. Script writing for documentary and drama – storyboard. Shooting with different camera positions in outdoor- long shot, medium shot, close up and zoom. Shooting with different camera positions in Outdoor - tilting and panning. Exposure to audio recording equipment's. Handling of audio editing software. Sound - Audio recording and voice dubbing. Sound - Audio mixing, Presentation of produced program.

Suggested Readings

1. Wetzel Alan. 1985. *Television production McGraw*. 704p. Hill Book Company New York S - New Delhi.
2. Glyn Arkin. 1975. *Television Sound Operation*. Hunting house New York McGraw-Hill Book Company New York S -- New Delhi.
3. Herbert Zettle. 2010. *Video Basics*. 432p. Wadsworth Publishing, Belmont, California.
4. John Eargle. 1980. *Sound Recording*. 355p. Van Nostrand Reinhold Now.
5. Millerson Gerald and Owens Jim. 2008. *A Hand book of Video Production.* 352p. Butterworth-Heinemann, Oxford.
6. Millerson Gerald and Owens Jim. 2009. *Television Production*. 399p. Focal Press, London.

Instructional Video Production 1 (0+1)

Objectives

i. To impart skills in handling video camera and camera support systems
ii. To provide technical exposure to shooting
iii. To build competency in mobile editing applications
iv. To impart skill in linear and non-linear editing techniques
v. To get familiar with the video editing open-source software

Practical

Hands on experience of DSLR and video camera. Familiarization of open source software for video editing. Familiarization of open source software for audio editing. Video editing with using of smart phones (mobile) in mobile apps. Synchronization of audio in video editing smart phones (mobile). Familiarization of exporting final video output in mobile apps. Familiarization of creating videos using images and text. Designing of video titles with using adobe photoshop(text). Importing text titles from photoshop in video editing. Familiarization of voice recording techniques with using of smart phones (mobile). Practicing – installing of video and audio software into desktop computer. Practicing – installing of audio recording equipment with sound card. Advanced techniques of exporting of final video for different formats and sizes. Advanced video editing techniques – voice synchronization to video with using advanced software. Working with video libraries and graphics libraries. Recording techniques - video and audio online and offline editing. Recording techniques - video and audio linear editing and video and audio nonlinear editing. Editing of the recorded

outdoor program by non-linear editing. Importing video - working methods of offline video editing. Advanced techniques of editing-cut-mix with advanced software etc. Using graphics and animation in video production. Application of open-source software–gimp, blender. Open Broad Casting Software (OBS). Google sketch up and any other. Presentation of produced program.

Suggested Readings

1. *Television Production.* 399p. by Gerald Millerson.
   https://archive.org/details/televisionproduc0000mill_y2t1.
2. *Editing Digital Video: The Complete Creative and Technical Guide (Digital Video and Audio)* by Robert M. Goodman, Patrick McGrath
3. https://onlinecourses.swayam2.ac.in/ntr21_ed09/preview
4. *Computer Graphics and Animation*. book pdf
   http://cs.wellesley.edu/~cs110/lectures/M01-color/graphics.pdf
5. *Learning Modern 3D Graphics Programming*. book pdf
   https://www.docdroid.net/UKocmTz/arcsynthesis.pdf.html#page=194
6. *Blender master class*. book pdf
   http://dl.finebook.ir/book/9e/11032.pdf
7. *A Basic Tutorial of Blender* https://www.cs.auckland.ac.nz/~jli023/opengl/blender3dtutorial.htm
8. *Camp Blender*
   http://web.engr.oregonstate.edu/~mjb/blender/blender.1pp.pdf
9. Using Sketch Ups
   http://web.engr.oregonstate.edu/~mjb/sketchup/sketchup.1pp.pdf

Post-IV Semester

Internship (only for exit option for award of UG-Diploma) 10 (0+10)

Objectives

i. To integrate theory and practice
ii. To assess interests and abilities in their field of study
iii. To develop work habits and attitudes necessary for job success
iv. To develop communication, interpersonal and other critical skills for job interview process
v. To explore career alternatives prior to graduation

Activity

The students will have internship/ training for 10 weeks' duration either in the institute or in industry or related organisations. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students.

The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

Semester V

Human Physiology 3 (2+1)

Objectives

i. To acquire knowledge about human physiology, structure of different system and mechanism of human body

ii. To learn knowledge regarding organ system and Integration of the organ systems to maintain proper internal environment

Theory

Physiological process - Introduction. Structural basis of human body – cells and their functions. Structural basis of human body – tissues and their functions. Skeletal system. Joints. Muscular system- Function. Nervous system - Functions of brain. Functions of spinal cord. Nerve impulse reflexes. Physiology of digestion. Digestive enzymes and their functions. Functions of liver. Absorption from the intestine. Composition and functions of blood. Composition and functions of lymph. Structure of heart and course of blood circulation. Blood pressure and factors affecting blood pressure. Pulse rate and heart sounds. Intracellular and extracellular water compartment. Mechanism of respiration. Respiratory rates. Volume and transport of gases. Physiology of kidney. The location, secretions and function of various endocrine glands-pituitary, thyroid, parathyroid. The location, secretions and function of various endocrine glands – adrenal, testes, ovaries. The location, secretions and function of various endocrine glands –Pancreas, Placenta, pineal gland. Male reproductive organs and their functions. Female reproductive organs and their functions. Pregnancy. Changes in the mother. Fertilization. Development of foetus. Lactation.

Practical

Demonstration of animal viscera. Identification of systems and organs Identification of cells – epithelial muscle, skeletal system, nerves etc. Transverse section of stomach Intestine– small and large demonstration of specimens of spleen Kidney and brain models of excretory and reproductive organs. Estimation of RBC and WBC count by heamocytometern. Estimation of hemoglobin in mammalian blood. Estimation of bleeding and clotting time and blood groups. Demonstration of differential counting of WBC using peripheral smear, T.L.C. and D.L.C. PCV ESR, micro and macro heamatocrit. Measurement of pulse rate and blood pressure Its variation with exercise. Heart beat and Heart sound. Testing for sensation Special sensors. Measurement of body temperature. Demonstration/Estimation Respiratory quotient Inspiration Expiration and measurement of O2 and CO2 at various partial pressure in lungs.

Suggested Readings

1. Best C and Taylor N B. 1979. *Physiological Basis of Medical Practice*. 1437p. Igaku-Shoin Ltd., Tokyo.

2. Chaterjee C C. 2012. *Human Physiology*. (Vol. I & Vol. II). 592p. CBS Publications.
3. David F, Stacia B M and Charles L S. 1993. *Human Physiology Foundations and Frontiers. (*2nd Edn.). 880p. Mosby Pub.
4. Donnersberger A B and Scott A L. 2005. *Laboratory Textbook of Anatomy and Physiology. (*8th Edn.). 512p. Jones and Bartlett Learning, Burlington, Massachusetts.
5. Ganong W F. 1995. *Review of Medical Physiology*. 781p. Prentice Hall.
6. Hall J E. 2016. *Guyton and Hall Text Book of Medical Physiology. (*13th Edn.). 1168p. Elsevier, India.
7. Jain A K. 2009. *Human Physiology for BDS. (*3rd Edn.). 594p. Avichal Publishing Company, New Delhi.
8. Marieb E N and Hoehn K. 2004. *Human Anatomy and Physiology*. (6th Edn.). 1564p. Pearson Education, Inc., London.
9. Waugh A and Grant A. 2014. *Ross and Wilson Anatomy and Physiology in Health and Illness. (*6th Edn.). 1094p. Elsevier Ltd, Churchill Livingstone, London.

Food Hygiene and Sanitation 1 (1+0)

Objectives

i. To enable the students to know the significance of hygiene and sanitation in maintenance of health
ii. To learn the importance of maintaining personal and food hygiene

Theory

Concept, significance and interrelationship of health, hygiene and sanitation. Principles of food hygiene. Food safety hazards: chemical, physical, effect of food composition. Beneficial and harmful microorganism in foods: an introduction. Food hygiene-Public health hazards due to contaminated foods. Food borne infections and intoxication, symptoms, sources and modes of transmission and method of prevention and control. Personal hygiene of food handler. Characteristics of good health and hygienic habits to promote good health. Toxins in foods: Naturally occurring, External. Effect of environmental pollution on food safety. Waste disposal. Water pollution, purification of water, quality criteria and standards of portable water.

Suggested Readings

1. Bedi Y P. 1970. *A Handbook of Hygiene and Public Health*. 524p. Atma Ram and Sons Publication, New Delhi.
2. Gibney M J, Margetts B M, Kearney J M and Arab L (Eds). 2004. *Public health Nutrition*. 392p. The Nutrition Society Blackwell Science, Oxford.
3. Frazier W C and West Hoff D C. 1988. *Food Microbiology*. (4th Edn.). 539p. Tata McGraw Hill Inc., New Delhi.
4. Jacob M. 1989. *Safe Food Handling: A Training Guide for Managers of Food Service Establishment*. 148p. WHO, Geneva.
5. Marriott N G. 1985. *Principles of Food Sanitation*. 369p. Van Nostrand Reinhold Publication, New York.
6. Park K. 2000. *Text book of Preventive and Social Medicine- A Treatise on Community Health*. (16th Edn.). 200p. Banarasidas Bhanot Publication, Jabalpur.
7. Srivastava A. 2013. *Food Hygiene and Sanitation.* 315p. Neha Publishers and Distributors.

Techniques of Fabric Construction 3 (1+2)

Objectives

i. To acquire an understanding of loom and knitting machine
ii. To develop skill in making different types of weaving and knitting
iii. To acquaint with the various fabric construction methods

Theory

Introduction of different types of fabric construction techniques woven fabrics, Simple and compound woven structures. Characteristics of woven fabric. History of weaving and looms. Classification of looms on the basis of mechanism, means of running loom, structure and means of weft insertion. Parts of loom, loom accessories and their functions (Mechanism of weaving: primary, secondary and tertiary motions). Basic weaves: Plain, twill, satin and their variations. Complex/ Fancy weaves: extra yarn fabrics, pile fabrics, leno weave, dobby and jacquard weave. Knitting: principle of knitting, types of knitting machines, their parts and functions. Knitting stitches: warp and weft knits, types of knit fabrics. Nonwoven Fabrics: Manufacturing process, characteristics and end uses.

Practical

Observation of fabric structures– Woven, knitted and nonwoven fabrics. Collection of fabric samples of different types of basic and fancy weave and their identification. Manual representation of woven design on graph sheet – plain weave, rib weave, basket weave, twill weave, satin and sateen weaves. Handloom and its parts. Observation of loom setting, weaving calculations and yarn preparation and making a plain weave sample on loom. Introduction and practice to various tools used in CAD weave software. Representation of basic weaves (plain, rib, basket, twill and satin) using textile design software. Hand knitting- two needle method, holding the needles and the yarn, casting on and knitting of plain, rib and purl knit sample. Knots of macramé. Stitches of crochet. Manual felting. Visit to weavers service centre/textile industry for observation of weaving/knitting mechanism/finishing of fabrics.

Suggested Readings

1. Gokarneshan N. 2020.*Fabric Structure and Design*. (3rd Edn.). 184p. New Age International Private Ltd.
2. Hollen N and Saddler J. 1968.*Textiles*. 256p. Macmillan Company, New York.
3. Joseph M L. 1986.*Introductory Textile Science*. (5th Edn.). 464p. CBS College Publishing, New York.
4. John G. 1999.*World Textiles: A Visual Guide to Traditional Techniques*. 240p. Thames &Hudson publications.
5. Kadolph S J. 2013.*Textiles*: *Pearson New International Edition*. 596p. Pearson Education Ltd, Asia.
6. Kaur N. 2011.*Fashion Concepts. Comdex: Fashion Design* (Vol. I). 846p. Dream Tech Press.
7. Labarthe J. 1964.*Textiles: Origins to Usage*. 562p. McMillan Company Ltd., New York.
8. Potter M D and Corbman B P. 1967. *Textiles: Fibre to Fabric*. 495p. McGraw Hill Co., New York.

9. Vatsala R. 2003. *Textbook of Textiles and Clothing*. 448p. Indian Council of Agricultural Research, New Delhi.
10. Wynne A. 1997.*Textiles the Motivate Series*. 320p. Macmillan Hill Co.
11. https://textilelearner.net/application-of-cad-in-textile/.
12. https://www.slideshare.net/mjrtipu/different-software-use-for-textile-design.
13. https://textilelearner.net/best-textile-design-software/ .

Principles of Textile Designing 3 (0+3)

Objectives

i. To impart knowledge about textile designs and process of applied designing
ii. To inculcate ability to develop and arrange motifs into patterns for various articles

Practical

Introduction to textile designing (Basic process of textile designing), skills and qualities required in textile designer. Classification of textile designs and methods of producing designs on textiles: Structural designs through yarn manipulation, weaving, knitting and other techniques and decorative designs through printing, dyeing, painting, finishing, embroidery and appliqué work. Elements of design: Line, shape, space, form and colour (Drawing various types of lines, shapes and forms. Colour: Colour wheel, value and intensity charts, related and contrasting colour schemes. Concept of positive and negative design space). Principles ofdesign: Balance, rhythm, proportion, emphasis and harmony (Proportion: Planning of basic shapes, scale of shapes and forms, division of space, creating optical illusion with lines and shapes. Balance: Creating formal and informal balance in design. Rhythm: Creating rhythm through repetition, progression, radiation and gradation of colour and pattern. Emphasis: Creating emphasis in design by the use of contrast of hue, value, line, shape and size and use of spacing around motif. Harmony: Harmony of line, shape, size, colour and texture in a design). Software for textile designing. Motif and its geometry (Motif as basic unit of design: selection of components of motif, motif development, symmetrical and asymmetrical motifs and their arrangements, Geometry involved in basic textile designing: translation, rotation, reflection and glide reflection, Pattern arrangements with motif in different repeats). Tools and menu of CAD software and its use for motif development. Development of patterns using different types of motifs (Developing geometrical/ abstract/stylized/naturalistic motifs and Pattern arrangements using different colour schemes to create variety in pattern). Use of CAD for pattern arrangement using different design repeat and colour schemes. Development of different types of border patterns. Preparation of swatch book: Fabric samples of different types of applied designs (dyed and printed fabrics).

Suggested Readings

1. Beitler E J and Lockhart B. 1961. *Design for You.* (2nd Edn.). John Wiley and Sons, Inc. New York.
2. Bhatnagar P. 2005. *Decorative Design History in Indian Textiles and Costumes*. 170p. Abhishek Publications, Chandigarh, India.
3. Broomer G F and Horn G F. 1977. *Art in Your World*. 282p. Davis Publications, Inc., Worcester, Massachusetts.

4. Evans H M and Dumesnil C D. 1982. *An Invitation to Design*. 358p. Macmillan Publishing Co. Inc., New York.
5. Gahlot M and Naik S D. 2014. *Principle of Design and Application*. E-Home Science Courseware Consortium (NAIP).
6. Goldstein H and Goldstein V. 1954. *Art in everyday life*. (4th Edn.). 515p. Macmillan Publishing Co. Inc., New York.
7. Graves M. 1951. *Art of Colour and design*. (2nd Edn.). 439p. McGraw- Hill Company, New York.
8. Miller J. 2003. *The Style Sourcebook*. 416p. Mitchell Beazley.
9. Naik S D and Wilson J A. 2006. *Surface Designing of Textile Fabrics*. 120p. New Age International (P) Limited Publishers, New Delhi.
10. Wilson, J. 2001. *Handbook of Textile Design: Principles, Processes and Practice*. 152p. Woodhead Publishing Limited, CRC Press, Cambridge.
11. Wilson, J. 2001. *Handbook of Textile Design*. 160p. Woodhead Publishing Series in Textiles. Elsevier
12. https://nios.ac.in/media/documents/srsec321newE/321-E-Lesson-29B.pdf.

    https://www.mathsisfun.com/geometry/index.htmlhttps://coe.hawaii.edu/ethnomath/wp-content/uploads/sites/12/2019/10/Geometry-Translations-Rotation-Reflection-and-Dilations-in-Ethnic-Patterns-and-Designs.pdf.
13. https://teachers.yale.edu/curriculum/viewer/initiative_10.04.09_u.

    https://en.wikipedia.org/wiki/Textile_design.
14. https://www.emis.de/monographs/Isometrica/isometrica-2.pdf.
15. https://condor.depaul.edu/ppereira/sym/Notes/Seven.pdfhttps://silo.tips/download/borders-decorative-borders-are-everywhere-an-expression-of-the-pleasure-we-findhttps://math.okstate.edu/geoset/Projects/Borders/howclass.htm.

Consumer Education 3 (1+2)

Objectives

i. To create awareness on the importance of consumer education and management at individual and family levels
ii. To understand the financial levels at banking, crediting etc. by the consumer
iii. To create awareness among the consumers about their problems, rights, responsibilities and food adulteration and durable goods
iv. To identification of food adulterants
v. To learning about the calculations of income tax, cost of credit, installment buying etc.
vi. To practical applications of consumer redressal forum

Theory

Consumer: definition, types, characteristics of Indian consumers. Consumer problems and vulnerability at market place. Consumer rights and responsibilities. Guidelines for good buying: durable and nondurable goods, house/apartments. Consumer service providers. Consumer

movement in India. Consumer Protection Act and its constituent Acts in consumer welfare, consumer welfare organizations. Consumer redressal forum. E-consumerism.

Practical

Understanding and identification of consumer problems related to Weights and Measures, ATM and credit cards, Banking services. Collection and detection of food samples for adulteration – Spices– Milk and Milk Products, Ghee and oils. Collection and detection of food samples – Rice and Dhals. Reviewing of Misleading, advertisements through print media. Reviewing of Misleading advertisements through electronic media. Evaluation of consumer products. Visit to consumer protection Organizations. Review of case studies of consumer disputes redressed. Planning for exhibits on consumer education. Preparation of exhibits for consumer education. Organizing exhibition for consumer education and e- consumerism.

Suggested Readings

1. Clarke J, Newman J, Smith N, Vidler E and Westmarland L. 2007. *Creating Consumers.* 192p. Sage Publications, New Delhi.
2. Eastwood D B. 1997. *The Microeconomics of Consumer Behaviour*. 269p. Dame Publications, INC, Houston.
3. Himachalam. 1998. *Consumer Protection and Law.* 213p. APH Publishing Corporation, New Delhi
4. Majumdar R. 2010. *Consumer Behaviour Insights from Indian Market.* 350p. PHI Learning Private Limited, New Delhi.
5. Mike L. 1986. *The Complete Interior Decoration.* 192p. Mc Donald, United Kingdom.
6. Rice N and Tucker. 1976. *Management in Family Finance.* 492p. John Wiley and Sons, New York.
7. Seetharaman P and Sethi M. 2002. *Consumerism Strategies and Tactics.* 320p. CBS Publishers and Distributors, New Delhi.
8. Verghese M N, Ugale W N and Srinivasan K. 1997. *Home Management. 224p.* New Age International, New Delhi:

Adolscent Development 3 (2+1)

Objectives

i. To understand the ways in which physical, cognitive, social, emotional, and personality development interact in development of adolescent

ii. To educate about the contemporary issues in adolescent development, challenges and issues

Theory

Meaning, significance, characteristics and developmental tasks, significance of the stage. Theoretical perspectives on adolescence –biological, psycho-analytical, psycho-social, social- cognitive and cultural , lifespan perspective, learning perspective, humanistic perspective, ecological perspective, socio cultural perspective, and the positive youth development perspective. Physical and sexual development in adolescence. Physical transition from child to adult, puberty

causes and changes. Psychological impact of puberty, early and late maturation and its psychological implications, body image and its psychological implications. Cognition during adolescence, theoretical perspectives on adolescent cognitive development, gender differences in mental abilities. Socio-emotional development during adolescence. Transition in emotions, heightened emotionality, common emotional patterns, coping mechanism, maturity and adjustment, early and late maturation and its psychological implications, socialization difficulties in social transition, social attitudes and behaviour, influence of peers, conformity and self-assertiveness. Identity development. Erikson's identity Formation theory. Marcia's Statuses Identity. Identity diffusion, identity foreclosure, identity moratorium, self-concept. Moral development during adolescence and value orientation – theoretical perspectives. Mental Health and resilience. Life skills and their importance. Challenges of adolescence sexuality, aggression, delinquency, understanding of AIDS, substance abuse, alcoholism, personality disorders, depression, suicide, eating disorders, health problems, psychological problems, social problems. Dating and relationships. Guidance and Counselling for adolescents– need and importance. Changing roles in family and society.

Practical

Survey on adolescent problems and conflicts. Attitude towards sexuality/substance abuse. Profile of behavioural problems through case study, gender issues of adolescence. Adolescents future planning and orientation study through interviews. Tests related to skills and abilities of adolescence: e.g., Adolescence Girl's Empowerment Scale. Differential Aptitude Test. Behaviour Problem checklist (CBCL). Problem solving ability test (PSAT) Guidance need inventory. Life Style Scale. Anecdotal records.

Suggested Readings

1. Berk L E and Meyers A B. 2010. *Infants, Children, and Adolescents.* (7th Edn.). 272p. Prentice Hall, PTR.
2. Conger JJ. 1977. *Adolescence and Youth: Psychological Development in a Changing World*. 700p. Harper and Row, New York.
3. Dandekar K. 1996. *The Elderly in India*. 229p. Sage Publications, New Delhi.
4. Hayslip B and Panek P. 1989. *Adult Development and Aging*. 618p. Harper and Row, New York.
5. Newman BM and Newman PR. 2009. *Development through Life: A Psycho Social Approach.* 720p. Cengage Learning, Boston.
6. Hazen E P, Goldstein M A, Goldstein M C. (2011). *Mental Health Disorders in Adolescents: A Guide for Parents, Teachers, and Professionals.* 337p. Rutgers University Press: New Brunswick, NJ.

Adulthood Development 2 (1+1)

Objectives

i. To acquaint students regarding the developmental areas of adults and its theoretical orientation
ii. To develop understanding of changes and adjustments in adulthood

Theory

Emerging adulthood, importance, stages, characteristics and conflicts. Meaning, characteristics and developmental tasks of adulthood, stages of adulthood. Principles of adult development. Four principles of adult development and aging. Theoretical and ecological perspectives of adult development: Psychosocial theory, Peck elaboration of Erickson, Levinson's theory, Sheehy's adult transition, Erikson's Psychosocial theory, Identity Process Theory, Activity Theory, Socio-emotional Selectivity Theory. Theoretical perspectives in adult development. Bio-psychosocial perspective, Ecological perspective, Life Course perspective. Klaus Riegel's Dimensions of Development Theory. Antecedent influences for growth and development during adulthood. Physical, motor, social, emotional, and cognitive and language characteristics of Early, Middle and Late adulthood. Personality development, happiness and satisfaction, life style choices, marriage and family transitions. Career, theories of career choice, Job satisfaction. Adjustments during adulthood: Menopausal adjustments, Empty nest, career changes, retirement, leisure. Health during adulthood and prevention of chronic diseases, physical and neuro-cognitive disorders. Old age: demography of old age, theories of biological aging. Old age: Care during old age. Antecedent influences for developmental changes during old age. Adjustment to death, widowhood, dying and bereavement. Counselling for adults and the aged – need and importance.

Practical

Administering of adulthood scales on personality. Preparation of interview schedule for adults on life satisfaction. Interviews on career satisfaction. Interviews on dual role burden for women. Case study on health condition. FGDs on ageing problems. Content analysis of films, books on adulthood conflicts and resolutions. Visits to institution of aged and their evaluation - record writing and presentation.

Suggested Readings

1. Dacey J S and Travers J F. 2002. Human Development - Across the Lifespan. McGraw Hill, Boston.
2. Dandekar K. 1996. The Elderly in India. Sage Publications, New Delhi.
3. Hayslip B and Panek P. 1989. Adult Development and Aging. Harper and Row.
4. Hurlock E B. 2003. Developmental Psychology - A Life Span Approach. Tata McGraw Hill, New Delhi.
5. Kail R V and Cavanaugh J C. 2004. Human Development - A Life-Span View. Thomson-Wadsworth, United States.

Project Management 3 (2+1)

Objectives

i. To develop understanding regarding project, project management and its techniques
ii. To develop skill in writing a project proposal

Theory

Project – Concept, characteristics and types. Project Management – Concept and elements. Phases of Project Life cycle- initiation, planning, execution, and closure. Formulation of Project Proposal- Concept and need. Elements of Project Formulation- Project Appraisal-Feasibility Analysis, Techno-Economic Analysis, Input Analysis. Financial Analysis. Cost- Benefit Analysis. Network Analysis. Project management techniques- PERT and CPM.

Practical

Visit to institutions managing following types of projects: Technology generation project. Transfer of Technology (ToT) project. Women entrepreneurship project. Women and child development project. Agriculture development project. Rural development project. Preparation of reports of the institutions visited. Presentation of report. Visit to state level funding agencies. Preparing reports of the funding agencies visited. Presentation of report. Preparation of a short-term project proposal. Presentation of project proposal. Working on project management techniques: PERT, CPM.

Suggested Readings

1. Goel B B. 2008. *Project Management- Principles and Techniques*. 430p. Deep and Deep Publications Pvt. Ltd. New Delhi.
2. Agarwal M R. 2010. *Project Management*. 480p. Garima Publications, Jaipur.

Study Tour- Non-gradial 2 (0+2)

To be conducted for 10-14 days after 5th semester.

The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organizations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ States and the social and cultural differences existing in the country. After the visit, the students will submit a report and make a presentation.

Semester VI

Nutritional Biochemistry 3 (2+1)

Objectives

i. To understand the relationship of chemical and physiological functions of various specialized cells of the body to their roles in metabolism and nutrition
ii. To describe the major pathways of energy metabolism, how they are regulated, modified during different physiological states and their consequences
iii. To understand the biochemical aspects of nutrients and utilization of nutrients in the body

Theory

Introduction: Definition, historical development, relevance for home science. Carbohydrates: Definition, classification, structure, Glycolysis, TCA cycle. Lipids: Definition, classification, structure, B-oxidation. Protein and amino acids: Definition classification, structure, path of entry of amino acids into metabolism, urea cycle. Role of vitamins and minerals in metabolism. Nucleic

acid: Nitrogenous base, nucleotides, DNA and RNA structure. Enzymes: Nature, classification, mechanism of enzyme action and factors affecting its inhibition, coenzymes and cofactors. Brief orientation of biochemical energetic and biological oxidation. Acid base balance.

Practical

Qualitative analysis of carbohydrates. Qualitative analysis of amino acids. Qualitative analysis of protein. Determination of acid value, saponification value and iodine number. Demonstration on estimation of nitrogen by Kjeldhal method. Demonstration on estimation of fat by Soxhlet method. Determination of pH.

Suggested Readings

1. Conn E E and Stumpf P K. 2002. *Outlines of Biochemistry*. 712p. John Wiley and Sons, New Delhi.
2. Deb A C. 1996. *Fundamentals of Biochemistry*. 932p. New Central Book Agency Pvt. Ltd., Calcutta.
3. Murray R A, Grammer D K, Mayes P A and Rodwell W. 1996. *Harper's Biochemistry*. 800p. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Rao R K. 1975. *Textbook of Biochemistry*. 581p. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Plummer D T. 1971. *Introduction to Practical Biochemistry*. 362p. Tata Mc-Graw Hill.

Human Nutrition 3 (2+1)

Objectives

i. To equip the students with basic knowledge about macro- and micro- nutrients and role in human nutrition
ii. To enable them to understand the rich sources, deficiency and toxicity of various nutrients

Theory

Historical development of nutrition. Definitions of terms used in nutrition -Nutrients, RDA, Daily Value, Balanced diet, Food pyramid, My plate, Glycemic index, Glycemic load, Food Security, Nutritional Security, BMR, BMI, health, functional foods, phytochemicals, nutraceuticles, dietary supplements. Energy, units, sources and requirements, fuel value of foods, methods of measuring energy value of foods, energy requirements of body, physical activity and thermogenic effects of foods, BMR and factors affecting methods of measuring BMR and measuring TEF. Macronutrients: classification, functions, sources, requirements, digestion, absorption of carbohydrates. Lipids, types, functions, sources, requirements, digestion, absorption and health conditions associated with lipids. Classification, functions, sources, requirements, digestion, absorption of proteins, classification and functions amino acids, health conditions associated with proteins. Fibre- types, source and importance in human health. Vitamins, classification, functions, sources, requirements, deficiency and toxicity of fat-soluble vitamins A, D, E and K and water-soluble vitamins C, B- complex- thiamine, riboflavin, niacin, folic acid, biotin pyridoxine and cyanacobalamine. Minerals, classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorous, magnesium, sodium, potassium, chloride, micro minerals, iron, iodine, fluorine, copper, zinc. Factors affecting

bioavailability of important minerals. Water, functions, sources, distribution in body, water and electrolyte balance.

Practical

Serving size of common dishes. Planning and preparation of nutrient rich dishes: protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin and ascorbic acid. Calculate calorie and cost of dishes prepared for above nutrients. Evaluation of three days energy balance. Planning and preparation of dishes based on simple processing techniques to improve bioavailability of nutrients, germination, fermentation, mutual supplementation. malting and others. Planning and preparation of low-cost nutritious recipes.

Suggested Readings

1. Agarwal A and Udipi S. 2014. *Text Book of Human Nutrition*. Jaypee Medical Publication, Delhi.
2. Gibney M J, Lanham-New S A, Cassidy A and Voster H H. 2019. *Introduction to Human Nutrition*. (3rd Edn.). Wiley-Blackwell Publication.
3. ICMR-National Institute of Nutrition. 2020. *Nutrient Requirement of Indians: A Report of the Expert Group*. ICMR.
4. Mann J and Truswell S. 2012. *Essentials of Human Nutrition*. (4th Edn.). Oxford University Press.
5. Sehgal S and Raghuvanshi R S. 2007. *Textbook of Community Nutrition*. ICAR Publication.
6. Srilakshmi B. 2018. *Nutrition Science*. (6th Edn.). New Age International Private Ltd Publishers, New Delhi.

Traditional Textiles and Costumes of India 3 (2+1)

Objectives

i. To learn the characteristic features/designs of the traditional textiles and costumes of different states of the India
ii. To learn the characteristic features of the traditional textiles and style in costumes of different states of the India
iii. To develop an understanding of the classification of traditional textiles based on the process of making it
iv. To develop an understanding of the methods and materials used in processing and production for different categories of traditional textiles
v. To develop an understanding of the techniques of traditional embroideries, prints and woven textiles
vi. To inculcate skill for adaptation of traditional textiles' designs and costumes' styles in contemporary textiles and apparels

Theory

Historic perspective, classification and importance of traditional Indian textiles and costumes in Textiles and Apparel industry. Introduction of Textile Arts -Embroideries, rugs, carpets, shawls, sarees and wraps. Factors affecting diversity of textiles and costumes of India: Geographical factors, socio-economic factors, customs, traditions and religious factors. Impact of adaptation of traditional

motifs and costumes in contemporary apparel designing. Traditional Indian costume of Northen India- Jammu and Kashmir, Punjab and Haryana. Western India- Rajasthan, Gujrat and Maharashtra, Southern India-Andhra Pradesh, Tamil Nadu, Kerala and Karnataka. Eastern India-Orissa, West Bengal, Assam, Nagaland, Meghalaya, Manipur, Arunachal, Mizoram, Tripura. Central India-Uttar Pradesh, Madhya Pradesh and Bihar. Style of costumes: stitched garment, draped garment, head covers, wraps. Importance of Geographical Indications for traditional Indian textiles. Woven textiles (Origin, material and techniques used) Shawls from Kashmir, Assam and Nagaland, Kota Doria, Patola, Sujani, Tangaliya, Pachhedi, Chanderi, Maheshwari, Brocades, Dacca muslin, Baluchari, Jamdani Tangail, Paithani, Himroo, Amru, Dharvaram, Sambhalpuri, Vichitrapuri, Venkatgiri, Gadwal, Narayanpet, Ilkal, Khann, Kanjeevaram, Lepcha, Pochampalli, Ikat. Printed, painted and dyed textiles (Origin, material and techniques used). Painted textiles- Patachitra, Pichhavai, Worli and Phad mordant painted textiles Kalamkari- Masulipatnam and Srikalahasti, Madhubani. Printed textiles- Calico printing and Handblock printed- Ajrakh, Rogan, Sanganeri, Bagh, Dabu, Yarn resist dyed Patola, Mashru, Ikat, Bandhej. Fabric resist- Sugadi, Bhandej, Laheriya.

Practical

Documentation of motifs and sample preparation of traditional textiles. Creative projects: Preparation of one article by adapting traditional motifs and embroidery in contemporary textiles. Preparation of portfolio and collection of visuals that depict the different traditional textile and its application in contemporary apparel designing (Pictures of traditional textiles with the descriptive analysis and Pictures of the traditional costumes with constructional details). Visit to National craft museum and exhibition/art galleries. Collection of varied style of male and female traditional costumes of different states of India for hands on experience. Documentation of traditional textiles and styles in traditional costumes and development of portfolio: (Collection of images and samples for development of theme board, Development of storyboard, Development of range of textile/ apparel product and Display and presentation of portfolio). Creative projects: organizing exhibition/ fashion show. Creating dolls display of traditional costumes of different states. Preparation of mini costumes of both male and female in group assignments and project work. Visit to National craft museum and exhibition/art galleries.

Suggested Readings

1. A Compendium of Indian Handicrafts and Handlooms covered under Geographical Indications (GI). 204p. Development Commissioner (Handloom), Ministry of Textiles, Govt. of India, New Delhi.
2. Bhatnagar P. 2004. *Traditional Indian Costumes and Textiles*. 101p. Abhishek Publications, Chandigarh.
3. Bhatnagar P. 2005. *Decorative Design History in Indian Textiles and Costumes*. 170p. Abhishek Publication, Chandigarh.
4. Chisti R K. 2010. *Sari Tradition and beyond*. 274p. Roli books Pvt Ltd. New Delhi.
5. Gillow and Barnard N. 2014. *Indian Textiles*. (1st Edn.). 224p. Thames and Hudson, London.
6. Gosh G and Shukla G. 2014. *Ikat Textiles of India*. 145p. A.P.H. Publishing, New Delhi.
7. Karolia A. 2019. *Traditional Indian Handcrafted Textiles: History, Techniques, Processes, Design*. Vol I & II. (1stEdn). 686p. Niyogi Books Pvt. Ltd., New Delhi.
8. Mehta R J. 1970. *Master Piece of Indian Textiles*. 56p. D. B. Taraporevale Sons and Co. Private Ltd.

9. Mulkraj A. 1980. Treasure of Indian Textiles Calico Museum, Ahmedabad. (1st Edn.). 145p. Marg Publication, Bombay.

Principles of Management 2 (2+0)

Objectives

The course aims to help students to-

i. Understand the nature of management
ii. Know about the process of management
iii. Study the systems approach to management

Theory

Management: Concept, nature, Importance. Management as a profession. Universality of management. Professionalism of management on India. Tasks of a professional manager. Motivating factors of management: Values- concept, significance, characteristics, sources, classification, development of value pattern. Goals - Concept, classification, SMART goal setting, strategies for achieving SMART goals. Standards - Concept, classification. Standard of living - Inter - relatedness of Values, goals and standards. Resources - Definition, Meaning and importance, types, characteristics, factors affecting their use and guidelines. Role of resources in management, conservation of resources. Management of household resources: Time - tools and process of time management, time plan and steps in making time plan. Factors affecting time use. GANTT Chart - Energy - types and sources of energy. Functions of management. Management skills. Process of Management: Planning: Importance, types, characteristics and techniques, barriers to effective planning. Organizing: Meaning and importance, characteristics and techniques. Controlling: Definition, Concept, Importance, phases and factors. Evaluating: Definition, Need and types of evaluation. Decision making process: Concept, importance, scope, types, steps and factors affecting decision making. Communication: Process, types of communication, barriers of communication. Systems approach to management: Conceptual framework of management, systems approach, sub - systems and interactions with other systems. Family - the managerial unit, the environment surrounding the family, management and changes in environment. Origin, classification and role of Motivation in Management.

Suggested Readings

1. Gupta R S, Sharma B D and Bhalla N S. 1997. *Principles and Practice of Management.* 525p. Kalyani Publishers, New Delhi.
2. Gupta S, Garg N and Aggarwal A. 1993. *Textbook of Home Management, Hygiene and Physiology*. 423p. Kalyani Publishers, New Delhi.
3. Kaur H and Macneil C. 1994. *Theory and Practice of Home Management.* 311p. Surjeet Publications, New Delhi.
4. Mullick P. 1997. *Handbook for homemakers*. 127p. Kalyani Publishers, New Delhi.
5. Nickell P and Dorsey J M. 1959. *Management in Family Living.* 639p. Wiley Eastern Private Ltd., New Delhi.
6. Shukul M and Gandotra V. 2017. *Home Management and Family Finance.* Dominant Publishers, New Delhi.

Computer Aided Designing-II 3 (0+3)

Objectives

The course aims to help students-

i. To draw the room plans for various activities

ii. To draw the floor plans with different SQFT areas

iii. To add the interior details in developed drawings

Practical

Developing a simple bubble diagram and schematic diagrams of various residential zones through CAD: Cooking, dining, living, rest areas, entrance, operative zone, service zone. Drawing the floor plans of various rooms through CAD drawing: kitchen, dining room, bedroom, living room. Drawing the conceptual floor plans with different SQFT area. Dimensioning the floor plans. Adding Text to Floor plan. Adding furniture to floor plan. Drawing elevations of different types of residential buildings through CAD. Creating 3-D Models of structural features using viewport. Creating varietal effect through hatching technique in CAD. Use of Rendering Techniques in interiors through CAD. Developing conceptual drawing of small residential project. Printing and plotting a drawing.

Suggested Readings

1. *AutoCAD 2017: A Power Guide for Beginners and Intermediate*. (2nd Edn.). 502p. Create Space Independent Publishing Platform. CADArtifex. 2016.
2. Ching F D K (6th Edn.). 2015. *Architectural graphics*. 272p. Wiley
3. Chopra A and Huehls R (1st Edn.). 2017. *Sketch Up for Dummies* (For Dummies (Computer/ Tech). 466p. For Dummies.
4. Cline L (1st Edn.). 2014. *Sketch Up for Interior Design: 3D Visualizing, Designing, and Space Planning*. 291p. Wiley Secondary Reading.
5. Fane B. 2016. *Auto CAD for Dummies*. (18th Edn.). 544p. For Dummies.
6. Obermeier B and Ted Padova T. 2016. *Photoshop Elements 15 For Dummies*. (1st Edn.). 448p. For Dummies.
7. Onstott S. 2010. *Enhancing Architectural Drawings and Models with Photoshop*. (2nd Edn.). 360p. John Wiley & sons.
8. Tondreau B. 2011. *Layout Essentials: 100 Design Principles for Using Grids (Design Essentials)*. (1st Edn.). 208p. Rockport Publishers.

Marriage and Family Dynamics 3 (2+1)

Objectives

i. To provide the knowledge about the dynamics of Contemporary marriage and family system in India

ii. To understand Family stress and crisis

iii. To empower the students by providing them knowledge about the laws and Acts related to marriage and Family life

iv. To develop an understanding about the need and importance of family life education, sex education and family planning

v. To prepare the students to work as Marriage and Family Counselor

Theory

Marriage: Definition, philosophy, past and present concept of Hindu Marriage, Goals and Functions of Marriage. Characteristic features of Hindu, Muslim and Christian Marriage. Types and Forms of Marriage in India (Ancient and Prevalent Forms). Readiness for marriage – Definition, Meaning and importance of readiness, Areas of readiness for marriage. (Identifying characteristics of readiness for marriage). Mate Selection: Meaning, model/method of mate selection - field of mate selection - Theories of mate selection (Ways of mate selection in tribal India. Factors responsible for wrong mate selection - Guidelines for mate selection,). Factors influencing mate selection and desirable qualities in mate. Trends in mate selection. Newspaper ads for marriages, Online matrimonial sites, their use and problems and prospects. Dating, Courtship and engagement: Meaning and objectives of Dating, courtship and engagement. Importance of engagement. Wedding: Definition meaning and purpose of Wedding ceremonies rituals and ceremonies of marriage in different religions of India. Marital roles and behaviour. Definition, importance and concept of marital roles (marriage as status and role transition) Changing gender roles. Factors responsible for change in gender roles, role conflict. Marital Adjustment and Success: Definition, Areas of marital adjustment. Types of marital relations and adjustment - factors influencing marital adjustment - marital adjustment over the family life cycle, obstacles in marital adjustment, improving marital adjustment - marital adjustment techniques , general technique of resolving differences - Marital Success and criteria of Marital Success - Marital dissolution: Definition, types of marital dissolution, Voluntary and Involuntary, Causes of Marital Dissolution, Separation distress and factors effecting it - Divorce, factors responsible for divorce, consequences of divorce on spouse and children , factors responsible for an increase in the rate of marital dissolution, factors responsible for refraining from divorce after marriage failure, social process of marital failure and divorce, children's response to divorce, children as weapon against divorce, Adjustment to Divorce - alternatives to marriage- Singlehood, heterosexual cohabitation/consensual union, homosexual union, reasons behind it and merits and demerits.

Family: Meaning, Definition and Characteristics of Family functions, forms/types of family. Family structure and relationship in India-Pattern of changes in family structure and relationships in India - Impact of globalization, industrialization, technological advancement and immigration on family structure and functions - family (education and employment of women) and Extra familial factors (technology, peer group, society) responsible for the change and consequences of these changes on the family life and society - Family life cycle: Definition, Stages of Family Life Cycle, importance of studying family life cycle, - developmental tasks, developmental tasks of stages of family life cycle - Role expectation of different family members at different stages of family life cycle - Forms of Families; typical and alternative forms of families- Characteristics of single parent families, female headed families, single child families, childless families, adoptive families, dual earner families, reasons behind alternative form of family and their merits and demerits. family stress – Definition, types/categories of stressors, variables affecting family/response to stress, Hill's ABCX Mode/theory of family stress, causes of family stress, effects/impact of family stress, manifestations/recognizing symptoms of family stress, stress coping strategies, correlates of family

stress - Family crisis- Definition, Characteristics, Stages of crisis. Effect of crisis and Adjustment to crisis factors which affect meeting the crisis, general things to do in times of crisis – Marriage Laws and acts - Dowry, adoption, divorce and inheritance in India - Education for Parenthood and Family Planning, Family Life Education, Concept, Definition, objectives of Family Life Education; role of family and related agencies in Family Life Education, Family Planning: Meaning; objectives Importance and Methods - Family counselling - Fundamentals of Premarital, marital and family counselling: Objectives and Importance.

Practical

Study of motives of marriage and trends in mate selection. Study of characteristics of nuclear, joint, atypical and alternative forms of families. Study of marital roles and adjustments. Study of changing roles and relationship in marriage and family system across family life cycle. Study of family crisis and coping strategies in families. Visit to marriage bureau and family counselling centres. Interviewing, assessment and developing case studies on people undergoing, premarital, marital and family stress – reviews of books and films on marital relationships, conflicts and coping.

Suggested Readings

1. Adams B N and Merton R K. 1980. *The Family: A Sociological Interpretation*. 457p. Rand McNally College Publishing Company, Chicago.
2. Ahuja R. 2006. *Indian Social System*. 393p. Rawat publication, New Delhi.
3. Atkinson B J. 2005. *Emotional Intelligence in Couple Therapy*. 392p. Norton, NY.
4. Benokraitis V N. 2014. *Marriage and families*. 600p. Pearson Publication, Delhi.
5. Brownman A H. 1970. *Marriage for Mordens*. 576p. MacGaw-Hills Inc., USA.
6. Gottman J M (Ed.). 2004. *The Marriage Clinic Casebook*. 249p. Norton, NY.
7. Gottman J M. 1999. *The Marriage Clinic: A Scientifically Based Marital Therapy*. 480p. Norton, NY.
8. Gottman J M and DeClair J. 2002. *The Relationship Cure*. 336p. Crown, NY.
9. Gupta G R. 1976. *Family and Social Change in Morden India*. 263p. Oxford University Press, Kolkata India.
10. Gurman A S and Jacobson N S (Eds). 2015. *Clinical Handbook of Couple Therapy. (5thEdn.)*. 79p. Guilford, NY.
11. Kapadia K M. 1966. *Marriage and Family in India*. 426p. Oxford University Press, Kolkata.
12. Kumar R. 2000. *Violence Against Women*. 326p. Anmol Publication Pvt. Limited, New Delhi.
13. Kurian G. 1974. *The Family in India A Regional View*. 394p. Mouton & Co NV Publishers, The Hague Netherlands.
14. Landis J T and Landis M G. 1966. *Building A Successful Marriage*. 557p. Prentice Hall Inc, Englewood Cliff, New Jersey.

Diffusion and Adoption of Innovations 3 (2+1)

Objectives

i. To develop skills in identification of appropriate technologies for rural families

ii. To develop competence in diffusion of need based technologies among rural families

Theory

Concept and elements of diffusion process. Perceived attributes of innovation. Adoption – definition, adoption process. Innovation – decision process. Types of innovation – decision and consequences of innovation. Factor affecting adoption of an innovation. Innovativeness and Adopter categories – concept, types and characteristics. Types of adopter categories and their characteristics. Change agents and opinions leader. Change proneness – acceptance and resistance to social change. Appropriate technologies for rural families with special reference to Community science. Appropriate technologies for rural families with special reference to Drudgery reduction, Agriculture and Animal husbandry. Constraints in adoption of technologies. Behavior change communication (BCC) strategies.

Practical

Content analysis of adoption studies. Identification of key communicators and opinion leaders in locality. Identification and rating of appropriate technologies by rural women. Survey on adoption of appropriate technologies in community. Diffusion of need based appropriate technologies among rural families through various communication methods Farm and home visits. Diffusion of need based appropriate technologies among rural families through various communication methods demonstration, group discussion, role play and exhibition etc. Case studies/Success stories regarding adoption of technologies. Identification of constraints faced by rural families in adoption of technologies. Preparation and presentation of report.

Suggested Readings

1. Dasgupta S. 1989. *Diffusion Agricultural Innovations in Village India*. 193p. Wiley Eastern Ltd, New Delhi.
2. Jalihal K A and Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. 312p. Concept Publ. Co.
3. Ray G L. 2005. *Extension Communication and Management*. 382p. Kalyani Publ.
4. Reddy A A. 1987. *Extension Education.* 344p. Shree Lakshmi Press. Bapatla. Guntur, AP.
5. Rogers E M. 2003. *Diffusion of Innovations*. (5th Edn.). 576p. The Free Press, New York
6. Somani L L. (2012). *Extension Methodologies for Transfer of Agricultural Technology*. 432p. Image Print Media, Udaipur
7. Supe S V. 2009. *Textbook of Extension Education*. 288p. Agrotech Publishing Academy, Udaipur.

Semester VII

The student will choose elective courses as suggested

S. No.	Course Title	Credit Hours
1	Research Methodology	3 (2+1)
2	Statistical Methods	2 (1+1)
3	Elective courses (any courses from specializations)	15
	Total	**20**

Research Methodology 3 (2+1)

Objective

To understand the meaning and importance of research, research procedures and develop skills in designing and executing research.

Theory

Research – Meaning and Importance. Types of Research. Quality of Researcher. Steps of Research. Selection and delineating of research problem, statement of general and specific objective, formulation of assumptions and hypothesis, planning research design, selection and development of data collection tools, collection of data, analysis and interpretation of data, drawing conclusion, writing research report. Understanding some concepts in research: assumption, delimitations, operational definition, measurement and its levels, Variable and their types. Hypothesis – Meaning, importance, characteristics and ways of stating hypothesis. Review of literature – Importance, sources of literature, organizing review, collection and presentation. Research Design: Historical or documentary, Experimental, Ex-post-facto, Survey, Case study, Field studies. Sampling – Meaning and importance. Sampling techniques, determine size of sample. Techniques of data collection: Observation, interview and questionnaire, Projective technique. Scale and tests – Meaning and construction: validity and reliability of tools. Data analysis – tools and methods, interpretations of data, documentation and presentation. Summary, conclusion and recommendations. Writing abstract. The research report. Formal style of writing, chaptalization, heading, pagination, tables and figures, appendices and bibliography, acknowledgement. Writing for publications.

Practical

Identifying problem, formulating research hypothesis, questionnaire design, collection of secondary data, analysis and report writing. Use of reference management software, article writing.

Suggested

1. Bajpai S R. 1966. *Methods of Social Survey and Research*. 408p. Kitab Ghar, Kanpur.
2. Best W. 1983. *Research in Education*. (4th Edn.). 431p. Prentice Hall of India.
3. Carter G V. 1971. *Essentials of Education Research: Methodology and Design*. 470p. Appleton Century Crofts.
4. Koul Lokesh. 2009. *Methodology of Educational Research*. (4th Edn.). 560p. Vikas Publications House Pvt Ltd., Delhi.
5. Kerlinger F N. 1973. *Foundations of Behavioural Research.* (2nd Edn.). 741p. Holt Rinehart Winstons.

Statistical Methods 2(1+1)

Objective

To develop understanding among students about sampling and data analysis techniques, methods of data analysis using various statistics.

Theory

Introduction to Statistics and its Applications in Agriculture. Graphical Representation of Data. Measures of Central Tendency and amp. Dispersion. Definition of Probability. Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial and amp: Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance. One sample and amp: two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Analysis of Variance. Analysis of One-Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement. Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles. Deciles and amp: Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles. Deciles and amp: Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments. Measures of Skewness and amp: Kurtosis (Ungrouped Data). Moments, Measures of Skewness and amp: Kurtosis (Grouped Data). Correlation and amp. Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal B L. 2013. *Basic Statistics*. (6th Edn.). 832p. New Age International Private Limited.
2. Gareth J, Daniela W, Trevor H and Robert T. 2013. *An Introduction to Statistical Learning: with Applications in R*. 426p. Springer.
3. Gupta S C. 2017. *Fundamentals of Statistics*. 1219p. Himalaya Publishing House.
4. Karaca Y and Cattani C. 2019. *Computational Methods for Data Analysis*. 619p. De Gruyter, Berlin, Germany.
5. Panse V G and Sukhatme P V. 2009. *Statistical Methods for Agricultural Workers*. 328p. ICAR, New Delhi.
6. Rao G N. 2018. *Statistics for Agricultural Sciences*. (3rd Edn.). 515p. BS Publications / BSP Books.
7. Snedecor G W and Cochran W G. 1989. *Statistical Methods*. (8th Edn.). Wiley-Blackwell.
8. Sprent P. 1993. *Applied Non-Parametric Statistical Methods*. (2nd Edn.). 260p. Springer.
9. Sukthame V and Ashok C. 1984. *Sampling Theory of Surveys with Application. (*3rd Edn.). 542p. Iowa State Pr.
10. Wetherill G B. 1983. *Elementary Statistical Methods*. (3rd Edn.). 356p. Chapman and Hall.
11. William S. Cleveland. 1994. *The Elements of Graphing Data*, (2nd Edn.). 297p. AT&T Bell Laboratories.

ELECTIVES COURSES

Course Number	Course	Credit Hours
Elective-1 Food and Nutrition		
1.	Food Analysis	3 (1+2)
2.	Normal and Therapeutic Nutrition	3 (2+1)
3.	Food Product Development and Formulations	2 (1+1)
4.	Clinical Nutrition	2 (2+0)
5.	Diet and Nutrition Counseling	1 (0+1)
6.	Sports Nutrition	2 (2+0)
7.	Community Nutrition and Education	2 (1+1)
Elective-2 Apparel and Textile Science		
1.	Advance Draping Technique	3 (0+3)
2.	CAD- Pattern Making and Grading	2 (0+2)
3.	Quality Analysis in Textiles and Apparels	3 (2+1)
4.	Apparel Production Management	3 (3+0)
5.	Agro Textiles	2 (1+1)
6.	Recent Advances in Textiles	2 (2+0)
Elective-3 Resource Management and Consumer Science		
1.	Residential and Commercial Space Design	3 (1+2)
2.	Colour and Lighting in Interiors	3 (2+1)
3.	Tourism and Hospitality Management	3 (1+2)
4.	Financial Management and Consumer Behaviour	3 (2+1)
5.	Work Space and Product Design	3 (1+2)
Elective-4 Human Development and Family Studies		
1.	Developmental Challenges in Children	3 (2+1)
2.	Methods and Materials for Teaching Young Children	3 (1+2)
3.	Computer application in ECCE	3 (1+2)
4.	Guidance and Counselling	3 (2+1)
5.	Parent Education and Community welfare Programs	3 (2+1)
Elective-5 Extension Education and Communication Management		
1.	Extension Program Management	3 (1+2)
2.	Extension Training Management	3 (1+2)
3.	Advertising and Social Marketing	3 (1+2)
4.	Public relations and Communication Management	3 (1+2)
5.	Web designing	3 (0+3)
	TOTAL	**20**

* The student will take anyone elective as per choice.

Food and Nutrition

Food Analysis 3 (1+2)

Objectives

i. To familiarize students with the equipment and techniques of food analysis

ii. To enable students to analyze the composition of foods

Theory

Sampling and sampling techniques. Proximate analysis- Moisture, ash, crude fat, crude fibre, crude protein and carbohydrates by difference. Principles and methods of food analysis. Basic principles: Refractometry, polarimetry, densitometry, HPLC, GLC, spectrophotometry, electrophoresis, automatic amino acid analyzer. Determination of starch. Test for unsaturation of fats, rancidity of fats. Qualitative analysis of protein by Biuret method, Ninhydrin method, Lowry's method and Dye-binding method. Principles and methods for estimation of minerals. Atomic absorption spectroscopy, colorimetric, titrimetric and gravimetric methods. Methods for determining physical and rheological properties of food.

Practical

Proximate analysis: Moisture, ash and carbohydrate by difference. Demonstration of kjelplus, fibreplus, sox-plus. Estimation of sugar content of fruit and reducing and non-reducing sugars in cereals. Estimation of starch content of cereals Determination of iodine value and saponification number of fats. Estimation of minerals, iron, calcium and phosphorus. Estimation of vitamins: Ascorbic acid, Protein quality analysis, in-vitro method. Physical test for grain quality and rheological properties of foods.

Suggested Readings

1. AOAC. 2000. *Association of Official Analytical Chemists*. 2200p. AOAC, Washington, DC.
2. Joslyn M A. 1970. *Methods in Food Analysis: Physical, Chemical and Instrumental Methods of Analysis*. 845p. Academic Press, New York.
3. NIN. 2003. *A Manual of Laboratory Techniques*. 420p. Sumit prakashsn.
4. Pearson D. 1973. *Laboratory Techniques in Food Analysis*. 323p. Butterworths and Co., London.
5. Pomeranz and Yeshajahu. 1987. *Food Analysis Theory and Practice*. (2nd Edn.). 608p. AVI Publ. Company, Westport.

Normal and Therapeutic Nutrition 3 (2+1)

Objectives

i. To acquire basic knowledge of nutrient requirements, recommended dietary allowances, and dietary modification under different physiological conditions and disease conditions

ii. To develop practical skills in planning and management of diets for the different age groups under normal/ physiological conditions keeping in mind the dietary guidelines and to modify the diet plans to suit the disease conditions

Theory

Determination of nutritional requirements. Basic principles of menu planning, factors affecting planning menus for individual and family. Steps involved in meal planning. Concept of calorie consumption unit. Factors (physiological and psychological) affecting food requirements of individuals, families and different groups of people. Classification of vegetarianism. Importance of balanced diets. Food exchange list. Use of food exchange list in diet planning. Introduction to normal nutrition- Food, nutrient requirement and menu planning of adults (male and female of all activities level), pregnant women, lactating women, Infants. Breast feeding, advantages of breast feeding, breast feeding during illness, feeding of pre-term baby, feeding problems. Weaning and complementary feeding. Food and nutrient requirement of pre-school children, school age children, adolescents, old age people Physiological and psychological changes during old age. Introduction to therapeutic nutrition. Definition of therapeutic nutrition/ Diet therapy, objectives of therapeutic diet. Principles of diet therapy and Importance and modification of normal diet to therapeutic diets. Therapeutic adaption- change in consistency, change in energy intake, change in nutrient, change in fiber, change in frequency of feeding, change in elimination of food. Methods of feeding- enteral feeding, parenteral feeding, advantages and disadvantages of these methods. Routine Hospital Diet- clear liquid diet, liquid diet, semi-solid diet, soft diet, normal diet, bland diet, high and low-calorie diet, high and low protein diet, high and low fiber diet, low cholesterol diet etc. Aetiology, symptoms and dietary management in acute and chronic fevers. Typhoid, influenza, tuberculosis. Viral and auto immune diseases- causes, symptoms and diet management. Allergy - causes, symptoms and diet management. etiology, symptoms and dietary management in gastrointestinal disorders- Diarrhoea, constipation, peptic ulcer, diverticular disease, inflammatory bowel disease, celiac disease, lactose intolerance etc. and other disorders. Aetiology, symptoms and dietary management in liver diseases- fatty liver, hepatitis, jaundice, cirrhosis of liver. Aetiology, symptoms and dietary management in cardiovascular disease, atherosclerosis and hypertension. Aetiology, symptoms and dietary management in diabetes mellitus. Aetiology, symptoms and dietary management in overweight and obesity and underweight. Aetiology, symptoms and dietary management in renal disease- nephritis, nephrotic syndrome acute renal failure, chronic renal failure etc. Aetiology, symptoms and dietary management in cancer.

Practical

Standardization of serving size portions. Planning, preparation and calculation of diets for different age Groups-Infancy, preschool age, school age, adolescent, adult, old age. Planning, preparation and calculation of diets for pregnant and lactating women. Planning, preparation and calculation of packed lunches, clear liquid diet, full fluid diet, soft diet, tube feeding diet, high calorie/ fiber diet etc. Planning, preparation and calculation of diets for following diseased condition- diarrhea, constipation, peptic ulcer, hepatitis, hypertension, atherosclerosis, diabetes, mellitus, overweight/ obesity.

Suggested Readings

1. Agarwal A and Udipi S. 2014. *Textbook of Human Nutrition*. 596p. Jaypee Medical Publication, Delhi.
2. Antia P. 1986. *Clinical Dietetics and Nutrition*. 454p. Oxford University Press, Mumbai.
3. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. 368p. Westville Publication, Delhi.

4. Srilakshmi B. 1995. *Dietetics*. 480p. New Age International Publishers, New Delhi

Foods Product Development and Formulations 2 (1+1)

Objectives

i. To learn various aspects of product development and formulation related to production, quality evaluation

ii. To understand the principles of marketing, branding, positioning, viability, feasibility and other commercial aspects of food products

iii. To develop new products in practical situations and improve and innovate the existing food products

iv. To develop entrepreneurship skills in the area of Food Product Development and Formulations

Theory

Concept of product development and food formulation. Techniques used in forecasting new products needs. New product ideas. Infra-structural requirement and contributory role of various disciplines involved in products development. Sequential steps of product development and food formulation. Food ingredients; nutritional relevance: physical and chemical properties in relation to product formulation. Nutritional changes due to processing. Evaluation of sensory characteristics and consumer acceptance of products. Consumer protection, nutrition labeling, Food packaging, advertising and marketing and economics. Improving success potential of new products, market exploration and acquisitions. Quality controls procedures employed in product development. Procedure for obtaining patents. Legal aspects of product development.

Practical

Sensory evaluation techniques. Recognition test: basic tastes, odour recognition, aroma perception. Exercises with other senses, tactile and pressure, kinesthetic, temperature, pain, auditory and colour. Threshold tests for basic tastes. Difference tests; paired, triangle and duo trio tests. Ranking test. Descriptive tests: flavor profile and dilution flavor profile. Scoring tests. Project: Product formulation and evaluation. Visit to a food industry.

Suggested Readings

1. Baker R C. 1988. *Fundamentals of New Food Product Development (Developments in Food Science)*. 287p. Elsevier Science Ltd.

2. Prusa K and Gilbert K. 2019. *Food Product Development Lab Manual*. 117p. Iowa State University, United States.

3. Sharma A. 2018. *Food Product Development*. 412p. CBS, India.

Clinical Nutrition 2 (2+0)

Objectives

i. To understand basis of RDA derivation and use knowledge to understand individual variations and provide personalized nutrition

ii. To interpret clinical results and apply the findings in formulating therapeutic diet

iii. To understand rationale and use of nutraceuticals and functional foods

Theory

Methods for estimating RDA: Basic terminology in relation to nutritional requirements. Methods for studying the nutrition Requirements. Population survey of dietary intakes of nutrients, Growth studies, Depletion and repletion studies, Nutrient balance studies, Use of isotopically labelled nutrients. Nutrient turnover. Obligatory losses of nutrients. Clinical results and their interpretation: Interpretation of clinical testing of blood serum and urine with particular emphasis on their interpretation related to nutritional status and disease (PEM, liver, cardiovascular and renal disorders, diabetes mellitus, underweight, overweight and obesity). Nutritional Biomarkers. Introduction to free radicals: free radicals, reactive oxygen species, production of free radicals in cells, damaging reactions of free radicals on lipids, proteins, carbohydrates, nucleic acids, Free radicals' theory of ageing, enzymatic and non-enzymatic antioxidant defence, synthetic antioxidants. Nutraceuticals and dietary supplements: Definitions of Nutraceuticals, Functional foods, Dietary supplements, Nutrigenomics, probiotics, Prebiotics and postbiotics, interaction between nutrients, infections and drugs. Nutraceutical factors in specific foods. Classification of Nutraceutical factors based on chemical nature and mechanism of action. Occurrence and Therapeutic uses of Carotenoids (Lycopene, Lutein, Zeaxanthene, Astaxanthene). Quinones (Tocopherol). Proteins and Minerals (Melatonin, Glutathione, Shilajit, Carnitine). Phenolics and Polyphenolics (Reservetrol, Grapeseed extract, Tea, Pycnogenol, Avenanthramides from Oats, Rutin, Soy Isoflavones, Curcumin). Sulphur Compounds (Glucosinates). Essential Fatty acids (Fish oils, α- Linolenic acid). Dietary fibres and complex carbohydrates as functional food ingredients. Regulatory issues of Nutraceuticals and Dietary Supplements.

Suggested Readings

1. Baetge E E, Dhawan A and Prentice A M (Eds). 2016. *Next Generation Nutritional Biomarkers to Guide Better Health Care: 84th Nestlé Nutrition Institute Workshop, Lausanne, September 2014.* 126p. Karger Medical and Scientific Publishers.
2. Das L, Bhaumik E, Raychaudhuri U and Chakraborty R. 2012. Role of Nutraceuticals in Human Health. *Journal of food science and technology*, **49**(2): 173-183.
3. Elia M, Ljungqvist O, Stratton R J and Susan A L (Eds). 2013. *Clinical Nutrition*. 545p. Wiley, Germany.
4. Gupta R C, Lall R and Srivastava A (Eds). 2021. *Nutraceuticals: Efficacy, Safety and Toxicity*. 1396p. Academic Press.
5. Mahan L K and Escott-Stump S. 2000. *Krause's Food, Nutrition and Diet Therapy*. (10th Edn.). 1396p. W.B. Saunders Co., Pennsylvania.
6. *Nutrient Requirement for Indians: Recommended Dietary Allowances and Estimated Average Requirements*. 2020. 343p. National Institute of Nutrition, India (nin.res.in).
7. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. 368p. Westvills Publication, Delhi.
8. Sobotka L and Forbes A (Eds). 2019. *Basics in Clinical Nutrition.* (Vol. I). (5th Edn.). 676. Galen.
9. Wildman R E, Wildman R and Wallace T C. 2016. *Handbook of Nutraceuticals and Functional Foods*. CRC Press.

Diet and Nutrition Counselling 1 (0+1)

Objectives

i. To develop the knowledge for understanding the concepts of diet, structural, compositional and nutritional importance of various diet

ii. To develop the skills in communication, learn the counseling techniques, group process skills and behavior modification theories and develop the educational tools.

Practical

Communication to Promote Change. Interviewing., Counseling, Behavioral Modification, Modifying Cognitions, Motivation, Principles and Theories of Learning, Planning Learning, Implementing and Evaluating Learning, Group Dynamics. Delivery of Oral Presentations and Workshops, Planning, selecting and Using Media.

Suggested Readings

1. Baetge E E, Dhawan A and Prentice A M (Eds). 2016. *Next Generation Nutritional Biomarkers to Guide Better Health Care: 84th Nestlé Nutrition Institute Workshop, Lausanne, September 2014.* 126p. Karger Medical and Scientific Publishers.
2. Das L, Bhaumik E, Raychaudhuri U and Chakraborty R. 2012. Role of Nutraceuticals in Human Health. *Journal of food science and technology* **49**(2): 173-183.
3. Elia M, Ljungqvist O, Stratton R J and Susan A L (Eds). 2013. *Clinical Nutrition*. 544p. Wiley, Germany.
4. Gupta R C, Lall R and Srivastava A (Eds). 2021. *Nutraceuticals: Efficacy, Safety and Toxicity.* 1396p. Academic Press.
5. Mahan L K and Escott-Stump S. 2000. *Krause's Food, Nutrition and Diet Therapy*. (10th Edn.). 969p. W.B. Saunders Co., Pennsylvania.
6. *Nutrient Requirement for Indians: Recommended Dietary Allowances and Estimated average requirements*. 2020. 343p. National Institute of Nutrition, India (nin.res.in)
7. Raghuvanshi R S and Mittal M. 2014. *Food Nutrition and Diet Therapy*. 368p. Westvills Publication, Delhi.
8. Sobotka L and Forbes A (Eds). 2019. *Basics in Clinical Nutrition* (Vol. 1). (5th Edn.). 676p. Galen.
9. Wildman R E, Wildman R and Wallace T C. 2016. *Handbook of Nutraceuticals and Functional Foods*. 350p. CRC press.

Sports Nutrition 2 (2+0)

Objectives

i. To learn the selection of the right balance of carbohydrates, proteins, and fats to provide energy and build or maintain muscles, designing diet plans, and use of nutritional supplements

ii. To understand the special nutritional requirements for physical activities related to sports and exercise

iii. To apply the knowledge to improve the performance of sportspersons

Theory

Introduction. Nutritional considerations for sports / exercising person as compared to normal active person. Energy substrate for activities of different intensity and duration, aerobic and anaerobic activities. Fluid balance in sports and exercise, importance, symptoms and prevention of dehydration, Sports drink, Energy enhancers and other commercial sports food products. Macro Nutrients-Carbohydrate as an energy source for sport and exercise, carbohydrate stores, fuel for aerobic and anaerobic metabolism, Glycogen re-synthesis, CHO Loading, CHO composition for pre-exercise, during and recovery period. Role of fat as an energy source for sports and exercise. Fat stores, regulation of fat metabolism, factors affecting fat oxidation (intensity, duration, training status, CHO feeding), effect of fasting and fat ingestion. Protein and amino acid requirements. Factors affecting Protein turnover, Protein requirement and metabolism during endurance exercise, resistance exercise and recovery process. Important micronutrients for exercise- B complex vitamin and specific minerals. Exercise induced oxidative stress and role of antioxidants. Chronic dieting and eating disorder. Female athletic triad, sports anaemia Dietary supplements and ergogenic aids (nutritional, pharmacological and physiological). Use of Nutritional supplements in strength/ power sports and team sports- use, effects, efficacy and safety – Creatine monohydrate, Sodium bicarbonates, Nitrates – B-Alanine, Caffeine – Protein supplements – Fat burners.

Suggested Readings

1. Banardot D. 2000. *Nutrition for Serious Athletes*. 351p. Human Kinetics Publishers.
2. Driskell J A and Wolinsky I. 2002. *Human Kinetics Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition*. 288p. CRC Press.
3. Jeukendrup A and Gleeson M. 2010. *Sport Nutrition: An Introduction to Energy Production and Performance*. (2nd Edn.). 682p. Human Kinetics Publishers.
4. McArdle W D, Katch F I and Katch V L. 2009. *Sports and Exercise Nutrition. 672p.* Lippincott Williams and Wilkins.
5. Satyanarayan K, Rao N C and Malhotra M S. 1985. *Recommended Dietary Intakes for Indian Sportsman and Women.* 139p. Human Kinetics, National Institute of Nutrition, Hyderabad

Community Nutrition and Education 2 (1+1)

Objectives

i. To develop awareness of the students about the magnitude of nutritional problems and develop ability to assess the problems and devise nutrition education material for them

ii. To comprehend the importance and determinates of nourishment decision practices and apply standards of network appraisal and nourishment instruction to design the appraisal, execution observing and assessment of a focused in community nutrition intercession

Theory

Malnutrition- Definition and causes, PEM, Marasmus, Kwasiorkor and vicious cycle of malnutrition. Assessment of nutritional status. Clinical signs and symptoms, nutritional anthropometry, biochemical tests, biophysical tests and diet survey methods. Major nutritional problems prevalent in India and the state of Protein energy malnutrition, anaemia, vitamin A

deficiency, iodine deficiency disorders, obesity, hypertension, atherosclerosis and diabetes mellitus. National programmes and role of national and international agencies in improving nutritional status of the community, Integrated Child Development Service (ICDS), supplementary Nutrition Program (SNP), Applied Nutrition Program (ANP), Mid Day Meal Program (MDMP), Vitamin A Prophylaxis Program and Anaemia Prophylaxis Programme, Food and Agricultural Organization (FAO), World Health Organization (WHO), United Nations Children's Fund (UNICEF), UNDP, CARE and other Voluntary and Government Agencies. Nutrition education- Objectives, methods and principles.

Practical

Assessment of nutritional status of an individual/community using anthropometry and dietary survey, Preparation of schedule, Survey work, Analysis of data, Writing of report. Visit to local health centre to identify clinical signs and symptoms of nutritional problems. Identification of adulterants in common foods. Visit to an ICDS Block Development of audio visual aids- radio script, popular article, chart/posters, leaflets etc. Planning, implementation and evaluation of nutrition education for a target group.

Suggested Readings

1. Bamji S M, Rao P N and Reddy V. 2003. *Textbook of Human Nutrition*. 600p. Lord and IBH Publishing Co. Pvt. Ltd.
2. Jelliffe D B. 1966. *The Assessment of the Nutritional Status of the Community*. 271p. WHO Geneva.
3. Salil S and Rita S R. 2007. *Textbook of Community Nutrition*. 524p. ICAR publication, New Delhi.
4. Swaminathan M (eds). 1998. *The First Five Years: A Critical Perspective on Early Childhood Care Education in India*. 312p. Sage Publication, New Delhi.

Apparel and Textile Science

Advance Draping Techniques 3 (0+3)

Objectives

i. To enable the students to make pattern from sketch /photograph using draping technique
ii. To enable the students to obtain perfect fit and harmony between the fabric and design of the garment

Practical

Draping, trueing and stitching– dartless shirt, surplice front, bustier. Draping and stitching skirts. Draping collars, sleeves, lowered exaggerated armhole sleeve. Cowls. Flounces, ruffles and peplums. Dresses – sundress and sculptured dress. Draping knits. Designing custom clothing. Analysis and presentation.

Suggested Readings

1. Bane A. 1996. *Creative Clothing Construction*. 448p. Mc Graw-Hill.
2. Connie A C. 1989. *The Art of Fashion Draping*. III Edition. 464p. Fair Child Publ.
3. Janine M and Michal P. 1987. *Modeling on the Dress Stand*. 192p. John Wiley & Sons Publishers.
4. Natalie B. 1987. *Dress Fitting*. 120p. John Wiley & Sons Publishers.

CAD–Pattern Making and Grading 2 (0+2)

Objectives

i. To impart skill in Computer Aided Designing in Apparel Designing
ii. To learn skill in pattern making and grading using CAD software

Practical

Introduction to pattern making software. Basics of pattern making tools (System and general tool bar, Edit tool bar, Accessories tool bar, Insert tool bar, Modify tool bar and Advance tool bar). Basics of pattern making menus (File menu, Edit menu, Piece menu, Grading menu, Pleat menu, Dart menu, Design menu, View menu, Option menu and Help menu). Creating grading basic patterns (Bodice front, back and sleeve, Skirt front and back). Fundamentals of patternmaking software. Detailed use of drawing and editing tools. Creating basic sloper/ pattern set- bodice front and back, skirt front and back and sleeve. Development of sloper/patterns of selected designed dresses using pattern making software. Grading sloper/ patterns in pattern making software. Marker making in pattern making software by manual and automatic methods. Preparation of portfolio of developed sloper/pattern.

Suggested Readings

1. CAD pattern-making software manual
2. Davis LM. 1980.*Visual Design in Dress*. 339p. Prentice Hall.
3. Rene W C. 1997. *CAD for Fashion Design*. 174Prentice Hall.
4. Taylor P. 1990. *Computers in Fashion Industry*. 215p. Heinemann Publications.
5. Veinsinet D O. 1987. *Computer Aided Drafting and Design-Concept and Application*. 384p. McGraw-Hill Inc. US.
6. Winfred H A. 1994. *CAD in Clothing and Textiles*. 180p. Wiley.

Quality Analysis in Textiles and Apparels 3 (2+1)

Objectives

i. To inculcate knowledge on quality control aspects
ii. To impart knowledge and hands on experience on textile testing procedures
iii. To impart skill in Inspection and quality analysis of different apparels

Theory

Importance of quality control and textile testing and introduction to various organizations/ institutes dealing with textile testing. Sampling techniques of fibre, yarn and fabric for testing. Standard conditions of testing and their importance. Testing of fibre dimensions- length, thickness, fineness, crimp, moisture content, strength, elasticity, linear density, and fibre imperfections. Testing of yarn dimensions: count, twist, single yarn strength and elongation, lea strength, evenness, hairiness, crimp, moisture regain, burst strength, pilling and yarn imperfections. Testing of fabrics- Physical, mechanical, comfort, colourfastness and fabric imperfections (physical testing of fabrics - thickness, GSM, fabric count, drapability, thermal conductivity, shrinkage, stiffness, elongation and crease resistance, mechanical testing of fabrics- tensile strength, tear strength, dimensional stability, abrasion resistance, bending length and flexural rigidity. Testing of Comfort properties of fabrics- heat transfer, thermal protection, air and moisture permeability, water absorption and water repellence. Tests for colour fastness- washing, perspiration, light, rubbing and dry cleaning). Accepted Quality level (AQL) - Pre-production, production and post-production inspection of fabrics, sewing threads, buttons, zippers, buckles and ancillaries like linings and interlinings, labels and packaging material. Statistical quality control (SQC)- Different statistical techniques and their application in textile and apparel testing.

Practical

Demonstration of fibre testing for length, thickness, fineness, crimp, moisture content, strength, elasticity, and linear density. Demonstration of yarn testing for count, twist, single yarn strength and elongation, lea strength, evenness, hairiness, crimp, moisture regain, burst strength hand pilling. Physical testing of fabrics for testing thickness, GSM, fabric count, drapability, thermal conductivity, shrinkage, stiffness, elongation, and crease resistance. Mechanical testing of fabrics for testing tensile strength, tear strength, dimensional stability, abrasion resistance, bending length and flexural rigidity. Testing for comfort properties of fabrics for heat transfer, thermal protection, air and moisture permeability, water absorption and water repellence. Quality analysis of selected apparels- women's kurti, men's shirt and t-shirt. Visit to textile testing laboratory/ Quality control department in a textile or apparel industry.

Suggested Readings

1. Booth J E. 1996.*Principles of Textile Testing*. III Edition. 579p. CBS Publishers and Distributors Pvt. Ltd, Delhi.
2. Grover E B and Hamby D S. 2011.*Handbook of Textile Testing and Quality Control*. 624p. Wiley India Pvt. Ltd.
3. Goel A and Kholiya R. 2014.*Textile Testing: A Laboratory Manual.* University Press. G.B. Pant University of Agriculture and Technology, Pantnagar.
4. Kothari V K. 1999.*Testing and Quality Management*. 543p. IAFL Publications.
5. Mehta P V and Bhardwaj K S. 1998.*Managing Quality in the Apparel Industry*. 327p.New Age International Publishers.
6. Paul J. 2005.*Textile Testing*. 280p. APH Publishing Corporation.
7. Rao J V. 2008. *Quality Evaluation*. NITRA Publications, Ghaziabad.
8. Saville B P. 1999.*Physical Testing of Textiles*. 310p. Woodhead Publishing Limited.

Apparel Production Management 3 (3+0)

Objectives

i. To make students aware of the whole apparel production system
ii. To endow the students with the advanced apparel production process
iii. To introduce students with various trends in management of Garment industry
iv. To familiarize students with apparel costing methods and pricing techniques

Theory

Introduction to apparel industry (apparel product types, organizational structure and sectors of the garment industry, developments in recent years, opportunities and challenges in Indian apparel sector, overview of global apparel industry, major trends in international apparel technological concepts). Different departments of apparel industry and their functioning (Design department, Marketing and business development department, Purchasing department, Finance department, Production department, Operations department). Apparel Production Technology (Material sourcing, Cutting technology- Forms of spreading for different types of fabrics, types of spreading machinery. Cutting techniques, considerations of cutting parameters for different fabrics, cutting machines and its working principle, fusing technology: Fusing materials, components of fusing, types of resin coating and its applications. Fusing machine types, working principle and their application, Sewing technology: Features, mechanism, working principle and application of single needle lock stitch (SNLS) machine, double needle lock stitch (DNLS) machine, over lock machine, blind stitch machine, button sewer and buttonhole machines, bar tack machines; stitches and seams, feed mechanism and working aids, needles and threads and Pressing and finishing technology: Classification of pressing, components of pressing/finishing machinery and equipment. Thread trimming, quality checking of garments and pressing, Apparel Production Systems). Warehousing- Assortment and storage methods. Packing: Function and scope of packing, packing methods, instructions, materials, weight, ratio, and labelling considerations for shipment by air and sea, packing marks. Capital management: Support system – banks, govt. agencies and institutions. Fixed and working capital. Cost accounting: Classification of cost elements- direct and indirect. Determination of factory cost, administration cost and sales cost of an apparel product. Manufacturing cost account statement - preparation and analysis, cost behaviour patterns – fixed, variable, semi variable. Calculations related to job order costing and process costing. Pricing methods: Cost plus pricing methods / full cost pricing, conversion cost pricing, differential cost pricing; variable cost pricing, direct cost pricing. Derivation of cost of apparel products – woven / knits. CM, CMT cost analysis for various styles. Activity based costing, Cost analysis for various styles of garments. FOB/CIF/C and F pricing of apparels. Personnel management- Human Resource Planning, job analysis, recruitment and selection, Training and development, compensation, performance appraisal, communication, career planning and development, conflict solution, personal audit, organization development, work environment. Industrial psychology. Trade globalization and its effect on Indian apparel industry.

Suggested Readings

1. Carr H and Latham B. 2008. *The Technology of Clothing Manufacture*. (4th Edn.). 352p. Wiley- Blackwell Publishing.

2. Chuter A J. 1995. *Introduction to Clothing Production Management*. (2nd Edn.). 208p. Wiley - Blackwell Publishing.
3. Eberle H. 2008. *Clothing technology: from Fibre to Fashion*. (5th Edn.). 304p. Verlag Europa-Lehrmittel, Nourney, Vollmer GmbH and Co.,
4. Gerry C. 2006. *Introduction to Clothing Manufacturers*. (2nd Edn.). 208p. Wiley-Blackwell Publishing.
5. Grace I K and Ruth E G. 2005. *Apparel Manufacturing: Sewn Product Analysis*. (4th Edn.). 672p. Pearson/Prentice Hall, New Jersey.
6. John M and Nance V. 1998. *Human Resource Management*. 730p. Irvin/McGraw Hill.
7. Jones R M. 2006. *The Apparel Industry*. (2nd Edn.). 328p. Wiley-Blackwell Publishing.
8. Kunz G I.2011. *Going Global: The Textile and Apparel Industry. (*2nd Edn.). 446p. Fairchild Books.
9. Leap T L and Crino M D. 1993. *Personal/Human resource management*. 719p. Macmillan Publishing.
10. Monappa A and Saiyadin S M. 1991. *Personal Management*. 433p. McGraw Hill Publishing Company.
11. Paula J and Myers-Mc D. 2010. *Apparel Production Management and the Technical Package*. 224p. Bloomsbury Academic.
12. Shaeffer C. 2001. *Sewing for the Apparel Industry*. (1st Edn.). 425p. Prentice-Hall.
13. Thomas A G. 1994. *The Art of Sewing*. 206p. UBS Publishers Distributers ltd.
14. https://www.onlineclothingstudy.com/2018/11/different-departments-in-garment.html.
15. https://www.techtarget.com/searchhrsoftware/definition/human-resource-management-HRM#:~.
16. https://en.wikipedia.org/wiki/Human_resource_management.
17. E- course: Hayavadana, C.H. Sc., TXAD 412, Apparel Industry Management 3 (3+0), ANGRAU, Hyderabad.

Agro-Textiles 2 (1+1)

Objectives

This course will enable students to:

i. Impart knowledge about various agrotextiles, its uses, application fields and advantages
ii. Acquaint the students with the techniques involve in manufacturing of different agro-textiles and study the recent development in the field
iii. Enable the students to Identify the properties required for agro textiles

Theory

Introduction to Agro-textiles. History, significance, Fibres used, Fabric Construction details, Properties required, production techniques and Advantages. Substantial Role of Agro-Textiles in Agricultural Applications- meaning, need, application, materials used, types, characteristics, advantages and constraints of different agro-textiles: Sun screen, Bird protection nets, Plant nets, Ground cover, Wind protectors, Windshield, Root ball net, Insect meshes, Turf protection net, mulch mats, monofil nets, cold and frost controls, covering pallets, anti hail stone nets, harvesting

nets, packing materials. Agro textiles for Animal husbandry, Fishing and aquaculture nets-meaning, need, application, materials used, types, characteristics, advantages and constraints of different agro textiles used in Animal husbandry, Fishing and aquaculture. Marketing strategy Significance of agro-textiles in technical textiles industries, Past, present and future prospects, techno-economics of agro-tech.

Practical

Introduction to all types of agrotextiles – showcasing the fabric samples and their applications. Survey for agro textiles in the market and collection of swatches. Identification of swatches, preparation of agro textile portfolio. Assessment of the functional property of agro textiles. Mini project (group activity)- Designing agro-textiles for specific functional performance.

Suggested Readings

1. www.textileworld.com/textile-world/.../agrotextiles-a-growing-field/. Accessed on 15th January 2025.
2. textilelearner.blogspot.com/2012/02/agro-textiles-general-property.htm. Accessed on 16th December 2024.
3. http://www.textilemedia.com/technical-textiles/new-textile-materials/agrotextiles/9.http://www.textileworld.com/Issues/2005/September/NonwovensTechnical_Textiles/Agrotextiles-A_Growing_Field. Accessed on 16th December 2024.
4. http://www.fibre2fashion.com/industry-article/textile-industry-articles/agrotextiles-a-rising-wave. Accessed on 16th December 2024.
5. http://www.indiantextilejournal.com/articles. Accessed on 15th January 2025.
6. Hira Manisha A. Agro-textile Products and Their Usage. Sasmira, Mumbai
7. *Handbook of Agro Textiles*: www.technotex.gov.in
8. http://www.technicaltextile.net/articles/agro-textiles/detail.aspx7article icl=5386. Accessed on 15th January 2025.
9. Horrocks AR and Anand S C. 2000.*Handbook of Technical Textiles*. 640p. Woodhead Publication Ltd, Cambridge.

Recent Advances in Textiles 2 (2+0)

Objectives

i. To develop an understanding among student about recent trends in fibres, fabrics, chemical processing and bio-finishes

ii. To impart knowledge about smart textiles, wearable clothing, use of microfibres, nano fibres and its application, microencapsulation, nanotechnology, technical textiles and application areas

Theory

Recent researches in production and manufacture of textile fibers, yarns and fabrics. Bio-finishes and processing of natural textiles and their conversion into clothing. Developments in the field of functional textiles, technical textiles and its application areas. Use of special techniques in textile processing. Thrust areas of contemporary research and future projections.

Suggested Readings

1. Journals of Apparels and Textiles
2. Online researches available on CERA and other web portals.

Resource Management and Consumer Science

Residential and Commercial Space Design 3 (2+1)

Objectives

By the end of the course the students will be able to:

i. Gain knowledge in designing space for family living
ii. Get exposure to design and decorate residential spaces
iii. Gain managerial skills and handle space efficiently for multiple functions
iv. Study building Codes, fire safety and barrier - free designs as essential components of laying out interior space
v. Learn use of presentation boards to assist clients in visualizing the design project

Theory

Residential and commercial buildings: types and characteristics. Factors influencing building design. Approaches to planning residential and commercial spaces. Steps in Design process. Understanding on building bye laws and standards. Design and space organization analysis of independent houses and apartments of different income groups. Estimation of cost of fittings, fixtures, furniture, lighting and materials for residential and commercial interiors. Study of commercial interiors for business establishments, hotels/ restaurants, hospitals, educational buildings, public service buildings. Specifications writing, tenders and contracts.

Practical

Develop conceptual drawings and floor plans for various income groups. Develop layouts of furniture, lighting, electrical and plumbing for various income groups. Practical applications of design and space organization of apartments and flats and analysis. Cost estimation for designing interiors of various income groups. Planning of ergonomic work layout for a small project (1000 sq. ft.). Planning of ergonomic work layout for hills areas and commercial areas. Evolving interior decoration details with material sample for the small project. Evolving interior decoration details with material sample for hills areas. Evolving interior decoration details with material sample for the large commercial area. Presentation of the detailed work done for small projects. Presentation of the detailed work done for hill areas. Presentation of the detailed work done for large commercial projects.

Suggested Readings

1. Bonda P and Sonsnowchik K. 2007. *Sustainable Commercial Interiors.* 320p. John Wiley and Sons Publication.
2. Crafts. 1999. *The office–Designing for Success.* 224p. Images Publication
3. Francis D. 1997.*The New Office*. 256p. Conran Octopus Publication

4. Harmon S and Kennon K. 2011. *The Codes guide book for Interiors.* (5th Edn.). 544p. John Wiley and Sons Publication.
5. James A. 1997. *Building Construction – Interior systems.* 156p. CBS Publishers and Distributors, New Delhi.
6. Joseph D C, Julius P and Martin Z. 1991. *Time - Saver Standards in Interior Design and Space Planning*. 1000p. McGraw-Hill Inc., US
7. Jones Lynn M and Allen Phyllis S. 2009. *Beginnings of Interior Environments.* (10th Edn.). 448p. Pearson Education Inc., New Jersey.
8. Karlen M. 2009. *Space Planning Basics.* (3rd Edn.). 256p. John Wiley and Sons Inc., New Jersey.
9. Knowles E and Boehr K M. 2014. *A comprehensive guide for selecting interior finishes.* 259p. Pearson education, USA
10. Piotrowski C and Rogers E. 1999. *Designing Commercial Interiors*. (2nd Edn.). 344p. John Wiley and Sons Publication.
11. Ralph Leibing W. 1999. *Architectural Working Drawings*. (4th Edn.). 704p. John Wiley and sons, New York.
12. Renuka S and Reddy Mahalakshmi V. 2009. *Housing and Space Management.* 382p. Directorate of Information, and Publications of Agriculture (DIPA), ICAR, New Delhi.
13. Sam K. 2003. *Space Planning for Commercial and Residential Interiors.* 524p. McGraw–Hill Professional, New York.

e-books

1. *Fundamentals of Building Orientation and Green Building features*. (4th Edn.). October 2015. Published by Indian Railways Institute of Civil Engineering, Pune.
2. *Model Building Bye-Laws*. 2016. Ministry of Urban Development, Government of India.
3. *National Building Code of India 2016.*Vol. 1. Published by Bureau of Indian Standards, New Delhi.
4. *Indian Standard- Recommendations for Basic requirements of Educational Buildings. 2006*. Published by the Indian Standards Institute, New Delhi.

Colour and Lighting In Interiors 3 (2+1)

Objectives

This course aims to help students to

i. Acquaint with various aspects of color and lighting
ii. Understand the theories and qualities of colour
iii. Study uses and applications of different colours
iv. Understand various aspects of colour in vision
iv. Get awareness about different sources of light and benefits of effective lighting
vi. Enrich the students with knowledge about right placement of lighting fixtures
vii. Study the amount of light needed for different activities

Theory

Importance of colour and light in interior environment. A brief history of colour as an interior design element. Physics of light. Physiology of vision. Properties of colour. Hue, value and intensity - harmony, mixing and colour interactions. Approaches and theories of colour. Cultural, physical and psychological effects of colour. Types of colour schemes. Related and contrast colour schemes. Factors to consider while choosing colour schemes for buildings. Visual tricks Use and application of colour in interiors of residential and non-residential buildings. Suitable colour schemes for residential, commercial, public, educational and religious building interiors. Importance and sources of lighting. Cultural and social aspects of lighting. Properties of lighting-Reflection, absorption, transmission and diffusion. Types of lighting. Decorative aspects of lighting. Lighting requirements for household activities. Lighting requirements in commercial buildings. Measurement of light and its units. Types of lamps, their characteristics and suitability to various rooms. Types of lighting based on direction of use, place of use, purpose and portability. Lighting controls. Lighting Luminaires/ fixtures. Factors affecting the quantity of illumination in a room. Method of calculating lighting requirements for various rooms. Lighting for outdoor living and gardens. Colour rendition. Use of colour and lighting in architecture. Use of colour and lighting in problematic areas - disguise and camouflage. Lighting different spaces in the interiors. Important Lighting terms. Importance of Controlling Luminance. Eco - friendly lighting benefits and ideas. Need for quality in the selection of colours and lighting in the built environment.

Practical

Study of types of colour schemes in residential interiors. Study of types of lamps and lighting used in residential interiors. Planning colour schemes for residential interiors. Group discussion on use of colour and lighting in interiors. Study of types of colour schemes in commercial interiors. Study of types of lamps and lighting used in commercial interiors. Presentation on use of colour and lighting in commercial interiors. Suggesting suitable colour schemes for commercial buildings and its cost estimation. Group discussion on suitable colour schemes for residential and commercial buildings. Suggesting suitable colour schemes for commercial buildings and its cost estimation. Group discussion on suitable colour schemes for residential and commercial buildings. Suggesting suitable lighting fixtures for residential buildings and its cost estimation. Drawings to show the effect of different types of lighting in interior spaces. Lighting calculations for interior spaces using different methods- cavity method and point to point method. Suggesting suitable lighting fixtures for commercial buildings and its cost estimation. Group discussion on suitable lighting fixtures for residential and commercial buildings. Prepare a colour and lighting plan for problematic areas like space below stair case and estimate the cost. Prepare a colour and lighting plan for problematic areas like, irregular shape rooms or narrow areas and estimate the cost. Market survey to understand the available safety and emergency lighting systems and presentation of report.

Suggested Readings

1. Grosslight J. 1984. *Effective Use of Daylight and Electric Lighting in Residential and Commercial Spaces*. 249p. Practice Hall, New Jersy.
2. Itten J. 1970. *The Elements of Colour.* 96p. Van Nostr and Reinhold Company, NewYork.
3. Nielson K J and Taylor D A. 1990. *Interiors an Introduction.* 464p. Wm. C. Brown Publishers. IA, USA.
4. Nissen Lu Ann, Faulkner R and Faulkner S. 1994. *Inside Today's Home.* 672p. Harcourt Brace College Publishers, New York.

5. Seetharaman P and Pannu P. 2005. *Interior Design and Decoration.* 336p. CBS Publishers and Distributors. New Delhi.

6. Zelanski P and Fisher M P. 1999. *Colour.* 176p. Prentice Hall, New Jersey.

Tourism and Hospitality Management 3 (1+2)

Objectives

The course aims to help the students to gain a basic knowledge of:

i. Skills associated with problem solving, creative and critical thinking; related to tourism industry

ii. Applying the concepts and skills necessary to achieve guest satisfaction

iii. Demonstrating knowledge of multi - cultural perspectives to meet the needs of the guests and employees

iv. Leading with the knowledge that the foundation of tourism and hospitality is based on the respect for the host culture with the responsibility to perpetuate unique values, traditions, and practices of that place

v. Demonstrating ability to perform basic and supervisory level job functions in hotel and restaurant careers

Theory

Tourism Management Introduction to Tourism, Growth and development of modern tourism, Tourism in India, Heritage/ Cultural, Pilgrimage Tourism, Medical, Hot Spots and Culinary Tourism. Business and Cruise Tourism. Eco-tourism/ Rural tourism. Emergence of Eco-tourism / Rural tourism: Concept and definitions. Growth and development issues in eco-tourism. Travel Agency and Tour Operation and logistics (Airlines operation and ticketing. Ships cruise services) business in India. Emerging trends of tourism, Impacts of Tourism. Ethics issues in tourism - Introduction to Hospitality Management. Basic Management Principles: planning, organizing, staffing, leading, controlling with specific reference to hospitality. Hotel hierarchy: GM, departmental heads, supervisors. Operational employees Soft Skills in Hospitality: personal development, motivation. Communication techniques and skills. Hostess training Services offered to guests such as food and accommodation services and personal services Front Office management. Maintenance of front office records: Housekeeping services, cleaning and linen services, Bed making Accommodation Operations: Role of accommodation operations in hospitality. Public areas – maintenance and decoration.

Practical

Study of all the activities of a tourism office and report Planning for a tour: Heritage, Eco, Wildlife, Pilgrimage, medical etc. Planning for Accommodation operations. Preparation of a tour package. Visit to different tourist spots. Planning layouts of front office of different institutions. Mock sessions on front office handling. Mock sessions on Communication Techniques and Skill. Mock sessions on Handling Complaints and Emergencies. Mock sessions on Handling various types of clients. Practical sessions on Hostess training. Services offered. Practical sessions on housekeeping services. Report writing.

Suggested Readings

1. Dharmarajan S and Seth R. 2007. *Tourism in India-Trends and Issues.* (1st Edn.). 232p. Har Anand Publications Pvt. Ltd., New Delhi.
2. Gupta S. 2006. *World Tourism in New Millennium.* ABD Publishers, Jaipur, Firstedition.
3. Kamra K K and Chand M. 2006. *Basics of Tourism- Theory, Operation and Practice.* (1st Edn.). 270p. Kanishka Publishers, New Delhi.
4. Maken D. 2004. *Strategies and Planning in Tourism and Industry.* (1st Edn.). 300p. Adhyayan Publishers and Distributors, Delhi.
5. Puri M and Chand G. 2006. *Tourism Management.* (1st Edn.). 339p. Pragun Publications, New Delhi.
6. Roday S, Biwal A and Joshi V. 2009. *Tourism Operations and Management.* (1st Edn.). 502p. Oxford University press publication, New Delhi.
7. Sharma R B. *World Tourism in 21st Century.* (1st Edn.). Alfa Publications, New Delhi.

Financial Management and Consumer Behaviour 3 (2+1)

Objectives

i. To develop understanding of concepts of income and expenditure among families
ii. To provide skills and techniques requisite to tackle consumer problems and management of finance and consumer education
iii. To enhance knowledge on consumer behavior and issues and e-tailing concepts

Theory

Importance of financial management. Income concepts; Circular flow of Income: the wheel of wealth, factors affecting fluctuations in income, depreciation in money value: inflation, deflation, consumer price index. Financial planning - Steps of successful financial planning; Financial spending plan. Budget: types, steps, advantages and disadvantages. Credit and credit instruments. Saving and investment. Taxation. Consumerism and Consumer Protection: Consumer rights and responsibilities, Consumer Protection Act 2019, Other important Govt. Laws/ Acts for protecting consumers. Consumer Courts: Redress mechanism. Consumer Protection Councils. Advertising Standards Council of India. Standards and standardization and legislative measures for regulating quality. Role of Govt. and NGOs for consumer protection and welfare. Consumer issues and challenges. Consumer behaviour: Defining consumer behaviour, meaning and importance of consumer behaviour. Consumer decision making: Determinants and consumer choices, impact of technology on consumer choices and economic well - being, factors affecting consumer behaviour. Social, cultural and group influences on consumer behavior, Individual determinants, motivation and personality on consumer behaviour. Environmental influences on consumer behaviour. E-consumer behaviour: E - marketing/ E - consumerism/ E - business/ E - tailing. Digital marketing: techniques and strategies. Trends in marketing with respect to consumer behaviour.

Practical

Conducting survey on few families to study various sources of family income, drawing income profiles, and studying their methods of handling money income. Planning Budgets

for families with different income groups. Exercise on calculation of Consumer Price Index. Preparing educational aids on Consumer Rights and Responsibilities. Exercise on filing a consumer complaint in Consumer Forum. Collecting/ studying fraudulent advertisements on print and electronic media and reporting about them. Collecting different products with Standardization marks. Collecting Product Labels and studying labeling details. Market survey to study Weights and Measures practices by vegetable sellers, cloth sellers, ration shops, petrol pumps, LPG cylinders etc. and making a report. Visit to Consumer Forum. Carryout a short study (may be using google forms) to study Consumer behaviour components in buying any product. Reporting and presentation. Explore problems/ cheating in e-shopping.

Suggested Readings

1. Bhatt R. 2010. *Consumer Behaviour.* 263p. Common Wealth Publishers Pvt. Ltd.
2. Dewett K K and Navalur M H. 2006. *Modern Economic Theory.* 1024p. S Chand Publications, New Delhi.
3. Gross Grandall and Knoll. 1980. *Management for Modern Families.* (3rd Edn.). 466p. Prentice Hall, Inc. Englewood Cliffs, New Jersey.
4. Khan M. 2011. *Consumer Behaviour and Advertising Management*. 390p. New Age International Private Ltd. Publishers.
5. Nickel and Dorsey. 1976. *Management in Family Living.* (4th Edn.). 492p. Willey Eastern Limited, New Delhi.
6. Rice, Nickel and Tucker. 1976. *Management in Family Living.* (5th Edn.). 566p. John Wiley and Sons, Inc. New York, London.
7. Sharma S and Singh R. 2021. *Advertising: Planning and Implementation.* 456p. Prentice Hall India Learning Private Limited.
8. Shukul M and Gandotra V. 2006. *Home Management and Family Finance.* Dominant Publishers and Distributors, New Delhi.
9. Seetharaman P and Sethi M. 2001. *Consumerism. Strategies and Tactics*. 320p. CBS.
10. Swanson B B. 1983. *Introduction to Home Management.* 332p. Macmillan Publishing Co. Inc., New York.
11. Waugh A E. 1987. *Principles of Economics*. 624p. Mc Graw Hill Book Company, Inc. NewYork.

Workspace and Product Design 3 (1+2)

Objectives

The course aims to help students in:

i. Developing skills in space designing for different activities
ii. Understanding the importance of space designing to avoid work related health hazards.
iii. Developing skills in designing workspace for residential, commercial and industrial units
iv. Developing skills in design consideration in product development
v. Familiarizing with product design and product manufacturing terminologies
vi. Understanding how to use users in product design cycle
vii. Evaluating the products in the consumer market from usability perspective

Theory

Body Mechanics. Functional design of workspace. Concept of functional design, centre concept, design and arrangement of different work centers, designing of work surface, storage and work accessories/ appliances. Lighting/ furniture requirements for different activities. Hazards of ill designed workstations. Functional designing of workspace for physically handicapped and elderly population. Design concepts: Design definition, design terminologies (user-centered design, user-friendly design, accessible design, universal design, usability, etc.). Design process. Design sustainability-Ergonomic factors in design, user interface, use of design elements for ease of operation of a product. Quality Control and Standardization of Product, and product certification. Design consideration for accessible products. Work, worker workplace interrelationship.

Practical

Evaluation of existing workstation in a residential product. Understanding the selected consumer products through guidelines given by manufacturers. Evaluation of selected product to find out the ease of operation. Ideation of design concepts.

Suggested Readings

1. Bootheroyd G, Dewhurst P and Knight W. 2002. *Product Design for Manufacture and Assembly.* 698p. CRC Press.
2. Dalela S and Saurabh. 1999. *Textbook of Work Study and Ergonomics.* 492p. Standard Publication.
3. Frey D. 1998. *Auto CAD 14.* 631p. BPB Publication.
4. Galer Ian.1982. *Applied Ergonomics Handbook.* 272p. Butterworth sand Co.
5. Grandgean E. 1978. *Ergonomics of the Home.* 344p. Taylor and Francis.
6. Marcelo M S. 2021. *Ergodesign Methodology for Product Design: A Human - Centered Approach.* 50p. Taylor & Francis Ltd.
7. Marcelo M S. 2021. *Handbook of Usability and User Experience Research and Case Studies.* 640p. CRC press.
8. Panero J and Zelnik M. 1979. *Human Dimension and Interior Space.* 716p. Whitney Library of Design, US.
9. Ron H (Special Eds). 2000. *Using Auto CAD 2000.* 832p. Prentice Hall of India.
10. Sharma D D. 2000. *Total Quality Management.* 456p. Sultan Chand and Sons.
11. Singh S. 2007. *Ergonomics Interventions for Health and Productivity.* 617p. Himanshu Publication.
12. Karwowski W, Szopa A, Soares M M. 2021. *Standards and Guidelines in Human Factors and Ergonomics.* 756p. CRC press.

Human Development and Family Studies

Developmental Challenges in Children 3 (2+1)

Objectives

i. To be able to identify children with developmental challenges
ii. To develop a positive attitude among people towards the developmentally challenged
iii. To create awareness of mainstreaming
iv. To understand the rights of the developmentally challenged child
v. To impart knowledge on intervention strategies
vi. To create awareness among people regarding the various welfare services available for those with developmental challenges

Theory

Developmental Challenges: classification and types. General provisions for persons with developmental challenges. Identification of 'At Risk' children. Special needs and special education: Definition of special needs of children and special education, terminologies for children with special needs, history of special education, current trends and issues in special education. Need and objectives of Special Education. The NEP/NPE (2020) and the pDefiningrogram of action relating to special education. Legislation and litigations of special education. Labelling: definition and its effects. Mainstreaming: definition, models of mainstreaming, problems in implementing mainstreaming, effect of mainstreaming on children with special needs. Intellectual disabilities: Definition, classification, Identification, Diagnosis, Prevalence, causes and measurement/ Assessment of Intellectually challenged, their psychological and behavioral characteristics and educational considerations for Intellectually challenged children, Instructional methodology, managing child in school. Learning disabilities: Definition, types, prevalence, causes and measurement of LD, psychological and behavioural characteristics of LD children, educational considerations for LD children, managing child in school. Communication disorders- definition, speech production, speech disorders, language disorders, multiple disorders (disorders associated with cerebral palsy, hearing impairment, cleft palate or cleft lip, MR, ED and LD), prevalence, causes of CD, identification, psychological and behavioural characteristics of CD children, educational considerations for CD ear, classification, prevalence, causes, measurement of AI children, psychological and behavioural characteristics of AI children, educational considerations for Achildren, managing child in school. Auditory impairment- definition, anatomy and physiology ofI children, managing child in school. Visual impairment - anatomy and physiology of eye, definition, classification, prevalence, Identification, causes and measurement of VI children, psychological and behavioural characteristics of VI children, educational considerations for VI children, aids and equipment, managing child in school. Physically challenged- definition, classification, prevalence, musculoskeletal conditions, congenital malformations, accidents, diseases and other conditions, psychological and behavioural characteristics of P challenged children, educational considerations for PC children, managing child in school. Neurological impairments - Convulsive disorder- causes, types, diagnosis, treatment, characteristics, managing child in school. Cerebral palsy- Definition, types, causes, Diagnosis, Treatment and managerial provisions, educational provisions for the children with cerebral palsy. Autism- definition, diagnosis and identification, assessment, causes, characteristics. Emotional disorders- definition, classification, prevalence, causes and identification of ED, psychological and behavioural characteristics of ED children, educational considerations for ED children, managing

child in school. Giftedness- definition, prevalence, origins of giftedness, screening and identification of giftedness, psychological and behavioural characteristics of gifted children, attitudes towards gifted children, educational considerations for gifted children, managing child in school. Rights and provisions for children with special needs in India. Constitutional provisions and protection for differently abled children in India. General provisions for persons with developmental challenges, Intervention- concept, methods, steps and process, intervention strategies for children with special needs, role of professionals, need and importance of family centred intervention – Family counselling for children with special needs.

Practical

Observational visits to institutes/case studies of children with special needs. Identification of children with special needs in the local community. Developing educational material on identification of children with special needs, organizing educational programmes for families of children with special needs, planning, recreational and vocational activities for children with special needs. Presentation of case study reports.

Suggested Readings

1. Achenbach T M. 1982. *Developmental Psychopathology.* (2nd Edn.). 770p. John Wiley, New York.
2. Berdine W H and Blackhurst A E. 1985. *An Introduction to Special Education.* (2nd Edn.). 743p. Harper Collins, Lexington.
3. Hegarty S And Alur M. 2002. *Education and Children with Special Need.* 220p. Sage publication. New Delhi.
4. Kar C. 1992. *Exceptional Children: Their Psychology and Education.* 183p. Sterling Publishers Pvt. Ltd., New Delhi.
5. Loring J and Burn G (Eds). 2016. *Integration of Handicapped Children in Society.* 234p. Routledge and Kegan Paul, London.
6. Mangal S K. 2007. *Educating Exceptional Children-An Introduction to Special education.* 604p. PHI Learning Pvt. Ltd., Dehli.
7. Prasad J and Prakash R. 1996. *Education of Handicapped Children, Problems and Solution.* 300p. Kanishka publication distribution. New Delhi.
8. Philip M and Duckworth D. 1982. *Children with Disabilities and their Families: A review of research.* Berks: 132p. NFER-Nelson Publishing Co., Windsor.
9. Rozario J and Karanth P. 2003. *Learning Disability in India.* 183p. Sage Publication. New Delhi.
10. Singh A N. 2001. *Enabling the Differently Able: Concepts, Education and Community.* 220p. Sipra publications, Delhi.
11. Taylor R L and Sternberg L. 1989. *Exceptional Children: Integrating Research and Teaching.* 419p. Springer Study Edition, Springer- Verlag. New York.
12. Tinberger N and Tinberger E A. 1986. *Autistic Children: New Hope for a Cure.* 372p. Allen and Unwin, London.
13. Werner D. 1987. *Disabled Village Children (Indian Edition).* 654p. Voluntary Health Association of India, New Delhi.

Methods and Materials for Teaching Young Children 3 (1+2)

Objectives

i. Identification of use of different creative materials

ii. Exploring different methods for use in the classroom

iii. Hands on practice of use of methods and materials

iv. Developing resource files on methods and materials for regular use in classrooms

Theory

Orientation on different methods and materials used for teaching young children. Children's literature:Definition, importance and different kinds of literature appropriate for young childre. Story telling- definition, types and different techniques for effective storytelling. Teacher led story telling methods. Children led story telling methods: Role play, singing, using masks etc. Creativity: Definition, types, characteristics of creative children. Art and art activities (Painting, drawing, paper craft, collage, modelling, printing and sand art). Use of raw material, natural material in art and creative work. Creative expression in young children. Iidentification of different types of creative expressions, developing rhymes with music and movements appropriate for young children. Puppets: Importance and types (finger, stick, sting, glove and shadow) in child development. Building blocks and their innovative uses. Importance of music and use of music and musical instruments for young children. Innovative Class room arrangements. Bringing nature into the classroom. Guest appearances in classroom: Use of films, documentaries in teaching concepts. Resource file, its importance and usefulness. Educating parents/teachers on use of learning materials for young children.

Practical

Use different methods and indigenous/creative materials for teaching young children. Survey and reporting of available different kinds of literature appropriate for infancy through early childhood. Reporting on different kinds of literature appropriate for infants and preschool children. Visit to Organizations and children's libraries for development of literature. Practicing different techniques of storytelling and analyzing effectiveness. Developing stories appropriate for young children. Developing stories on Folk tale. Developing moral stories. Developing stories related to epics. Identification of different types of creative expressions in young children. Planning and implementing activities to promote creative expressions among young children through a variety of media (Rhymes, drama, role play and story). Preparation of art file appropriate for young children. Preparation of paper craft. Preparation of Painting file. Preparation of drawing file. Preparation of murals. Preparation of printing and collage. Preparation of resource books teaching daily life concepts. Preparation of different types of puppets and Scripting for short puppet show and creative dramas. Preparation of finger/stick puppets. Preparation of string/ hand puppets. Preparation of shadow puppets. Preparation of collage, murals and models appropriate for infancy through early childhood. Art activities (Painting, tearing, cutting, pasting and collage, murals, modelling, printing blocks, sand and mud, water). Practicing musical activities: use of music, voice modulation and sound effects. Preparation of resource file and teaching materials for young children. Evaluation of materials for teaching young children. Organizing an exhibition for parents of young children.

Suggested Readings

1. Blackie P Bess, Bullough B and Nash D.1972. *Drama.* 63p. Macmillan, London.
2. Contractor M. 1984. *Creative Drama and Puppetry in Education.* 122p. National Book Trust of India, Delhi.
3. Currell D. 1985. *The Complete Book of Puppet.* 206p. A and C. Black, London.
4. Garretson R. 1966.*Music in Childhood Education*. 298p. Meredith Publishing Company, New York.
5. Hendrick J. 1980. *Total Learning for the Whole Child.* 416p. The C V Mosby, St. Louis.
6. Kaul V. 1991.*Early Childhood Education Programme.* 300p. NCERT, New Delhi.
7. Kaul V and Bhatnagar R. 1992. *Early Childhood Education, A Trainer's Handbook*. 223p. NCERT, New Delhi.
8. Lacper S Witherspoon R and Day B. 1984. *Good Schools for Young Children.* 569p. Mac Millan, New York.
9. Maxim G. 1985.*The Very Young.* 568p. Wadsworth Publishing Company, Belmont, California.
10. Murlidharan R and Asthana S. 1991.*Stimulation Activities for Young Children.* 68p. NCERT, New Delhi.
11. Robinson H. 1983. *Exploring teaching.* Allyn and Bacon, London.
12. Swaminathan M. 1984. *Play Activities for Young Children.* 214p. UNICEF, New Delhi

Computer Application in ECCE 3 (1+2)

Objectives

i. To enable students to equip 21st cenutary skills, abilities that have been identified as being required for success

ii. To strengthen students with Digital literacy skills: information literacy, media literacy, Information and communication technologies (ICT) literacy

Theory

Introduction to computer. Windows operating system. MS Word. Power point program. Excel Programme. Data management skills. Internet usage. Web based resources. ICT tools in classroom teaching. Introduction to multimedia. Basics of Graphic Design. Use of Digital technology. Definition of Digital images. Colour theory and basics. Digital imaging in multimedia and animation. Use of Design Elements in Digital Layouts. Scanning / Capturing Images. Masking and Colour adjustments. Editing Images, Cutting and Morphing. Work in different media, such as drawing, collage, and painting. Working with visual images. 3D Modeling - 3D Shading. Animation. Making videos with animation. Editing videos. Software available for preschool program. Integrating technology into ECCE classroom: Issues and challenges. Developing and maintaining digital records for ECCE. Using Digital Media to Support Early Learning. Digital Tools for Learning, Creating, and Thinking. Developmentally Appropriate Strategies for Early Childhood Educators. Effects of using computer applications for teaching and learning.

Practical

Create word document. Prepare a broacher to advertise preschool program. Power point presentation on parent education program. Design Flyer for conducting workshop. Prepare a

sample record of student information. Prepare a sample record of stock. Prepare sample record of fee payment particular. Prepare evaluation report of student. Prepare evaluation report of teachers. Google form for feedback. Create an animated story. Digital lesson on alphabet. Develop a video on any concept. You tube rhymes. 3D modelling on animals. Graphics for numerical skill development in children. Create a story of animals with visual effect. Develop a simple science experiment on a digital platform. Animated cartoons. Develop two animated characters for the concept introduction.

Suggested Readings

1. Adekemi A A. 2001. *Introduction to Computer Education.* An Unpublished Monograph, Obafemi Awolowo University, Ile-Ife.
2. Ajibade A. 2006. *Effects of Interactive Instructional Compact Disc Package on the Performance of English Language Learners in Schools of Science in Osun State.* Unpublished Ph. D. Dissertation, Faculty of Education, ObafemiAwolowo University, Ile-Ife.
3. Amani M and Albarkati S A. 2016. The Application of Computer in Education System and its Significance to Teaching and Learning, *International Journal of Computer Applications* **134**(9).
4. Hussein C. 2021. Computer Applications. Center for Research, Documentation and Publishing - FTHM - Lebanese University.
5. Fantozzi Victoria B. 2022. *Digital Tools for Learning, Creating, and Thinking: Developmentally Appropriate Strategies for Early Childhood Educators.* NAEYC, Washington DC.
6. Mahin L. 2004. PowerPoint pedagogy. Business Communication. *Quarterly* **67**: 219-222.
7. Paje Y M, Rogayan D V and Dantic M J P. 2021. Teachers' utilization of computer-based technology in science instruction. *International Journal of Technology in Education and Science (IJTES)* **5**(3): 427-446.
8. Software for Preschool program that the department has to purchase
   - https://sourceforge.net/software/child-care/india/
   - https://educase.io/daycare-management-software/
   - https://play.google.com/store/apps/details?id=preschool.erpsoftware.app and hl=en and gl=USEduSys Pre-school ERP -Childcare Play-school Management Software

(Footnotes: The course computer application in ECCE requires advanced skills in computer graphics, animation and digital techniques. As the HDFS faculty may not be equipped with computer skills needed in dealing with the course, an advanced training program in computer skills is required for the teachers. It is also required to hire a computer specialist to teach course content at least for one semester or till the faculty gets trained)

Guidance and Counselling 3 (2+1)

Objectives

i. To orient about different techniques of counselling and guidance for different problems /areas

ii. To learn about essential skills of family counselling and child guidance

iii. To understand various needs of children and families for counselling and guidance services

Theory

Guidance: concept, need, nature, scope, goals and essentials, characteristics, principles and assumptions, techniques, challenges, history. Guidance services in India. Foundations / Bases for Guidance: Philosophical, Psychological, Socio-cultural. Types /Areas of Guidance: Educational Guidance, Vocational Guidance, Personal-Social Guidance/ Group Guidance. Guiding children: Infants and Toddlers, pre-schoolers, school age. Guidance for adolescents: Career and Vocational guidance. Counselling: Meaning, Purpose, Goals and objectives, Scope, History, Characteristics, Principles, Levels, Classification. Thrust areas of Counselling. Life Span stages and counselling. Functions of counselling. Different types of counselling Techniques. Theories to counselling: Psychoanalytic theory, Roger's Self theory, Trait theory, Field theory, choice theory, behavioural learning theory, Family systems theory. Approaches to counselling. Psychoanalytical approach: psychotherapy/ psychoanalytic therapy, Transactional Analysis therapy. Behaviouristic approach: Behaviour therapy, Rational emotive behaviour therapy (REBT), Cognitive Behaviour Therapy (CBT). Humanistic approach: Client centered therapy, Gestalt therapy, Existential therapy and other Contemporary therapies: Adlerian therapy, Reality therapy, Family systems therapy, Feminist therapy. Counselling: Process, Aspects, Dimensions, Stages. Effective strategies in counselling. Counselling skills: Meaning, Categories. Premarital counselling: Concept, process, techniques. Marital Counselling: Couple counselling process and techniques. Family Counselling: Concept and its evolution, aims and objectives, types, process. Counselling for Special groups: delinquents, women, weaker sections, drug addicts, physically handicapped, emotionally handicapped, reluctant clients, surrogacy. Tools and techniques of Assessment in counselling: Standardised and non standardised techniques. Modern / current trends in counselling. Roles, Characteristics or Qualities of a Counsellor. Limitations of Counselling. Ethical issues and Dilemmas in Counselling.

Practical

Visit to Child Guidance institutions (CGC). Visit to Family guidance and Counselling institutions. Family Court/ Women protection Cell/ Domestic Violence cell. Visit to a career or vocational counselling centre. Review on various aspects of guidance and counselling. Studying problems and issues in children / adolescents(Educational, psycho-social, emotional and personality related). Demonstration on techniques of guidance by the trained professional. Simulation exercises on guidance for children/ adolescents. Developing guidance program for the identified children/adolescents. Executing guidance program on the identified children/ adolescents. Presenting reports on guidance program conducted. Identifying families with problems and conducting case studies. Demonstration on counselling techniques by the certified counsellor. Simulation exercises on counselling sessions. Developing counselling sessions for the identified families. Play therapy/ REBT/CBT. Executing counselling session. Presenting reports on counselling session conducted. Developing Resource Files on Guidance and counselling services for families.

Suggested Readings

1. Asha K K. 2008. *Guidance and Counseling.* 179p. Dorling Kindersly (India) Pvt. Ltd, New Delhi.

2. Chauhan S S. 2001. *Principles and Techniques of Counseling.* 296p. Vikas publishing house Pvt. Ltd., New Delhi.
3. Cooper S. 2005. *Counseling, Inception, Implementation and Evaluation.* 287p. Infinity Books, New Delhi.
4. Corney G. 2017. *Counselling and Psychotherapy,* (10th Edn.). 512p. Cengage learning, New Dehli.
5. Elizabeth R W and Peterson L E. 2000. *The Counseling Process, (6th Edn.).* 384p. Printice Hall Inc. U.S.A.
6. Geldard K and Geldard D. 2002. *Counseling Children - A Practical Introduction.* 344p. Sage Publications, New Delhi.
7. Geldard K and Geldard D. 2002. *Counseling Adolescents*. 344p. Sage Publications, New Delhi.
8. Hildebrand V. 1985. *Guiding Young Children*. (4th Edn.). 413p. Mac. Millan Publishing Company, New York.
9. Srivastava K K. 2003. *Principles of Guidance and Counseling.* 428p. Kanishka Publishers, New Delhi.
10. Indira M. 2000. *Guidance and Counseling.* 302p. Authors Press, New Delhi.
11. Jones R N. 2000. *Introduction to Counseling Skills.* 344p. Sage Publications, New Delhi.
12. Nayak A K. 2002. *Guidance and Counseling*. 250p. APH Publishing Corporation, New Delhi.
13. Narayana Rao S. 1997. *Counseling and Guidance*. 408p. Tata McGraw-Hill Publishing ompany Ltd., New Delhi.
14. Richard N J. 2003. *Basic Counseling Skills. A Helper's Manual*. 200p. Sage Publications, London.
15. Sharma R N and Sharma R. 2004. *Guidance and Counseling in India*. 496p. Atlantic Publishers and Distributors, New Delhi.
16. Vasantha R P. 2001. *Counseling Psychology.* 297p. Authors Press, New Delhi.

Parent Education and Community Welfare Programmes 3 (2+1)

Objectives

i. To develop skills and build confidence to educate the parents
ii. To enhance skills in developing intervention programmes for different vulnerable/ disadvantaged groups of the community
iii. To facilitate the students to work directly for the welfare of local community

Theory

Meaning, Need and Importance of Parent education and Community Welfare. Theories of Community education and its relevance to today's community. Social role valorization theory. Understanding recent issues and challenges of parent education and community welfare. Studying various methods of parent education. Wisconsin's components of community education. Need assessment: its importance, need assessment of parents, and vulnerable groups of the community. Program planning and implementation, methodology for parent and community education. National (Govt. and Non govt.) Community welfare programmes: Child and family welfare

programmes, constitutional provisions for children, act and legislation relating to protection and welfare of children, act for developmentally challenged, legislations pertaining to parents, women, youth, other gender and elderly. Appraisal of existing welfare programmes and their utility in the community. Ongoing income generating policies and programmes, gender mainstreaming programmes and policies, reservations, concessions and special facilities of Government of India for vulnerable groups of the community related to health, education, employment, industries and agriculture. International, national and regional policies and programmes (Govt. and Non govt.) for vulnerable groups, family and community. Identification of organizational structure/ implementing agencies at different levels. Role of NGO's in community development. Corporate social responsibilities: meaning, role of government in corporate sector and role of the institution (Corporate) in community development.

Practical

Visits to various government, non-government organizations and corporate sectors working for the welfare of the parents, children and community. Finding out role and challenges. Report presentation. Visit to local community to conduct parent and community needs assessment, identify vulnerable parents, families with problems and to conduct case studies, report presentation. Identification of areas and issues for parent education, developing parent education programmes: Planning, preparation (creating WhatsApp group, making online flyer) conducting, and evaluating parent education programmes. Report presentation. Awareness/capacity building Programmes with the help of change agent of community development/ organizations (Anganwadi worker, Asha worker, Mohila Shakti Kendra, KVK, FPC, ATMA, APART etc.) to orient community people to the procedure for obtaining different government/ non-government services (how, where, when, whom to apply). Orientation to the use of social platforms. Report presentation. Observation of / participation in community development programmes (Gaon Sobha, health camp etc.). Find out the missing link and develop a road map for a specific community (tribal areas, tea garden areas, slum areas etc.) for overall development and establishing linkages with different Government/Non-government agencies for welfare of that specific community. Report presentation.

Suggested Readings

1. Boraian P M. 2008. *Employment of Rural Women.* 223p. Concept Publishing Company, New Delhi.
2. Cempbell D. 2003. *Group Parent Education: Promoting Parents Learning and Support.* 249p. Sage Publication, Delhi.
3. Epstein L J. 2010. *School, Family and Community Partnership: Preparing educators and Improving School.* 376p. Westview press, US.
4. Marasimhan S. 2001. *Employment of Women.* Sage publication, New Delhi.
5. NIPCCD. 1994. *Child in India: A Statistical Profile.* NIPCCD, New Delhi.
6. Randhawa M S. 1991. *The Rural and Urban Aged.* 187p. National Book Organization, Unit IX, New Delhi.
7. Saraswathi S. 1988. *Youth in India*. 507p. ICSSR, Govt. of India, New Delhi.
8. TISS. 1994. *Enhancing the Role of Family as Agency for Social and Economic Development.* Vol. II, Part II. 287p. TISS Bombay.

9. UNICEF. 1990. *Children and Women in India: A Situation Analysis (*Unit VI & VII). 216p. UNICEF, India.

Extension Education and Communication Management

Extension program Management 3 (1+2)

Objectives

i. To understand the importance of extension program and program planning
ii. To impart knowledge regarding monitoring and evaluation of extension programs
iii. To acquire skills in collecting village information using PRA tools
iv. To gain practical experience in developing schedules and collecting information in rural areas
v. To develop practical experience in planning, implementing and evaluating small need based program

Theory

Extension program: meaning; definition, objectives and characteristics. Extension program planning: meaning, concept, objectives, principles. Steps in extension program planning. Professional abilities needed by planners and criteria for program planning, program implementation. Environment and rapport building. Role of local leaders. Local bodies. Organizations and extension agencies in program implementation. Participatory Rural Appraisal (PRA) tools and techniques: Transect walk, seasonal calendar, Venn diagram, daily routine charts. Participatory Rural Appraisal (PRA) tools and techniques: flow diagram, social mapping, matrix ranking. Steps in program implementation and constraints in implementation of programs at grass root level. Monitoring and evaluation of extension program: meaning, definition, concept and types. Pros and Cons of few national level extension program.

Practical

Visit to village to identify key informants and establishing rapport. Visit to village to identify rural institutions. Identifying needs and problems of the village with the help of questionnaire. Different PRA tools and its application for data collection: Transect walk, seasonal calendar, Venn diagram, daily routine charts. Participatory Rural Appraisal (PRA) tools and techniques: flow diagram, social mapping, matrix ranking. Development of schedule for collecting baseline information of village. Conducting village and household survey: Socio-economic survey, nutritional status. Conducting village and household survey: Agricultural problems use of Government schemes/programs. Development of need assessment schedule. Collection of data through the developed schedules. Conduct of need assessment. Analysis of data. Preparation of survey reports. Planning a small need-based program. Developing a detailed plan of work for the need based program. Implementation of the need-based program. Evaluation of the need based program implemented. Documentation and presentation of program findings.

Suggested Readings

1. Dahama O P and Bhatnagar O P. 2003. *Education and Communication for Development.* 734p. Oxford IBH, New Delhi.
2. Santha G, Tamilselvi G and Meenambigai J. 2013. *Extension Education and Rural Development*. 494p. Agrobios Jodhpur.
3. Gupta Debabrata Gupta D. 2011. *Extension Education: Core Contents and Emerging Area*. 408p. Agrobios (India), Jodhpur.
4. Ray G L. 2004. *Extension Communication and Management.* 382p. Kalyani Publishers, New Delhi.
5. Reddy A A. 2001. *Extension Education.* 344p. Sri Lakshmi Press, Baptala.
6. Sandhu A S. 2003. *Extension Program Planning*. 158p. Oxford IBH Publishing, New Delhi.
7. Supe S V. 2011. *Integrated Extension Education*. Agrotech Publishing Academy, Udaipur.
8. Verma V, Verma S and Rani E 2019. *Chapter-1 Programme Planning and Evaluation*, Multidisciplinary- 1.

Extension Training Management 3 (1+2)

Objectives

i. To develop understanding about process of training
ii. To develop skills in use of different training methods
iii. To develop competence in designing, implementation and evaluation of training program

Theory

Training -concept and importance. Types of training: Extension trainings. Online and blended training. Phases of training and its management. Qualities of a good trainer. Adult learning. Characteristics of adult learner. Principles of adult learning. Facilitation skills in training. Identification of training needs. Training methods: Lecture, demonstration, Field trip, Group discussion, case study, role play, T-group training, games, practice clinics, small group task. Steps of designing training program. Training evaluation: Meaning, importance, indicators and methods. Problems in training. Important training institutions in India for extension functionaries, farmers and entrepreneurs.

Practical

Visit to training institutes. Hands on experience on training methods: Lecture/Lecturette. Hands on experience on training methods: Demonstration. Hands on experience on training methods: Case study. Hands on experience on training methods: Role Play. Hands on experience on training methods. Games. Hands on experience: Identifying training needs and needs analysis. Formulation of training objectives. Familiarization with different steps of training. Familiarization with ice-breaking session. Familiarization with online and blended training. Familiarization with monitoring and evaluation tools. Checklist for planning training program. Planning of a training program according to mode of training. Procurement of training material and all preparation. Execution of training program. Evaluation of training program. Preparation and presentation of report.

Suggested Readings

1. Lynton R and Pareek U. 1991. *Training for Development*. 410p. Vistar Publ., New Delhi
2. Singh R P. 2000. *Management of Training Programmes*. 326p. Anmol Publications Pvt. Ltd. New Delhi - 110002 (India).
3. Singh R P, Jhamtani A and Singh P. 1996. *Training Management- A Handbook*. 124p. Jain brothers, 16/873, East Park Road, Karol Bagh, New Delhi.

Advertising and Social Marketing 3 (1+2)

Objectives

i. To build competence in designing digital social advertisements

ii. To capacitate students in developing and implementing social marketing program

Theory

Evolution and history of advertising, relevance of advertising in marketing. Role of advertising agency. Types of advertising: Traditional versus digital advertising, commercial versus social advertising. Various media for advertising. Advertising writing process: Steps for writing effective advertisement. Laws and ethics in advertising. Steps to create advertising strategy for marketing. Different types of advertising strategies. Social marketing: concept, need and philosophy, difference between commercial and social marketing. Principles and importance of social marketing in development. Marketing mix of social marketing. Models of social marketing. Role and strategies for digital marketing in community development. Social marketing process: Assessment and analysis of the problems. Planning for social marketing strategy based on the identified problems. Execution of social marketing program, Planning for publicity campaign, Execution of publicity campaign. Evaluation of program and reporting.

Practical

Visit to advertising agency and report writing. Designing social advertisements for newspaper. Designing social advertisements for radio. Designing social advertisements for television. Designing social advertisements for poster. Designing social advertisements for hoardings and wall paintings. Designing digital advertisement on social issues for social platforms like whatsapp and facebook. Analysis of the situation to find out the social problems in a community: collect information through secondary sources like newspapers, government documents etc. Focus group discussions with groups/ community to identify social problems and analyzing the situation.

Scanning social market situations-opportunities and constraints. Assessment and analysis of the problems. Preparation of report on collected information. Planning for social marketing strategy based on the identified problems: purpose, target audiences, objectives and goals, marketing mix strategies (4Ps), evaluation, budget, and implementation plans. Designing and pricing social products. Execution of social marketing program using Seven step model of social marketing: Pre knowledge test at field level (selected village). Rally on selected social issue at selected village. Skill training on selected problem. Field trip to relevant stakeholder (SAU/ State departments/ Entrepreneurs/ SHGs). Post knowledge test at field level (selected village). Evaluation of social

marketing program. Report writing and oral presentations and discussions based on observations and experiences gained in social marketing program.

Suggested Readings

1. Bhasin H. 2021. *Advertising Strategy in Marketing – Definition and Types*, Retrieved from https://www.marketing91.com/advertising-strategy/
2. Indeed, editorial team 2021. *How to write an effective advertisement: a complete guide*, Retrieved from https://in.indeed.com/career-advice/career-development/how-to-write-an-effective-advertisement
3. Kotler P and Roberto E L. 1989. *Social marketing: strategies for changing public behavior*. 401p. The free press, New York.
4. Manoff R K. 1985. *Social Marketing: New Imperative for Public Health*. 293p. Praeger, New York

Public Relations and Communication Management 3 (1+2)

Objectives

i. To provide knowledge about public relations and imparting skills in designing and preparing public relations tools
ii. To equip students in planning and executing public relations program
iii. To provide knowledge and capacitate students in effectively using communication skills and communication management

Theory

Public relation - Concept, related terms and evolution, role of government institutions in maintain public relations. Process of public relation and publics in public relation. Principles of Public relation. Public relation tools. Public relation models. Laws and ethics of PR- Law of Defamation, Law of invasion of privacy, Copyright act, Trademark, Protection of Civil rights act, Consumer protection act, RTI etc. Communication skills: Reading, writing, speaking, listening, soft skills. Public speaking: Characteristics, techniques, importance. Modes of delivery in public speaking, check list, need and purpose of public speaking. Communication techniques and communication network. Communication efficiency and effectiveness: factors affecting, communication fidelity and source creditability. Message distortion- factors affecting and types of message distortion.

Practical

Visit to public relation office under government sector for analyzing their public relations activities. Visit to non-government institutions for analyzing their public relations activities. Visit to university PRO office for analyzing their public relation activities. Design Flyer for establishing public relations of your organization. Design brochure for establishing public relations of your organization. Design newsletter for maintaining public relations of your organization. Plan a public relation strategy for popularizing new technology developed by your organization. Writing different types of press releases. Writing feature article. Prepare a consumer survey to know about preferences and attitude of your clientele regarding new technology. Prepare presentation for popularizing new technology among your clientele and show it to them, use public relations tools for it. Gather data on prepared consumer survey and analyze it. Prepare feedback form

and get it filled from clientele. Learning activities to assess and learn listening skills. Learning experiences for improving reading skills with an emphasis on building vocabulary and correct use of grammar. Writing report. Simulation games in communication distortion. Exercise on informative speaking. Exercise on persuasive speaking. Exercise on entertaining speaking. Exercise on impromptu speaking. Exercise on extempore speaking. Exercise on memorize speaking. Exercise on manuscript speaking.

Suggested Readings

1. Chandrakandan K, Karthikeyan C, Venkatesan C and Balaji Babu C. 2002. *Public Relations*. 90p. Authorspress global network, Delhi.
2. Loyd H. 1970. *Public Relations.* 177p. The English universities press ltd., London.
3. Stephenson H. 1960. *Handbook of Public Relations*. 855p. McGraw Hill ook co, New York.
4 Sharma Diwakar. 2004. *Public Relations: An Emerging Specialized Profession*. 216p. Deep and Deep Publication Pvt. Ltd. New Delhi.
4. Sharma Diwakar. 2004. *Public Relations: An Emerging Specialized Profession.* 216p. Deep and Deep Publications Pvt. Ltd. New Delhi.

Web Designing 3 (0+3)

Objectives

By the end of the course the students will be able to

i. Get insight of using tools in Adobe Photoshop, Dream Weaver
ii. Learn the basics to advanced HTML, Markup language, structural tags and attributes for web construction
iii. Hands on experience with working on website for page wise, popup windows, cascading styles, navigational elements
iv. Design websites, mobile application screens, advertisements with animations

Practical

Orientation to web designing, software used and familiarization with stock photography, image graphics, vector graphics and tools. Hands on experience with Adobe Photoshop: Pallets, colour modes, resolution options, file types and Using tools with real time example layers, blending, filters and designing of website, Designing banners for web site, web advertisements. Introduction of HTML 5.0, Working on basic structure of markup language and Hands on experience on markup language, Hands on experience on semantic markup language. Working on Head section, structural tags and attributes for construction of web site, content/ media tags for construction of web site. Construction of web site: Working on forms, Home page and Other page, Adding navigational elements and links, Adding asides and side bars and applying styles, Creating popup windows, Hands on experience with cascading style sheets: Border images, shadows, gradients, Text-shadow and stroke etc. Adobe Dream weaver: Basics, Meta tags, Script tags, Links, Inserting tables, images, videos, template design and Importing etc., Live website design project: Designing template, Adding menu system to project Insertion of web banners and advertisements and Final project evaluation. Designing for Social media- Blog, Twitter, Face book. Familiarization and working on SEO, web analytics and Making use of web analytics Configuration of Web Analytics with domain

name. Introduction of User Interface design and hands on experience - User Interface elements and principles, creating mockups, buttons, menus and forms, Designing of icons and vector objects, Creating pages in HTML by using user interface design. Applying style sheets and navigational elements and link, Designing of mobile application screen mockups/ screen in HTML, Presentation of developed websites, Final Practical examination.

Suggested Readings

1. Abdullah. 2011. *Web Technology*. 240p. Himalaya Publishing House.
2. Chisholm and May. 2008. *Universal Design for Web Applications: Web Applications, That Reach Everyone.* 179p. O'Reilly Media.
3. Gray Shelly, Denise Woods, William Dorin. 2008. H*TML: Comprehensive Concepts and Techniques*. 688p. Published by Cengage Learning.
4. Thakur M. 2017. *Multimedia and Applications*. (1st Edn.). 326p. Abhishek Publications, Delhi.
5. https://www.udemy.com/course/web-design-secrets/
6. https://kinsta.com/blog/web-design-courses
7. https://www.sanjaywebdesigner.com/articles/web-design-course-learn-from-best-website-designing-tips/

Semester VIII

S. No.	Course Title	Credit Hours
1.	Student READY Program (RAWE/ In plant /Industrial Attachment/ Internship / Experiential learning /Hands on Training/ Project Work)	20
	TOTAL	**20**

* Student will undertake Project Work based on the field work/ Community Problems and Needs identified in any one area (like Community Malnutrition/ Health Foods for Non-Communicable Diseases (NCD)/ Community Health and Hygiene/ Developmental Challenges of Children/ Processing of local foods/ Nutri Garden/ Immunity boosting indigenous plants/ natural dyeing/ Environmental Issues, Value addition of Agriculturebased byproducts, etc.)

SKILL ENHANCEMENT COURSES

Indicative options for SEC-I module***(any one module to be selected)*

Module	Course	Credit Hours
Bakery and Confectionary Management- I	Breads and Buns	2 (0+2)
	Biscuits and Cookies	2 (0+2)
Textile Design and Embellishment- I	Textile Dyeing and Printing	2 (0+2)
	Fabric Embellishment	2 (0+2)
Event Management and Housekeeping- I	Housekeeping and Service Management-I	2 (0+2)
	Floral Art and Design-I	2 (0+2)
Childhood Development and Assessment- I	Developmental Assessment I (Infancy and Toddlerhood)	2 (0+2)
	Developmental Assessment II (Childhood)	2 (0+2)
Extension Education for Community Development- I	Audio Visual Aids for Communication	2 (0+2)
	Extension Teaching Methods	2 (0+2)

Indicative options for SEC-II module*****(any one module to be selected)***

Module	Course	Credit Hours
Bakery and Confectionary Management- II	Cakes and Pastries	2 (0+2)
	Chocolate Making	2 (0+2)
Textile Design and Embellishment- II	Indian Embroideries	2 (0+2)
	Quilting and Patchwork	2 (0+2)
Event Management and Housekeeping- II	Housekeeping and Service Management II	2 (0+2)
	Event Planning and Management	2 (0+2)
Childhood Development and Assessment- II	Infant Stimulation Practices	2 (0+2)
	Health Practices in Early Childhood	2 (0+2)
Extension Education for Community Development- II	Computerized Instructional Aids Production	2 (0+2)
	ICT and New Media	2 (0+2)

Indicative options for SEC-III modules*****(any one module to be selected)***

Module	Course	Credit Hours
Food Service Management – I	Quantity Cookery	1 (0+1)
	Traditional Indian Foods	1 (0+1)
Fashion Designing – I	Garment Designing	1 (0+1)
	Accessory Designing	1 (0+1)
Interior Design and Decoration – I	Interior Designing and Decoration I	1 (0+1)
	Floral Art and Design II	1 (0+1)
Early Childhood Care and Education – I	Establishment of ECCE centers	1 (0+1)
	Program Planning and Execution in ECCE centers	1 (0+1)
Communication Technology and Journalism – I	Print Journalism	1 (0+1)
	Electronic Journalism	1 (0+1)

Indicative options for SEC- IV modules*****(any one module to be selected)***

Module	Course	Credit Hours
Food Service Management – II	Food Preservation and Storage-I	1 (0+1)
	Food Preservation and Storage-II	1 (0+1)
Fashion Designing- II	Fashion Illustration	1 (0+1)
	Portfolio Development	1 (0+1)
Interior Design and Decoration – II	Interior Accessories and Furnishings	1 (0+1)
	Interior designing and decoration II	1 (0+1)
Early Childhood Care and Education – II	Management of ECCE centre	1 (0+1)
	Monitoring and evaluation of ECCE centre	1 (0+1)
Communication Technology and Journalism – II	Audio and Video Recording	1 (0+1)
	Instructional Video Production	1 (0+1)

**The universities/ institutes are free to include other options for SEC as per the local needs and facilities available, also to interchange the modules in between semesters. The modules can be taken in campus or off-campus.

ONLINE COURSES
10 credit hours (Non-gradial)

The students will have to take 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons.) Community Science program.

The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal. The courses will be non-gradial as separate certificates would be issued by institutes offering the courses.

However, the University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the satisfactorily completed courses in final transcript issued to the student.

Suggestive list of online courses from SWAYAM/ MOOC

- Digital Media
- Basics of Photography
- Ergonomics Workplace Analysis
- Design, Technology and Innovation
- Visual Communication Design for Digital Media
- Certificate Course in Environmental Sustainability
- Consumer Protection Legislation
- Communication and Extension for Sustainable Development
- Intellectual Property
- NGO and Sustainable Development
- Counseling Psychology
- Gender Sensitization: Society Culture and Change
- Basics of Health Promotion and Education Intervention
- Psychology of Stress, Health and Well-being
- Diet Management in Health and Disease
- CAD/CAM Computer Aided Design / manufacturing
- Dairy and Food process and products technology
- Digital Image Processing
- Thermal Processing of Foods
- Nanotechnology, Science and Applications
- Testing of Functional and Technical Textiles
- Smart Materials and Intelligent System Design
- Advanced Textile Printing Technology
- Textile Product Design and Development
- Applied Ergonomics
- Evaluation of Textiles Materials
- Silkworm rearing and reeling technology
- Textiles and Quality Analysis
- Refresher Course in Advances in Textile Engineering
- Food Science and Processing
- Diet Management in Health and Disease
- Maternal Infant Young Child Nutrition
- Human Nutrition and Biochemistry
- Personality Development and Communication Skills
- Public Speaking
- Personality Development
- Emotional Intelligence
- Yoga Practices 1
- Yoga Practices 2
- Ethics: Theories and Applications
- Information Sources and Library Services
- Qualitative Research Methods and Research Writing
- Home Science – Extension and Communication Management
- Food Science and Processing
- Food Safety and Quality Control
- Interior Materials and Finishes
- Interior Furniture and Furnishings
- Communication Skills and Computer Operations
- Human Resource Management
- Business Plan and Finance Management

Minimum Standards for Establishing a College of Community Science

- **Degree Nomenclature:** B. Sc. (Hons.) Community Science

1. Minimum intake (per year): 60

2. Faculty:

A. Core faculty: 23

Food Science and Nutrition(0+2+4), Food Policy and Public Health(0+1+2), Apparel Design Management(0+1+2), Textile Science and Design(0+1+2), Family Resource Management and Consumer Science (0+1+2), Human Development and Family Studies (0+1+2), Extension Education and Communication Management (0+1+1).

B. Allied faculty:

Faculty for Mathematics, Computer science, Sociology, Psychology, English, Food Science and Technology, Biochemistry, Microbiology, Biotechnology, Agrometerology and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part-time faculty.

3. Land requirement (ha): 5

4. Essential Instructional units:

- Laboratories and instructional facilities as per V Deans' Committee report.
- This land is required for the establishment of College, an Academic block including Laboratories and Experiential learning programme.
- ELP units to be established under skill development or Entrepreneurial mode- 0.5 ha.

5. Divisons/Departments/Sections:

- Department of Food Science and Nutrition
- Department of Food Policy and Public Health Nutrition
- Department of Apparel Design
- Department of Family Resource Management and Consumer Science
- Department of Human Development and Family studies
- Department of Textile Science and Design
- Department of Extension and Communication Management.

6. Non-Teaching Staff:

Office space for Dean's office, Dean's committee room, account section, students record section, ministerial staff room, computer cell, academics and controller of exam cell, toilets and conveniences, visitors room and information room shall be required.

S. No.	Divisions/Departments/ Sections	Assistant/ Steno	Clerk	Lab Asstt./ Technician/ Attendants	Attendant/ Messenger	Total
1.	Department of Food Science and Nutrition	1	1	4	1	7
2.	Department of Food Policy and PublicHealth Nutrition	1	1	4	1	7
3.	Department of Family Resource Managementand Consumer Science	1	1	4	1	7
4.	Department of Extension Education &	1	1	4	1	7
	Communication Management					
5.	Department of Apparel Design	1	1	4	1	7
6.	Department of Textile Science and Design	1	1	4	1	7
7.	Department of Human Development andFamily Studies	1	1	4	1	7
	TOTAL	**7**	**7**	**28**	**7**	**49**

7. Manpower Requirement of Dean's Office and other common facilities

S. No.	Name of the Post	No. of Posts
1.	Dean	01

A. Establishment

1.	Assistant Administrative Officer	01
2.	P.A./P.S. to Dean	01
3.	Senior Assistants (Academic, budget and establishment)	03
4.	Clerks (one each for Academic, budget and establishment and one for girls hostel)	04
5.	Messengers	03
6.	Asstt. Librarian	01
7.	Shelve Assistants	02
8.	Assistant Professor Physical Education & Sports	01
9.	Steno	02
10.	Computer Assistant	01
11.	Driver (one each for light and heavy vehicle)	02
12.	Store Keeper	01
13.	Electrician	01

14.	Medical Officer	01
15.	Compounder	01
16.	Nurse	01
17	Hostel Warden	Charge with faculty
18.	Assistant Warden	02
19.	Cook	01
20.	Assistant Cook	01
21.	Mess Helpers/ waiters (service)	06
23.	Attendants for Deans Office, library, sports, Medical Hospital	08

9. Floor Space (Department wise):

S. No.	Details	Number	Dimensions (ft)
1.	Head of the Department's Chamber	5	10 × 15 each
2.	Office Room	5	15 × 20 each
3.	Associate Professors' Rooms	5	10 × 10 each
4.	Faculty Rooms (with individual workstations)	5	20 × 30 each
5.	Laboratories	15	20 × 30 each (3 labs per department)
College Building			
1.	Class Rooms	4	Seating capacity of 65 each
2.	Multipurpose Room/Examination Hall	1	Seating capacity of 100
3.	Toilets	9	2 ladies' and 1 gents'/floor (for 3 floors)
Other Infrastructure			
1.	Auditorium	1	Seating capacity of 500 persons
2.	Dispensary	1	As per requirement
3.	Sports Complex	1each	Outdoor & Indoor
4.	Multi Gym	1	As per requirement
5.	Faculty Room for sports complex	1	10 × 15
6.	Store Room for sports complex	1	10 × 20
7.	Toilets for sports complex	1 each	For ladies and gents
8.	Hostel	1	To accommodate 200 students and with provision of 3 guest rooms.
9.	Parking facility		As per the requirement
10	Library	1	As per the requirement
11.	Production cum Training Centre	1	As per the requirement

10. Laboratory Equipment:

	Analytical Laboratory		Clinical Investigation Laboratory
1.	HPLC	1.	Glucometer
2.	Spectrophotometer-2	2.	B. P. Instrument
3.	Kjel plus	3.	Pedometer
4.	Refrigerated centrifuge	4.	Haemoglobin meter
5.	Deep freeze	5.	Anthropometric rod
6.	Moisture estimation equipments	6.	Infantometer
7.	Vacuum cleaner	7.	Skinfold caliper
8.	Ultrasonic cleaner	8.	Weighing balance
9.	Muffle furnace	9.	Vernier caliper
10.	Autoclave	10.	Body composition analyzer
11.	Flash evaporator	11.	Heart Rate Monitor
12.	Laminar flow	12.	Blood Analyser
13.	Hot air oven		**Processing Lab and Product Development**
14.	Colony counter	1.	Laboratory Popping machine
15.	Incubator	2.	Utensil rack
16.	Magnetic stirrer with hotplate	3.	Potato bin
17.	Viscometer	4.	OTG
18.	Soxplus	5.	Fryer
19.	Fibreplus	6.	Counter refrigerator
20.	Viscometer	7.	Masala grinder
21.	Metabolic shaker	8.	Wet grinder
22.	Water bath shaker	9.	Potato pealer
23.	Photo fluorometer	10.	Vaccum sealing machine
24.	Distillation apparatus	11.	Hand refractometer
25.	Ion meter	12.	Flour mill
26.	Centrifuge	13.	Baking ovens
27.	pH meter	14.	Heavy duty
28.	BOD incubator	15.	Lyophilizer
29.	Sieve shaker	16.	Vegetable cutter
30.	Pipette washer	17.	Dough kneader
31.	Cyclo mixer	18.	Multimill
32.	Spectrophotometer	19.	Working table
33.	33. Colony counter	20.	Vacuum oven
34.	34. Homogenizer	21.	Tray dryer
35.	35. Wiley Mill	22.	Grinding mill
36.	36. Cabinet refrigerator	23.	Canning equipment

	Catering Laboratory	24.	Bottling equipment
1.	Microwave ovens	25.	Pouch filling machine
2.	Hot case cabinet	26.	Coffeemaker
3.	Flycatchers	27.	Tea maker
4.	Air curtain	28.	Electronic kitchen balance
5.	Food processor	29.	Refrigerator
6.	*Dosa* griddle plate	30.	Deep freeze
7.	Water purifier	31.	Heavy duty Mixer, Juicer, Grinder
8.	Refrigerators	32.	Stone separator
9.	Washing machine	33.	Chiller
10.	Cooking range and utensils	34.	Extruder
11.	Juicer and blender	35.	Pulper / smoother
12.	Utensils for cooking and serving	36.	Roti maker
		37.	Utensils for cooking and serving

	Nutrition Counselling Centre		**Weaving Lab**
1.	Computers	1.	Loom (Handloom)
2.	Scanners	2.	Table loom for sample weaving
3.	Video-editing workstation	3.	Bobbin winding machine
4.	LCD projector	4.	Creel board
5.	Laptop	5.	Wrapping drum
6.	Printers		**Clothing Lab**
7.	Photocopiers	1.	Foot-operated sewing machine
8.	Plasma screen	2.	Button hole machine
9.	Camera	3.	Interlock machine
10.	Measuring equipment	4.	Overlock machine
11.	Anthropometric kit	5.	Cutting table-individual use (2'×4')
		6.	Cutting table (Group- 5'×7')
12.	Body Composition Analyser	7.	Iron and ironing board
	Computer Lab(Clothing CAD Lab)	8.	Cutting, measuring (anthropometric kits, marking, pressing, miscellaneous tools
1.	Textile designing software	9.	Embroidery machine (Electric)
2.	Apparel designing software	10.	Embroidery machine (Computerized)
3.	Fashion illustration software		**Flat Pattern and Draping Lab**
4.	Weave designing software	1.	Industrial sewing machine
5.	Computers with accessories	2.	Dress forms of different sizes
6.	Digitizer	3.	Mannequins' (Male/Female/Children)
7.	Plotter	4.	Fashion Illustration boards with stands
8.	Digital camera		

	Lab		**Dyeing and Printing Laundry**
1.	Rack for keeping laundry reagents	1.	Water bath shaker
2.	Fully automatic washing machine	2.	Hot plates
3.	Automatic drying machine	3.	Steaming chamber
4.	Weighing balance	4.	Screen printing table 4' × 7'
		5.	Block printing table 4' × 4'
	Textile Chemistry Lab	6.	Microwave oven
1.	Distillation unit	7.	Water purifier
2.	Rack for keeping chemicals		**Office Requirements**
3.	Spirit lamps	1.	LCD projectors and Screen
4.	Pick glasses	2.	Printer
5.	Hot air oven	3.	Spiral Binding Machine
6.	Projection microscope	4.	Cutting Machine
7.	Weighing balance	5.	Lamination machine
8.	Other miscellaneous tools	6.	Photocopier
	List of Furniture		
1.	Students chairs		
2.	Students stools		
3.	Book Racks		
4.	Storage cabinets		
	Resource Management Equipment Lab		
1.	Water Filter	19.	Juicer
2.	Microwave Oven	20.	Hand Mixer
3.	Electric Oven	21.	Coconut Cutter Grater
4.	Vacuum Cleaner	22.	Chili Cutter
5.	Weighing Machine(Personal)	23.	Bar Blender
6.	Geyser	24.	Pressure Cooker
7.	Halogen Heater	25.	Food Processor
8.	Emergency Light	26.	Thermo Flask
9.	Refrigerator	27.	Electric Tandoor
10.	Cooking Range	28.	Sandwich Maker
11.	Washing Machine	29.	Bread Toaster
12.	Hand Machanical Grinder	30.	Potato Chipper
13.	LPG Stove (4 burner)	31.	Electric Kettle
14.	Kitchen Took Set	32.	Sprout Maker
15.	Oven Cookery Utensils	*33.*	*Idli* Maker
16.	Surface Cookery Utensils	34.	Electric Iron
17.	Coffee Percolator(all three types)	35.	Ironing Stand
18.	Dishwasher	36.	Chopper

37.	Cutter		**Ergonomics Lab**
38.	Citrus Press	1.	Digital Camera
39.	Tomato Slicer	2.	Weighing Machine(Electronic)
40.	Squeezer	3.	Stopwatch
41.	Salt and Pepper Grinder	4.	Hygrometer
42.	Grater	5.	Lux Mater
43.	Chipser	6.	Heart Rate Monitor
44.	Solar Educational Kit	7.	Treadmill
27.	Electric Tandoor	8.	Hygro thermometer
28.	Sandwich Maker	9.	Pedometer
29.	Bread Toaster	10.	Goneometer
30.	Potato Chipper	11.	Vibrometer
31.	Electric Kettle	12.	B.P. Monitor
32.	Sprout Maker	13.	Grip Dynamometer
33.	*Idli* Maker	14.	Spreading Caliber
34.	Electric Iron	15.	Anthropometry Meter
35.	Ironing Stand	16.	Seating Height Machine
36.	Chopper	17.	Lamination Machine
37.	Cutter	18.	Paper Cutting Machine
38.	Citrus Press	19.	Spiral Binder
39.	Tomato Slicer	20.	Laser Printer
40.	Squeezer	21.	LaserJet Colour Printer
41.	Salt and Pepper Grinder	22.	Scanner Scan jet
42.	Grater	23.	Computer System
43.	Chipser	24.	Interior Designer Software
44.	Solar Educational Kit		**(Auto CAD, Home Architect Deluxe)**
45.	Solar Cooker	25.	3D Max (Software)
46.	Solar Cooker(Parabolic Type)	26.	Advanced 3DMax (Software)
47.	Solar Lantern		**Multimedia Lab**
48.	Solar Drier	1.	Overhead Projector
49.	Solar Water Heater	2.	Public Address System
50.	Rice Cooker	3.	16 mm film projector
51.	Water Cooler(Dispenser)	4.	Auto slide projector
52.	Induction Cooker	5.	Record player
53.	Air Fryer	6.	Epidiascope
54.	Gas Connection	7.	V.C.R.
55.	Food Adulteration Testing Kit	8.	Motorized screen
56.	Knife Set	9.	Digital Camera
57.	Dinner Set	10.	Video Camera
58.	Tea Set	8.	Motorized screen
59.	Cutlery Set	9.	Digital Camera
60.	Table Mats and Table Napkins	10.	Video Camera
	Housing and Space Management lab.	11.	Computer with accessories
1.	Over head Projector +Screen	12.	V.C.D. Player

2.	LED Project + Monitor		**Multimedia Lab**
3.	Drawing Board	1.	Overhead Projector
4.	Drawing Scale	2.	Public Address System
5.	Engineering Scale	3.	16 mm film projector
6.	T-Set Square Scale	4.	Auto slide projector
	Interior Design and Decoration Lab	5.	Record player
1.	Flower Press	6.	Epidiascope
2.	Potter's Wheel	7.	V.C.R.
3.	Sponge	8.	Motorized screen
4.	Display Board Wall Mounted	9.	Digital Camera
5.	Portable Display Boards	10.	Video Camera
6.	Flower vases	11.	Computer with accessories
	Testing Laboratory	12.	V.C.D. Player
1.	Weighing Machine	13.	Plus Direct Projector
2.	Speech Audiometer	14.	Colour T.V.
3.	Infanto meter	15.	Digital Camera
4.	Digital HB Metter	16.	L. C.D.
5.	Bathroom scale	17.	Slide Projector
6.	Anthropometric Rod	18.	Scanner
7.	Standford Binescale	19.	Microphone
8.	Beam Balance	20.	Motorize screen
9.	Stapler big size	21.	Video Camera
10.	Sliding Caliper	22.	Camera
11.	Spreading Caliper	23.	Computer with accessories
12.	Assophemeter Caliper	24.	Director Projector
13.	Colour mixer	25.	Digital Camera
14.	Depth Prescription apparatus	26.	Slide projector
15.	Mirror drawing apparatus	27.	Printer
16.	Attention board	28.	Scanner
17.	Stop Watch	29.	Overhead Projector
18.	Lever Actuated Balance		**Laboratory Nursery School**
19.	Bhatia Battery	1.	Video Camera
20.	Scientific Calculator	2.	V.C.R
21.	Top Pan Self Indicating Balance	3.	Audio System
22.	Metronome	4.	Voltage Stabilizer
23.	Weighing Balance	5.	Projector LCD
24.	Skin fold Caliper	6.	Digital Camera
25.	Developmental Assessment Scale	7.	Refrigerator
26.	Wechsler Intelligence Scale	8.	Projector Slide film
27.	Cognitive tests	9.	AV folding projector
28.	Psychological Tests	10.	Radiator
	PHOTOGRAPHY LAB	11.	Music system
1.	Digital Camera	12.	Vacuum cleaner
2.	SLR Camera	13.	DVD Player
3.	Colour Photo Printer	14.	VCD Player
4.	Video Camera	15.	Radio Recorder
		16.	Cooler
		17.	Slide projector
		18.	Colour T.V.
		19.	Washing Machine
		20.	Microwave

AGRIBUSINESS MANAGEMENT

Course Curricula for Undergraduate Program in Agribusiness Management: UG-Certificate in Agribusiness Management; UG-Diploma in Agribusiness Management; B. Sc. (Hons.) Agribusiness Management

INTRODUCTION

As per the Terms of Reference of the 6th Deans" Committee, each member was assigned the task of restructuring the Undergraduate Programs in different disciplines. This report is an outcome of the valuable suggestions and recommendations of the Sixth Deans", Committee after having multistage in-depth deliberations and discussions in virtual meetings in addition to personal communications with the selected faculty members of the Agribusiness Management discipline of various State Agricultural Universities, ICAR Institutes and Private Agricultural Colleges, stakeholders from related industries and few alumni of the existing course Program across nation.

Restructuring of Undergraduate Programs in Agribusiness Management has been carried out as per National Education Policy 2020 (NEP-2020) guidelines to build among students a strong foundation of knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge.

In the present restructured course curriculum, more emphasis has been given to basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses via electives and online courses along with provision of advanced skill development through project work or experiential learning, etc. In addition, the provision of multiple exit and entry options at every stage in the educational career of students, which is a unique feature of the NEP-2020, has been incorporated in the restructured course curriculum of Agribusiness Management degree program .

The details of the course structure for the Undergraduate Programmes in Agribusiness Management [UG-Certificate, UG-Diploma and B.Sc. (Hons.) Agribusiness Management] have been prepared with due care and with inputs of Deans' and faculty members in the field of Agribusiness Management, across the country.

HIGHLIGHTS

- The 4-year undergraduate degree program in Agribusiness Management will consist of 167 credits and 4 credits of non-gradial courses will be additional. In addition, 10 credits of online courses have to be taken by the student as per his/her/ze choice with the consent of the Dean of the concerned College.
- More weightage has been given to skill enhancement courses in first two years. Students have been given flexibility and choice in selection of skill enhancement courses from a basket of multiple skill enhancement courses offered in all the four semesters of first two years.
- Students will be given 12 credits of skill-based courses in first, second, third and fourth semesters so that he/she/ze will acquire enough knowledge and skill through hands-on training in related domain to get Certificate at the end of first year and Diploma at the end of second year, if he/she opts to exit.
- After completing the courses of first year, if a student wishes to exit, he/she will be eligible for award of UG-Certificate in Agribusiness Management after completing an extra 10 weeks of internship (10 credits). The internship can be taken in the form of Industry placement/ Industry exposure/ Hands on training in related domain in the parent institute. The students continuing the study further would not have to attend the internship after first year. Similarly, after completing the courses for first two years and 10 weeks' internship, the student becomes eligible for UG-Diploma in Agribusiness Management on exit. The students continuing further for award of the B.Sc. (Hons.) Agribusiness Management need not take the internships after first and second years.
- These students are expected to acquire competency and confidence to start their own enterprise, as well as will have adequate competency for getting jobs.
- More emphasis has been given on proper amalgamation of theory and practical to provide them hardcore knowledge of the Agribusiness Management discipline. In the third year, the student will be taught intensive core courses of the discipline.
- Ten credits of online courses are at the discretion of students. Students have the choice of online MOOC courses to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these elective courses of 10 credits throughout the span of the degree Program.
- In seventh semester of the degree Program, students will be required to choose Elective Courses of 20 credits [any five courses of four credits each, from the List of Courses notified by the University] or the University/HAEI can offer additional Courses as Elective Courses.
- In eighth semester of the degree Program, students will be required to complete 20 credits by undergoing Student-READY Program [RAWE/In-plant training/ Industrial attachment/ Experiential Learning/ Hands-on-Training/ Project Work/ Internship/ Attachment to R & D Institute/ Laboratory, etc.].

Entry and Exit Options

The entry and exit options for the UG programs in Agribusiness Management are shown in the Figure 1 below:

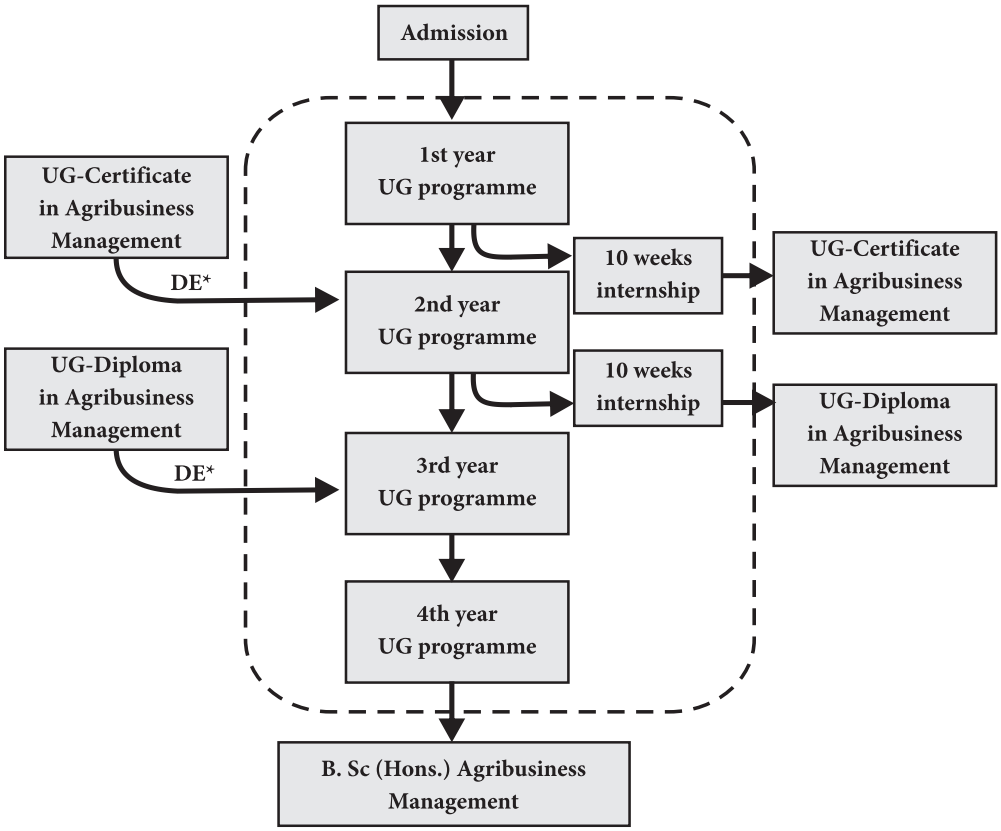


Fig. 1. Schematic representation of restructured B. Sc. (Hons.) Agribusiness Management

DE* Direct Entry in the Respective Year

Exit options

- **UG-Certificate in Agribusiness Management** (exit after first year and completion of 10 weeks internship)
- **UG-Diploma in Agribusiness Management** (exit after second year and completion of 10 weeks internship)
- **B.Sc. (Hons.) Agribusiness Management** (on successful completion of four-year degree requirements)

Admission Eligibility For Entry into 1st year UG Programme:- 10+2 Science with PCMB/PCB/ PCM or as per the criteria prescribed by the ICAR/ respective HAEI.

ACADEMIC PROGRAM

Semester wise course distribution

S. No.	Course Title	Credit Hours	Total Credit Hours
First Year			
Semester-I			
1	Deeksharambh (Induction-cum-Foundation Course)	2 (0+2)* NG	**22 (12+10)+2* (NG)**
2	Introduction to Agribusiness Management	2 (2+0)	
3	Fundamentals of Agricultural Economics	2 (2+0)	
4	Introduction to Agronomy and Crop Production Technology	2 (1+1)	
5	Management of Insect Pests of Crops and Stored Grains	2 (1+1)	
6	Management of Plant Diseases	2 (1+1)	
7	Basic Mathematics/Basic Botany	2 (2+0)	
8	Farming Based Livelihood Systems	3 (2+1)	
9	NCC-I/ NSS-I	1 (0+1)	
10	Communication Skills	2 (1+1)	
11	**SEC-1:** Computer Applications in Agriculture	2 (0+2)	
12	**SEC-2:** Production Technology for Bio-Agents and Bio-fertilizers	2 (0+2)	
Semester-II			
1	Farm Management, Production and Resource Economics	3 (2+1)	**23 (13+8)**
2	Marketing of Agricultural Inputs and Outputs	2 (1+1)	
3	Agricultural Finance and Insurance	2 (1+1)	
4	Introduction to Genetics and Plant breeding	2 (1+1)	
5	Principles and Practices of Seed Science and Technology	2 (1+1)	
6	Livestock, Poultry and Fish Production Management	2 (1+1)	
7	Environmental Studies and Disaster Management	3 (2+1)	
8	NCC-II/NSS-II	1 (0+1)	
9	Personality Development	2 (1+1)	
10	**SEC-3:** Seed Production and Seed Testing	2 (0+2)	
11	**SEC-4:** Livestock Production and Management	2 (0+2)	
Post-Semester II (Only for exit with UG-Certificate in Agribusiness Management)			
1	Internship (10 weeks)	10 (0+10)	

S. No.	Course Title	Credit Hours	Total Credit Hours
Second Year			
Semester-III			
1	Food Business Management	2 (2+0)	**20 (10+10)**
2	Value Chain and Retail Management in Agribusiness	2 (1+1)	
3	Introduction to Accountancy	3 (2+1)	
4	Soil and Water Management	2 (1+1)	
5	General Horticulture	2 (1+1)	
6	Protected Cultivation and Secondary Agriculture	2 (1+1)	
7	Agricultural Marketing and Trade	3 (2+1)	
8	Physical Education, First Aid, Yoga Practice & Meditation	2 (0+2)	
9	**SEC-5:** Poultry Production Technology	2 (0+2)	
Semester-IV			
1	Business Laws and Ethics	2 (2+0)	**21 (13+8)**
2	International Trade and Policy in Agriculture	2 (2+0)	
3	Agricultural Marketing Regulations	3 (2+1)	
4	Principles of Management and Organizational Behaviour	2 (1+1)	
5	Farm Machinery and Power and Custom Hiring Services	2 (1+1)	
6	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)	
7	Entrepreneurship Development and Business Management	3 (2+1)	
8	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
9	**SEC-6:** Development of Agribusiness Proposal	2 (0+2)	
Post-Semester IV (Only for exit option with UG-Diploma in Agribusiness Management)			
1	Internship (10 weeks)	10 (0+10)	
Third Year			
Semester-V			
1	Grading, Standardization and Quality Management in Agri-Food Products	2 (1+1)	**21 (13+8)**
2	Market Information and Intelligence	3 (2+1)	
3	Capital and Commodity Markets	2 (1+1)	
4	Cooperatives and Producers' Organizations	3 (2+1)	
5	Business Research Methods	3 (2+1)	
6	Sustainable Farming Systems and Precision Agriculture	2 (1+1)	
7	Intellectual Property Rights	1 (1+0)	
8	Fundamentals of Plant Biotechnology	2 (2+0)	
9	Social Entrepreneurship	1 (1+0)	
10	Applied Business Statistics	2 (1+1)	
11	Educational Tour (10-14 days)	2 (0+2)*	

S. No.	Course Title	Credit Hours	Total Credit Hours
	Semester-VI		
1	Corporate Social Responsibility and Managerial Ethics	3 (2+1)	**20 (15+5)**
2	Introduction to Managerial Economics	3 (2+1)	
3	Marketing Management	3 (3+0)	
4	Agribusiness Project Management	3 (2+1)	
5	Strategic Business Management	3 (2+1)	
6	Rural Marketing	3 (2+1)	
7	Commodity Futures Trading	2 (2+0)	
	Fourth Year		
	Semester-VII		
1	Electives [Student has to choose a minimum of 20 credits from the list of elective courses notified by the University]	20	
	Semester-VIII		
1	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/ Internship/ Attachment to R & D Institute/ Laboratory, etc.]	20	

*Non-gradial

Department/Section wise course breakup

S. No.	Course Title	Credit Hours
I	**AGRIBUSINESS MANAGEMENT and AGRICULTURAL ECONOMICS**	
1	Introduction to Agribusiness Management	2 (2+0)
2	Marketing of Agricultural Inputs and Outputs	2 (1+1)
3	Agricultural Finance and Insurance	2 (1+1)
4	Food Business Management	2 (2+0)
5	Value Chain and Retail Management in Agribusiness	2 (1+1)
6	Introduction to Accountancy	3 (2+1)
7	Business Laws and Ethics	2 (2+0)
8	International Trade and Policy in Agriculture	2 (2+0)
9	Agricultural Marketing Regulations	3 (2+1)
10	Principles of Management and Organizational Behaviour	2 (1+1)
11	Grading, Standardization and Quality Management in Agri-food Products	2 (1+1)
12	Market Information and Intelligence	3 (2+1)
13	Capital and Commodity Markets	2 (1+1)
14	Cooperatives and Producers' Organizations	3 (2+1)
15	Business Research Methods	3 (2+1)

S. No.	Course Title	Credit Hours
16	Corporate Social Responsibility and Managerial Ethics	3 (2+1)
17	Introduction to Managerial Economics	3 (2+1)
18	Marketing Management	3 (3+0)
19	Agribusiness Project Management	3 (2+1)
20	Strategic Business Management	3 (2+1)
21	Rural Marketing	3 (2+1)
22	Commodity Futures Trading	2 (2+0)
23	Entrepreneurship Development and Business Management	3 (2+1)
24	Agricultural Marketing and Trade	3 (2+1)
25	Fundamentals of Agricultural Economics	2 (2+0)
26	Farm Management, Production and Resource Economics	3 (2+1)
27	Development of Agribusiness Proposal	2 (0+2)
28	Agro-Tourism	4 (0+4)
29	Seed Business Management	4 (0+4)
30	Fertilizer Retailing	4 (0+4)
31	Food Retail Business Management	4 (0+4)
32	Supply Chain Management of Agricultural Commodities	4 (0+4)
33	Agri-Export Management	4 (0+4)
34	Hi-Tech Horticulture/Protected Cultivation	4 (0+4)
35	Packaging and Branding of Agricultural Commodities	4 (0+4)
36	e-Commerce in Agribusiness	4 (0+4)
37	Storage and Warehousing of Agricultural Commodities	4 (0+4)
38	Logistics Management of Agricultural Commodities	4 (0+4)
39	Custom Hiring of Agricultural Machinery	4 (0+4)
40	Application of ICT in Agribusiness	4 (0+4)
41	Value Addition to Agricultural Commodities	4 (0+4)
42	Financial Management	4 (0+4)
II	**AGRICULTURAL SCIENCES**	
1	Introduction to Genetics and Plant Breeding	2 (1+1)
2	Intellectual Property Rights	1 (1+0)
3	Introduction to Agronomy and Crop Production Technology	2 (1+1)
4	Sustainable Farming Systems and Precision Agriculture	2 (1+1)
5	Farming Based Livelihood Systems	3 (2+1)
6	Soil and Water Management	2 (1+1)
7	Management of Insect Pests of Crops and Stored Grains	2 (1+1)
8	Management of Plant Diseases	2 (1+1)

S. No.	Course Title	Credit Hours
9	Principles and Practices of Seed Science and Technology	2 (1+1)
10	General Horticulture	2 (1+1)
11	Protected Cultivation and Secondary Agriculture	2 (1+1)
12	Post-Harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
13	Farm Machinery and Power and Custom Hiring Services	2 (1+1)
14	Fundamentals of Plant Biotechnology	2 (2+0)
15	Social Entrepreneurship	1 (1+0)
16	Environmental Studies and Disaster Management	3 (2+1)
17	Production Technology for Bio-Agents and Bio-Fertilizers	2 (0+2)
18	Seed Production and Seed Testing	2 (0+2)
III	**ANIMAL SCIENCES**	
1	Livestock, Poultry and Fish Production Management	2 (1+1)
2	Livestock Production and Management	2 (0+2)
3	Poultry Production Technology	2 (0+2)
IV	**BASIC SCIENCES**	
1	Basic Mathematics/Basic Botany	2 (2+0)
2	Applied Business Statistics	2 (1+1)
3	Agricultural Informatics and Artificial Intelligence	3 (2+1)
4	Computer Applications in Agriculture	2 (0+2)
V	**GENERAL SCIENCES**	
1	NCC(1) / NSS(1)	1 (0+1)
2	NCC(2) / NSS(2)	1 (0+1)
3	Communication Skills	2 (1+1)
4	Personality Development	2 (1+1)
5	Physical Education, First Aid and Yoga Practice	2 (0+2)
VI	**INTERNSHIP / TRAINING COURSES**	
1	Internship [Only for exiting students after Second/Fourth Semester for Certificate Course/Diploma, if applicable]	10 (0+10)
2	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/Internship/Attachment to Rand D Institute/Laboratory]	20 (0+20)
VII	**NON-GRADIAL COURSES**	
1	*Deeksharambh* [Induction-cum-Foundation Course (2 weeks)]	2 (0+2)
2	Educational Tour (2 weeks)	2 (0+2)
VIII	**ONLINE COURSES**	
1	MOOCs/Online Courses	10

Category-wise Course Distribution

S. No.	Course Title	No. of Courses	Total Credits
I	**MAJOR COURSES**	**24**	**60 (43+17)**
1	Introduction to Agribusiness Management		2 (2+0)
2	Fundamentals of Agricultural Economics		2 (2+0)
3	Farm Management, Production and Resource Economics		3 (2+1)
4	Marketing of Agricultural Inputs and Outputs		2 (1+1)
5	Agricultural Finance and Insurance		2 (1+1)
6	Food Business Management		2 (2+0)
7	Value chain and Retail Management in Agribusiness		2 (1+1)
8	Introduction to Accountancy		3 (2+1)
9	Business Laws and Ethics		2 (2+0)
10	International Trade and Policy in Agriculture		2 (2+0)
11	Agricultural Marketing Regulations		3 (2+1)
12	Principles of Management and Organizational Behaviour		2 (1+1)
13	Grading, Standardization and Quality Management in Agri-food Products		2 (1+1)
14	Market Information and Intelligence		3 (2+1)
15	Capital and Commodity Markets		2 (1+1)
16	Cooperatives and Producers' Organizations		3 (2+1)
17	Business Research Methods		3 (2+1)
18	Corporate Social Responsibility and Managerial Ethics		3 (2+1)
19	Introduction to Managerial Economics		3 (2+1)
20	Marketing Management		3 (3+0)
21	Agribusiness Project Management		3 (2+1)
22	Strategic Business Management		3 (2+1)
23	Rural Marketing		3 (2+1)
24	Commodity Futures Trading		2 (2+0)
II	**MINOR COURSES**	**17**	**32 (19+13)**
1	Introduction to Agronomy and Crop Production Technology		2 (1+1)
2	Management of Insect Pests of Crops and Stored Grains		2 (1+1)
3	Management of Plant Diseases		2 (1+1)
4	Basic Mathematics/Basic Botany		2 (2+0)
5	Introduction to Genetics and Plant Breeding		2 (1+1)
6	Principles and Practices of Seed Science and Technology		2 (1+1)
7	Livestock, Poultry and Fish Production Management		2 (1+1)
8	Soil and Water Management		2 (1+1)
9	General Horticulture		2 (1+1)
10	Protected Cultivation and Secondary Agriculture		2 (1+1)
11	Farm Machinery and Power and Custom Hiring Services		2 (1+1)

S. No.	Course Title	No. of Courses	Total Credits
12	Post-Harvest Management and Value Addition of Fruits and Vegetables		2 (1+1)
13	Sustainable Farming Systems and Precision Agriculture		2 (1+1)
14	Intellectual Property Rights		1 (1+0)
15	Fundamentals of Plant Biotechnology		2 (2+0)
16	Social Entrepreneurship		1 (1+0)
17	Applied Business Statistics		2 (1+1)
III	**MULTI-DISCIPLINARY COURSES (MDC)**	**3**	**9 (6+3)**
1	Farming Based Livelihood Systems		3 (2+1)
2	Agricultural Marketing and Trade		3 (2+1)
3	Entrepreneurship Development and Business Management		3 (2+1)
IV	**VALUE ADDED COURSES (VAC)**	**2**	**6 (4+2)**
1	Environmental Studies and Disaster Management		3 (2+1)
2	Agricultural Informatics and Artificial Intelligence		3 (2+1)
V	**ABILITY ENHANCEMENT COURSES (AEC)**	**5**	**8 (2+6)**
1	NCC(I) / NSS(I)		1 (0+1)
2	NCC(II) / NSS(II)		1 (0+1)
3	Communication Skills		2 (1+1)
4	Personality Development		2 (1+1)
5	Physical Education, First Aid, Yoga Practice & Meditation		2 (0+2)
VI	**SKILL ENHANCEMENT COURSES (SEC)**	**6**	**12 (0+12)**
1	Computer Applications in Agriculture		2 (0+2)
2	Production Technology for Bio-Agents and Bio-Fertilizers		2 (0+2)
3	Seed Production and Seed Testing		2 (0+2)
4	Livestock Production and Management		2 (0+2)
5	Poultry Production Technology		2 (0+2)
6	Development of Agribusiness Proposal		2 (0+2)
VII	**ELECTIVES**		**20**
VIII	**INTERNSHIP / PROJECT / STUDENT READY PROGRAMME**		**20**
1	Student-READY Program [RAWE/In-plant training/Industrial attachment/ Experiential Learning/Hands-on-Training/Project Work/Internship/ Attachment to Rand D Institute/Laboratory]		
IX	**INTERNSHIP**	**1**	**10 (0+10)**
1	Internship [Only for exiting students after Second/Fourth Semester for Certificate Course/Diploma, if applicable]		10 (0+10)
X	**NON-GRADIAL COURSES**	**2**	**4 (0+4)**
1	*Deeksharambh* [Induction-cum-Foundation Course (2 weeks)]		2 (0+2)
2	Educational Tour (2 weeks)		2 (0+2)
XI	**ONLINE COURSES / MOOCs**		**10**
	TOTAL		**167+4*+10#**

*Non-Gradial Courses; #Online/MOOC Courses.

Table 1. Credits Allocation Scheme of UG Agribusiness Management Program (Credit Hours)

Semester	Core Courses-Major	Core Courses-Minor	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Project/ Training/ Student READY	Total Credits	Non-Gradial	Internship	Online Courses (MOOC)
I	4	8	3[1]	-	1[2] + 2[3]	4	-	**22**	2[4]	-	
II	7	6	-	3[5]	1[6] + 2[7]	4	-	**23**	-	-	
Post-II	-	-	-	-	-	-	-	-	-	10[8]	
III	7	6	3[9]	-	2[10]	2	-	**20**	-	-	
IV	9	4	3[11]	3[12]	-	2	-	**21**	-	-	**10[18]**
Post-IV	-	-	-	-	-	-	-	-	-	10[13]	
V	13	8	-	-	-	-	-	**21**	2[14]	-	
VI	20	-	-	-	-	-	-	**20**	-	-	
VII	20[15]	-	-	-	-	-	-	**20**	-	-	
VIII	-	-	-	-	-	-	20[16]	**20**	-	-	
Total	**80**	**32**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		**10**

(1) Farming based Livelihood systems
(2) National Cadet Corps-I (NCC-I) / National Service Scheme-I (NSS-I)
(3) Communication Skills
(4) *Deeksharambh* (Induction-cum-Foundation Course) of 2 credits (2 weeks duration).
(5) Environmental Studies and Disaster Management
(6) National Cadet Corps-II (NCC-II) / National Service Scheme-II (NSS-II)
(7) Personality Development
(8) Internship of 10 credits of to be completed by exiting students after Second Semester to get UG-Certificate in Agribusiness Management
(9) Agricultural Marketing and Trade
(10) Physical Education, First Aid, Yoga Practice and Meditation
(11) Entrepreneurship Development and Business Management
(12) Agricultural Informatics and Artificial Intelligence.
(13) Internship of 10 credits to be completed by exiting students after Fourth Semester to get UG-Diploma in Agribusiness Management
(14) Educational Tour of (10-14 days)
(15) Electives of a minimum of 20 credits to be chosen from the list of courses announced by the University.
(16) Student-READY Program [including RAWE/In-plant training/Industrial attachment/Experiential Learning/Hands-on-Training/Project Work/Internship/Attachment to Rand D Institute/Laboratory].
(17) Non-Gradial Courses
(18) Online courses of a minimum of 10 credits (from MOOCS/ SWAYAM/etc.) shall be chosen by the student with the permission of the Dean of the College.

Summary of Credit Distribution

Type of courses	Credits
Core courses (Major and Minor/s)	112
Common courses (MDC+VAC+AEC)	23
Skill Enhancement Courses (SEC)	12
Internship / Student READY	20
**Online Courses / MOOCs*	10**
Total	**167 + 10****

*Massive Open Online Courses

Detailed Syllabi

Semester I

Deeksharambh (Induction-cum-Foundation Course)- Non-gradial 2 (0+2)

The activities to be taken under *Deeksharambh* shall aim at creating a platform for students to

1. Helpings in for cultural Integration of students from different backgrounds
2. Know about the operational framework of academic process in University
3. Instilling life and social skills
4. Social awareness, ethics and values, team work, leadership, creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

i. Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University

ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences

iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences

iv. Activities to enhance cultural Integration of students from different backgrounds.

v. Field visits to related fields/ establishments

vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

Introduction to Agribusiness Management 2 (2+0)

Objectives

i. To gain a comprehensive understanding of agribusiness structures, functions, and dynamics

ii. To develop essential management skills applicable to agricultural enterprises

3. To explore strategies for optimizing production efficiency and maximizing profitability in agribusiness
4. To prepare for diverse careers in farm management, agricultural marketing, finance, and consulting

Theory

Indian Agriculture: Place of Agriculture in Indian Economy, trends in the structure of Indian Economy, Role of Agriculture in Economic Development in India. Trends in agricultural production and productivity, cropping pattern size of farms and farm efficiency. Functions of Management – Planning, organizing, staffing, motivation and control and Principles of Management. Indian agriculture: Impact of Liberalization, Privatization and Globalization on Agribusiness sector. Agribusiness Management: Definition, importance, Scope of Agribusiness Management, Agribusiness Management- Nature, definition, scope and functions. Agribusiness input and output services, Agricultural credit and foreign trade, Planning and Organizing agribusiness. New trends in Agribusiness: Contract farming, Types and scope of contract farming, Working of contracts, Contract models, Organic farming, Genetically modified food, Farmer Producers' Organizations (FPO) Case Studies.

Suggested Readings

1. Peter L Nuthall. 2016. *Farm Business Management: The Fundamentals of Good Practice*. CABI.
2. Ralph W Battles and Robert C. Thompson. 2001. Illustrated. *Fundamentals of Agribusiness Finance*. Wiley
3. Panigrahy S R. 2017.*Objective Agribusiness Management*. Scientific Publishers.
4. Robert H Usry and Lanny W Hass. 2000. *Agribusiness: Management, Marketing, Human Resource Development, Communication, and Technology*. Pearson Learning Solutions Standard.
5. Sharma Amod.2013. *Agri-business and Market Management*. Agrotech Publishing Academy.

Fundamentals of Agricultural Economics 2 (2+0)

Objectives

i. To understand the fundamental principles of economics as they apply to agriculture;
ii. To analyze the economic factors influencing agricultural production, distribution, and consumption.
iii. To explore the role of government policies and international trade in shaping the agricultural economy.
iv. To develop critical thinking skills to evaluate and address economic challenges and opportunities in agriculture.

Theory

Agricultural Economics: Meaning, definition, characteristics of agriculture, Nature and scope of agricultural economics, Distinction between agriculture and industry, Role of agriculture in economic development, Role of government interventions in agricultural development. Planning and Agricultural Development: Meaning and objectives, economic planning, benefits of planning, Agricultural development during different Five year Plans in India, Measures of reorganization of agriculture and NITI Aayog. Factors of production: Meaning of land and its characteristics, Labour

concept, Characteristics of labour and efficiency of labour, Capital concept and its characteristics, Forms of capital in agriculture and process of capital formation, Organization of business firms, Forms of business organizations and their characteristics. Land reforms: Land reforms and Land tenure systems, Concepts of agricultural land holdings in India. Theory of production: Meaning, definition, types of production functions, Laws of Diminishing Marginal Returns and Elasticity of production. Scale of production: Meaning, classification and economies of scale. Theory of costs: Meaning, definitions and different types of costs and their measurement. Revenue concept: Total revenue, average revenue and marginal revenue and profit maximization.

Suggested Readings

1. Reddy S Shubha. 2017. *Agriculture Economics*. Oxford and IBH.
2. Reddy S Shubha. 2005. *Finance*. Oxford and IBH Publishing Company Pvt. Limited. 2005.
3. Raju V T and Rao V S. 2017. *Economic of Farm Production and Management*. Oxford & IBH Publishing Co Pvt.Ltd
4. S S Acharya and N L Aggarwal. 1987. *Agricultural Marketing in India*. Oxford and IBH.
5. Koutsoyiannis A. 1975. Modern Microeconomics. Wiley.

Introduction to Agronomy and Crop Production Technology 2 (1+1)

Objectives

i. To understand the principles of agronomy and crop production technology.
ii. To learn about crop growth and development, including factors influencing yield and quality.
iii. To explore sustainable and efficient farming practices to enhance crop productivity while minimizing environmental impact.
iv. To gain practical knowledge of crop management techniques, including soil fertility, pest control, and irrigation.

Theory

Agriculture**,** Agronomy and their scope, tillage and tilth, crop density and geometry, factors affecting growth and development, crops and cropping systems, crop rotation and its principles, manures and fertilizers, irrigation, water resources, crop water requirement, water-use efficiency, irrigation-scheduling criteria and methods, quality of irrigation water, drainage. Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides. Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops, namely, rice, maize, sorghum, minor millets, pigeon pea, mung bean, groundnut and soybean. *Rabi* crops, namely, sorghum, wheat, chickpea, rapeseed and mustard, sunflower, sugarcane, cotton, tobacco and chilli.

Practical

Identification of crops, seeds, fertilizers, herbicides, tillage and sowing implements, Identification of weeds in crops, Methods of herbicide and fertilizer application, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Methods of irrigation. Methods of sowing of different crops. Nutrient functions and deficiencies, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of important crops, Visit to research centers of related crops.

Suggested Readings

1. Reddy TY and Sankara Reddi GH. 2008. *Principles of Agronomy.* Kalyani Publishers.

Management of Insect Pests of Crops and Stored Grains 2 (1+1)

Objectives

i. To understand the biology, ecology, and behaviour of insect pests affecting crops and stored grains.
ii. To learn effective strategies for monitoring, prevention, and control of insect pests in agricultural settings.
iii. To explore integrated pest management (IPM) approaches, including biological, cultural, and chemical control methods.
iv. To develop skills to assess and minimize economic losses caused by insect pests while promoting sustainable agriculture practices.

Theory

General account on nature and type of damage by different arthropods pests. Scientific name, order, family, host range, distribution, biology and bionomics, nature of damage and management of major pests of various field and horticulture crops. Factors affecting losses of stored grain. Insect pests, mites, rodents and birds associated with stored grain and their management. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different types of damage. Identification of various insect pests attacking different crops. Identification of insect pests associated with stored grain. Determination of insect infestation by different methods. Assessment of losses due to insects. Calculations on the doses of insecticides application technique. Fumigation of grains in store / godown. Identification of rodents and rodent control operations. Identification of birds and bird control operations. Methods of grain sampling under storage condition. Visit to nearest FCI godowns and ware houses.

Note: Each student should submit 25 insect pests samples representing different crops and stored products.

Suggested Readings

1. Bhargava and Kumawati. 2010. *Pest of Stored Grains and their Management*. New India Publishing.
2. Dhaliwal G S and Koul Opender. 2007. *Bio Pesticides and Pest Management*. Kalyani Publishers.
3. Dhaliwal G S and Arora Ramesh. 2006. *Principles of Insect Pest Management*. (2nd Edn.). 297p. Reprint. Kalyani Publisher.
4. Dhaliwal G S. and Heinrichs E A. 1998. *Critical Issues in Pest Management*. 287p. Common Wealth Publisher, New Delhi.
5. Hameed S F and Singh S P. 2005. *Handbook of Pest Management*. Kalyani Publishers.
6. Marwaha K K, Siddiqui K H and Singh J P. 2005. *Handbook of Crop Pest Control.* Kalyani Publishers.

7. Panwar V P S. 2006. *Agricultural Insect Pests of Crops and their Management*. (2nd Edn. & Reprint). 297p. Kalyani Publishers.
8. Ranjith A M. 2013. Illustrated. *Identification and Management of Horticultural Pest*. New India Publishing Agency.
9. Sharma Ramnivas. 2014. *Identification and Management of Horticulture Pest*. ABD Publisher.
10. Srivastav K P and Ahlawat Y S. 1999. *Pest Management in Citrus*. Research Periodicals & Book Publishing House.

Management of Plant Diseases 2 (1+1)

Objectives

i. To understand the biology, epidemiology, and ecology of plant diseases.
ii. To learn effective strategies for disease prevention, diagnosis, and management in agricultural systems.
iii. To explore integrated disease management approaches, including cultural, chemical, and biological control methods.
iv. To develop skills to mitigate the impact of plant diseases on crop yield, quality, and sustainability.

Theory

Objectives, historical development and economic significance of post-harvest diseases and seed-borne diseases. Study of important post-harvest diseases (transport, storage and market) of perishables and grains etc. Production of mycotoxins and their effects. Diagnosis and detection of plant pathogens carried through seeds, vegetatively propagated material. Harvesting, transportation, processing and methods of storage. Seed contamination, seed-borne infections and seed transmission. Packing and packaging, requirement of packing materials. Principles of plant disease management, viz., avoidance, exclusion, eradication, protection, immunization-HPR and biological control. Pesticides, Classification of fungicides. Mode of application. Biotechnological approaches of diseases management. IPR and related issues. IDM concepts and importance. Management of post-harvest diseases. IDM module for important post-harvest diseases.

Practical

Study of post-harvest disease symptoms caused by fungi, bacteria, virus, nematodes etc. Diagnosis and detection of various post-harvest diseases. Methods of detection and identification of seed-borne pathogens, isolation of biocontrol agents, Testing the efficacy of biocontrol agents by dual culture technique. Mass multiplication and methods of application of bio agents, Study of fungicides, bactericides, nematicides and their formulations. Study of pesticide compatibility and their safe-use. Study of plant protection equipments. Bioassay of fungicides, Seed treatment techniques for the control of seed-borne diseases. Biocontrol of post-harvest diseases. Study of seed packaging and storage techniques. Visit to vegetable and fruit markets, bio-pesticide/ pesticide firms. Visit to processing warehouse and testing laboratories.

Suggested Readings

1. Butani D K. 1984. *Insects and Fruits*. Periodical Expert Book Agency, New Delhi.
2. Metcalf R L and Luckman W H. 1982. *Introduction to Insect Pest Management*. Wiley Inter Science Publishing, New York.

3. Nair M R G K. 1975. *Insects and Mites of Crops in India*. ICAR, New Delhi.
4. Swaroop Gopal and Das Gupta. 1986. *Plant Parasitic Nematodes of India: Problems and progress*. ICAR, New Delhi.
5. Upadhyay K D and Dwivedi K. 1997. *A textbook of Plant Nematology*. Aman publishing house, Meerut
6. Vasanth Raju David, B. 2001. *Elements of Economic Entomology*. Popular Book Depot, Chennai.

Basic Mathematics / Botany 2 (2+0)

Basic Mathematics

Objective

To introduce the basic principles and functions in mathematics

Theory

Algebra: Progressions - Arithmetic, Geometric and Harmonic Progressions. Matrices- Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation-Growth rate, Average Cost, Marginal Cost, Marginal Revenue. Partial differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form $y = f(x)$ and $y = f(x1, x2)$.

Integral Calculus: Integration - Definite and Indefinite Integrals, Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Suggested Readings

1. NCERT. 2012. Mathematics of Class XII, NCERT India.
2. Sharma R D. 2014. Mathematics of Class XII, Dhanpat Rai Publisher.

Basic Botany

Objective

To introduces the basic taxonomy and classification of plants

Theory

Plant kingdom and features of each group; Morphology, modifications and functions of root, stem, leaf, flower and inflorescence; Pollination and fertilization; Fruit types; Structure of dicot and monocot seed, seed germination.

Cell structure; DNA, chromosome and genes; Cell and tissue types; Internal structure of root, stem and leaf.

Plant taxonomy, systems of classification; Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Suggested Readings

1. Bendre A M and Kumar A. 1999. *Textbook of Practical Botany*. Vol. II, (7th Edn). Rastogi Publications.
2. Bendre A M and Pande P C. 2009. *Introduction to Botany*. Rastogi publications.
3. Bhatia K N and Tyagi M P. 2020. *Elementary Biology*. Truemen Publication.
4. David M Hillis, H Craig Heller, Sally D Hacker, David W Hall and David E Sadava. 2020. (12th Edn). Life: *The science of biology*. Sunderland Publication. eBook.
5. Dutta A C. 1995. *A Class Book of Botany, (16th Edn)*. Oxford University Press.
6. NCERT. 2021. *Biology of Class XI*. NCERT. India.
7. Pande P C and Jain D K. 2022. *A Textbook of Botany Angiosperm*. S. Chand Publications.

Farming Based Livelihood Systems 3 (2+1)

Objectives

i. To make the students aware about farming based livelihood systems in agriculture

ii. To disseminate the knowledge and skill how farming based systems can be a source of livelihood

Theory

Status of agriculture in India and different states. Income of farmers and rural people in India. Livelihood-definition, concept and livelihood pattern in urban and rural areas. Different indicators to study livelihood systems. Agricultural livelihood systems (ALS); meaning, approach, approaches and framework. Definition of farming systems and farming based livelihood systems, prevalent farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- crops and cropping systems, livestock (dairy, piggery, goatry, poultry, duckry etc.), horticultural crops, agroforestry systems, aquaculture, duck/poultry-cum-fish, dairy-cum-fish, piggery-cum-fish etc. Evaluation indices for cropping system and farming systems. Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers. Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones. Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country. Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems. Schemes and program s by central and state government, public and private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agriculture-based livelihood enterprises. Study of components of important farming-based livelihood models/ systems in different agro-climatic zones. Study of production and profitability of crop-based, livestock-based, processing-based and integrated

farming-based livelihood models. Field visit of innovative farming system models. Visit of agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and study of agri-enterprises involved in industry and service sectors (value chain models). Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis. Evaluation indices for cropping system and farming systems. Case study of start-ups in agri-sectors.

Suggested Readings

1. Agarwal A and Narain S. 1989. *Towards Green Villages: A Strategy for Environmentally, Sound and Participatory Rural Development,* Center for Science and Environment, New Delhi, India.
2. Ashley C and Carney D. 1999. *Sustainable Livelihoods: Lessons from Early Experience*. Department for International Development: London, UK.
3. Bhatt B P, Abhay Kumar, Thakur P K, R S Amitava Dey U K, Sanjeev Kumar B K, Jha L K, Pathak K N, Hassan A, Singh S K, Singh K K and Singh K M. 2014. *Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar*. ICAR Research Complex for Eastern Region, ICAR Parisar, P.O. Bihar Veterinary College, Patna, Bihar.
4. Carloni A. 2001. *Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa.* Consultation Document, FAO, Rome, Italy.
5. Dixon J, Gulliver A and Gibbon D. 2001. *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World*. FAO and World Bank: Rome, Italy and Washington, DC, USA.
6. Evenson R E. 2000. *Agricultural Productivity and Production in Developing Countries*'. The State of Food and Agriculture, FAO, Rome, Italy.
7. Panwar A S, Ravisankar N, Prusty A K, Shamim M, Singh R, Bhaskar S, Malik S K, Tomar R K, Arunachalam A and Alagusundaram K. 2019. *Integrated Farming System models for Agricultural Diversification, Enhanced Income and Employment*. Indian Council of Agricultural Research, New Delhi.
8. Reddy S R. 2016. *Farming System and Sustainable Agriculture*. Kalyani Publishers, New Delhi.
9. Singh J P, Ravisankar N, Prusty A K, Sikka A K and Gangwar B. 2016. *Region Specific Synthesized Integrated Farming System Models for Improved Production, Profitability and Nutrition (Series 1).* IIFSR Bulletin No. 2016-1, AICRP on Integrated Farming Systems, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, pp. 1-88.
10. Walia S S and Walia U S. 2020. *Farming System and Sustainable Agriculture*. Scientific Publishers, Jodhpur, Rajasthan.

National Cadet Corps-I (NCC-I) 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline. Drill- aim, general words of command, attention, stands at ease, stand easy and turning. sizing, numbering, forming in three ranks, open and close order march, and dressing. Saluting at the halt, getting on parade, dismissing, and falling out. Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. Marking time, forward march, and halt. Changing step, formation of squad and squad drill. Command and control, organization, badges of rank, honors, and awards.

Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Service Scheme-I (NSS-I) 1 (0+1)

Objective

Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work; to be skilful in executing democratic leadership; developing skill in program; to be able to seek self-employment, reducing gap between educated and uneducated; increasing awareness and desire to help sections of society.

Practical

Orientation: history, objectives, principles, symbol, badge; regular Program s under NSS. Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health. NSS Program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth Program / schemes of GoI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is the agent of social change. Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration. Indian history and culture, role of youth in nation building, conflict resolution and peace- building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism. Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human

rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

Communication Skills 2 (1+1)

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication

Theory

Communication process: The magic of effective communication. Building self-esteem and overcoming fears. Concept, nature and significance of communication process. Meaning, types and models of communication. Verbal and non-verbal communication. Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic communication skills. Listening, speaking, reading and writing skills. Precise writing/ abstracting/summarizing. Style of technical communication. Curriculum vitae/resume writing. Innovative methods to enhance vocabulary, analogy questions.

Structural and functional grammar. Sentence structure, modifiers, connecting words and verbals. Phrases and clauses. Case: subjective case, possessive case, objective case. Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles. Agreement of verb with the subject: tense, mood, voice. Writing effective sentences. Basic sentence faults.

Practical

Listening and note taking. Writing skills; precise writing, summarizing and abstracting. Reading and comprehension (written and oral) of general and technical articles. Micro-presentations and impromptu presentations. Feedback on presentations. Stage manners; grooming, body language, voice modulation, speed. Group discussions. Public speaking exercises; vocabulary building exercises. Interview techniques. Organization of events.

Suggested Readings

1. Allport G W. 1937. *Personality: A Psychological Interpretation.* Holt, New York.
2. Brown M and Gyles B. 1994. *How to Interview and be Interviewed*, Sheldon Press, London.
3. Carnegie D. 1997. *The Quick and Easy Way to Effective Speaking.* Pocket Books, New York.
4. Francis Peter S J. 2012. *Soft Skills and Professional Communication.* Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. *Communication Skills.* Oxford University Press.
6. Neuliep J W. 2003. *Intercultural Communication: A Contextual Approach*. (2nd Edn.) Houghton Mifflin Co Boston.
7. Pease A. 1998. *Body Language.* Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. *Business Communication.* Oxford University Press.
9. Seely J. 2013. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press.
10. Thomson A J and Martinet A V. 1977. *A Practical English Grammar*. Oxford University.

SEC-1: Computer Applications in Agriculture 2 (0+2)

Objectives

i. To understand the role of computer applications in modern agricultural practices.
ii. To learn to use agricultural software and tools for data analysis, modeling, and decision-making.
iii. To explore the application of Geographic Information Systems (GIS) and remote sensing in precision agriculture.
iv. To develop skills in utilizing technology to optimize farm management, improve productivity, and reduce environmental impact.

Practical

Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management program. Use of electronic spreadsheet and graphics. Use of SPSS statistical application packages. Use of SAS in agriculture and its application. Working with MS-DOS. Database design. Data entry operation. Use of electronic spreadsheet and graphics. Basics of computer networking – LAN, SAN – BUS – Tokening – Star - Internet, Intranet – Basics of Email – Exposure to web browsing (structure of URL), Types of websites – Internet service provider – using internet news.

Suggested Readings

1. Sharma Manish, Anil Bhatt. 2016. *Computers in Agriculture: Fundamentals and Applications*. New India Publishing Agency – NIPA.
2. William Otto Rasmussen.2023. *Computer Applications in Agriculture*. (1st Edn) CRC Press.
3. Michael E Newman. 1994. *Computer Applications in Agriculture and Agribusiness*. Paperback

SEC-2: Production Technology for Bio-Agents and Bio-Fertilizers 2 (0+2

Objectives

i. To understand the principles and methods of producing bio-agents and bio-fertilizers.
ii. To learn techniques for mass production and formulation of beneficial microorganisms.
iii. To explore the role of bio-agents and bio-fertilizers in sustainable agriculture and soil health management.
iv. To develop skills to integrate bio-agents and bio-fertilizers into crop production systems for enhanced yield and reduced environmental impact.

Practical

A. **Agricultural Microbiology**: Relevance of Biofertilizer in Agriculture. Types of Biofertilizers [(a) Nitrogen fixers: *Rhizobium, Azotobacter, Azospirillum*, *Glucano* acetobacter, Cyanobacteria and Azolla; (b) P-solubilizers: PSB, PSF; (c) K-solubilizers; (d) Zn-solubilizers; (e) P-mobilizers: AM fungi; (f) Development of consortia]. Mass Production Techniques [(a) Carrier based; (b) Liquid Biofertilizers]. Methods of application. Quality Control (Standards as per FCO (1985) amended in 2009).

Suggested Readings

1. Atlas Bartha.1998. *Microbial Ecology - Fundamentals and Application.* (4th Edn). Pearson Education India
2. Bikas R. Pati and Mandal Santi M. 2015. *Recent Trends in Biofertilizers.* I K International Publishing House Pvt. Ltd
3. Eiri Board. 2007. *Handbook of Biofertilizers and Vermiculture*. Engineers India Research In.
4. Himadri Panda. 2007. *Complete Technology Book on Biofertilizer and Organic Farming*. Gene-Tech Books.
5. Nicklin J, Graeme-Cook K, Paget T. and Killington R. 1998. *Instant Notes in Microbiolog*. Springer-Verlag New York Inc.y.
6. M K Rai. 2006. *Handbook of Microbial Biofertilizers.* International Book Distributing Co.
7. Mark S. Coyne. 2004. *Soil Microbiology - An Exploratory Approach*. Delmar Publishers.
8. Michael Madigan, John Martinko, David Stahl and David Clark. 2011. *Brock-Biology of Microorganisms.* Pearson Education

B. **Agricultural Entomology**: Importance of biopesticides and other non-chemical approaches in pest management. Mass production of laboratory host, parasitoids and predators. Mass rearing techniques of rice moth, *Corcyra cephalonica* Stainton, *Trichigramma* Spp, *Goniozus nephantidis* (Muesebeck) and *Bracon bravicornins* Wesmael, predators, *Chrysoperla zastrowi* Sillemi (Esben-Petersen), *Cryptolaemus montrouzieri* Mulsant, *Micromus igorotus* Banks, Weed killers, *Zygogramma bicolorata* Pallister, Aquatic weed killer, *Cyrtobagous salviniae* Calder, Preparation of culture media, culturing and spore counting of *Nomuraea rileyi* (Farl.) *Samsonand Beauveria bassiana* (Bals.) /*Metarhizium anisopliae* (Met.) and *Lecanicillium lecanii* (Zimmerman), Mas production of Ha NPV/Sl NPV, Estimation of spore load from microbial pesticides, Preparation of Neem Seed Kernel Extract (NSKE), Preparation and use of Biodigester, Panchagavvya, GCK, cow urine and cow dung, Conservation measures for Natural Enemies and visit to Biocontrol Laboratories.

Suggested Readings

1. Koul O, Dhaliwal G S and Khokhar S. 2014. *Biopesticides in Sustainable Agriculture Progress and Potential.* Hardcover.
2. Veeresh G K, Shivashankar K and Suiglachar M A. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bengaluru.
3. WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*.WHO.
4. Woolmer P L and Swift M J. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF and Wiley.

C. Plant Pathology: Introduction about bio-pesticides/global scenario/advantages, disadvantages and mechanisms of action; Isolation and enumeration of fungal biocontrol agents from soil; Isolation and enumeration of bacterial biocontrol agents from soil; Purification of biocontrol agents; Hands on skills on mass production of *Trichoderma harzianum* and *Pacelomyces lilacinus* (isolation, preparation of mother culture, sterilisation, fermentation, quality analysis, mixing, packing and labeling); Characterization of fungal (*Trichoderma harzianum* and *Pacelomyces lilacinus*) antagonistic organisms (Morphological); Studies on antagonistic ability of fungal biocontrol agents through dual plate technique; Hands on skills on mass production of *Pseudomonas fluorescens* and *Bacillus subtilis* (isolation, preparation of mother culture,

sterilisation, fermentation, quality analysis, mixing, packing and labeling); Characterization of bacterial (*Pseudomonas fluorescens* and *Bacillus subtilis*) antagonistic organisms (Morphological); Studies on antagonistic ability of bacterial biocontrol agents through dual plate technique; Field evaluation of biocontrol agents; Evaluation of biocontrol agents against diseases of vegetables under protected cultivation; Evaluation of plant extracts (neem, tulsi, pongamia, etc) and liquid organic manures (panchagavya, beejamruta, Jeevamruta) against plant diseases; Registration procedures for biocontrol agents; Cost of production of various biocontrol agents.

Suggested Readings

1. Singh Dwijendra.2014. *Advances in Plant Biopesticides. Springer Nature.*
2. Franklin R Hall and Julius J. Menn.1998. Biopesticides: Use and Delivery. Humana Press Inc.
3. Pranab Dutta. 2022. Biopesticides. EBH Publishers.

Semester II

Farm Management, Production and Resource Economics 3 (2+1)

Objectives

i. To understand the principles of farm management and resource allocation in agriculture
ii. To analyze production economics to optimize resource use and maximize profitability on farms
iii. To learn about farm-level decision-making processes, including crop selection, input use, and technology adoption
iv. To explore the economic aspects of resource management, including land, labor, capital, and risk, in agricultural enterprises

Theory

Farm management: meaning, definitions and concepts; Nature and scope, objectives and relationship with other sciences; Decisions making process; Meaning and definition of farms sizes based on holding and ownership; Types of farming and their characteristics; factors determining types and size of farms; production economics and farm management principles; Meaning definition of production economics, concept of production function and its types, use of production function in decision making on a farm, factor-product, factor-factor and product-product relationship. Law of equi-marginal returns or principles of opportunity cost and law of comparative advantage; Cost principle: meaning and concept of costs, types of costs-seven costs and applied cost concepts, and their interrelationship, importance of cost in managing farm business; Farm records: types and importance of farm records and accounts in managing a farm; Farm planning and budgeting: meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting, linear programming; Risk and uncertainty: concept of risk and uncertainty in agriculture production, types/sources of risks and their management strategies. Crop/ livestock/machinery insurance: Weather based crop insurance scheme (WBCIS) and *Pradan Mantri Fasal Bhima Yojana* (PMFBY), their features; Resource economics: Meaning of resource economics difference between NRE and agricultural economics, unique properties of natural resources, positive and negative externalities in agriculture, inefficiency and welfare loss, solutions, management of common property resources of land, water, pasture, fishery and forest resource.

Practical

Basic concepts in production economics and farm management; study and visit to different farm layouts and appraisals of farm resources; Analysis of costs and revenue concepts; Computation of depreciation cost of farm assets; Determination of most profitable level of input use in a farm production process; Determination of least cost combination of inputs; Selection of most profitable enterprise combination; Application of equi-marginal returns/opportunity cost principle in allocation of farm resources; Application of the principle of comparative advantage; Estimation of cost and returns using CACP cost concepts for crop, horticulture and livestock enterprises; Farm inventory analysis; Preparation of optimum farm plan using budgeting technique using partial and complete budgeting; visit to farms to study farm records and accounts; preparation of profit and loss accounts compensation for crop loss; Collection and analysis of data on various resources in India; Practical Examination.

Suggested Readings

1. Chinna S S. 2017. *Agricultural Economics and Indian Agriculture.* Kalyani Publishers.
2. Heady E O and Dhillon, J L.2012. *Agricultural Production Functions*. Kalyani Publishers
3. Jhon, P. Doll and Frank. Orezen.1984. *Production Economics: Theory with Applications*. Wiley.
4. Johl S S and Kapoor T R. 2007. *Fundamentals of Farm Business Management*. Kalyani Publishers
5. Memoria C B. 1969. *Agricultural Problems of India*. Kitab Mahal.
6. Raju VT and Vishwashankar Rao.1993. *Economics of Farm Production and Management.* Oxford and IBH.
7. Sadhu and Singh, Fundamentals of Agricultural Economics. Himalaya Publishing House. 1999.
8. Sankhyan P L. 1988. *Introduction to Economics of Agricultural Production*. Prentic-Hall of India.

Marketing of Agricultural Inputs and Outputs 2 (1+1)

Objectives

i. To understand the principles of agricultural marketing, including input and output markets
ii. To learn about marketing strategies and techniques for agricultural inputs and products
iii. To explore pricing mechanisms, market structures, and distribution channels in the agricultural sector
iv. To develop skills to effectively market agricultural inputs and outputs, maximizing profitability for farmers and stakeholders

Theory

Agricultural Marketing- Definition, scope and classification of agricultural marketing.

Agricultural input marketing – meaning and importance; Agricultural Inputs and their types – farm and non-farm, role of cooperative, public and private sectors in agri input marketing. Seed Marketing: Importance, Types of seeds, Demand and supply of seeds; agencies involved in Seed marketing; distribution, export import of seeds; Role of NSC and State Seed Corporation. Government policy on seed marketing. Fertilizer Marketing: Production, export-import, supply of chemical fertilizers. Demand/consumption, regional disparity in consumption, pricing policy; subsidy on fertilizers; marketing system – marketing channels, Agencies involved in fertilizer marketing- Public, Private, Co-operative sectors. Problems in distribution. Plant Protection

Chemicals: Production, export/import, consumption, marketing channels. Electricity/Diesel Oil-distribution, pricing of electricity for agriculture use; subsidy on electricity. Farm Machinery and Implement: Production, supply, demand, distribution channels of farm machines; Agencies involved in distribution of agro-machineries and implements. Meaning and importance of Land reforms and tenancy in agriculture, ceiling, elasticity, pricing. Labour markets - productivity, heterogeneity, wage differentials – skill differentials. Credit: importance, types and sources. IT applications in agri- input marketing.

Practical

Input Market Analysis, Primary and Secondary Survey of input use, Exercise on Market Segmentation, Case Study on Product Management, Channel Management in Agri input, Case Study on Brand Management. Designing Communication and Promotion Measures – Seed, Fertilizer, Plant Protection Chemicals, Agricultural Machinery and Implements. Market Research – Seed, Fertilizer, Plant Protection Chemicals, Agricultural Machinery and Implements. Formulation of Marketing Strategy, Report Presentations.

Suggested Readings

1. Acharya S S and Agarwal N L.1987. *Agricultural Marketing in India*. Oxford and IBH.
2. Lekhi R K. 2006. *Agricultural Economics,* Kalyani Publications.
3. Ruddra Dutt and Sundharam K P M.1996. *Indian Economics*. Niraj Prakashan.

Agricultural Finance and Insurance 2 (1+1)

Objectives

i. To understand the principles of agricultural finance, including credit, investment, and risk management.
ii. To learn about financial tools and services available to farmers, including loans, grants, and insurance.
iii. To explore the role of insurance in mitigating agricultural risks such as crop failure, weather events, and market fluctuations.
iv. To develop skills to analyze financial statements, assess investment opportunities, and make informed financial decisions in agriculture.

Theory

Agricultural Finance – meaning, definition, nature and scope. Agricultural Credit - meaning, definition, importance and classification based on various criteria.

Credit Analysis - 3 Rs of Credit; 5 Cs of Credit; and 7 Ps of Credit; Repayment Plans. Financial Statements – meaning, types and uses. Time Value of Money / Principle of Time Comparison – meaning and importance. Compounding and Discounting.

History of financing agriculture in India. Nationalization of banks – meaning and objectives; Village Adoption Scheme – origin and objectives; Lead Bank Scheme – origin and functions; Regional Rural Banks – origin, objectives and features; Micro-financial Institutions: meaning and features; Self Help Groups (SHGs) – meaning and features.

Scale of finance and security for loans. Banking schemes for agricultural finance - Differential

Rate of Interest (DIR) Scheme – origin and features; Kisan Credit Card Scheme – origin, objectives and features. Financial inclusion – *Jan Dhan Yojana*, financial literacy and business correspondent model. NPAs in agricultural lending: applicability of the SARFESI Act in agricultural lending.

Financing Agencies: RBI – activities and functions; NABARD – genesis, objectives and functions; AFC – functions; ADB and World Bank – origin and functions; IMF, IFC and IDA. Deposit Insurance and Credit Guarantee Corporation of India (DICGC) – Origin and functions.

e-Payment systems - The Banking Ombudsman Scheme-Non-Banking Financial Institutions (NBFI) – meaning and structure, types of activities of NBFIs -Merchant banking in India - Functions - Mutual Funds – Features and structure - Credit rating agencies in India, Process - Factoring mechanism - Forfeiting services.

Insurance – meaning and definition. Crop Insurance Scheme – origin, meaning, importance and advantages of crop insurance, Comprehensive Crop Insurance Scheme (CCIS), National Agricultural Insurance Scheme (NAIS), Modified National Agricultural Insurance Scheme (MNAIS), and Weather based Crop Insurance and *Fasal Bhima Yojana* and Unified Package Insurance Scheme (UPIS). Assessment of crop losses, determination of compensation, limitations in application and estimation of crop yields. Livestock insurance – origin, meaning and importance.

Practical

Exercises on time value of money - compounding and discounting. Estimation of credit needs for crop and livestock enterprises. Determination of scale of finance for farm enterprises. Repayment plans for short-term loans and term loans. Estimation of risk in crop and livestock enterprises. Estimation of premium amount for insurance. Visits to financial inclusion branch of commercial bank and regional rural bank; and insurance agency in public and private sectors. Visit to weather station.

Suggested Readings

1. Agarwal R N. 1996. *Financial Liberalization in India- A Study of Banking System and Stock Markets*. Delhi B R Publishing.
2. Bagchi A K. 1987. *The Evolution of the State Bank of India (Part I and II)*. Oxford University Press,
3. Bhasin Niti. 2007. *Banking and Financial Markets in India*. New Century Publications.
4. Gulati Ashok and Seema Bathla. 2002. *Institutional Credit to Indian Agriculture: Defaults and Policy Options*. NABARD Occasional Paper- 23.
5. Karthykeyan T K. 1990. *Long-term Financing of Agriculture Land Development Banks in a Multi-Agency System*. Bombay; Himalaya.
6. Mathur B L. 1989. *Indian Banking- Performance, Problems and Challenges*. Jaipur National Publishing House.
7. Mishra R K. 2005. *Banking Sector Reforms and Agricultural Finance*. Sonali Publications.
8. Murray William G. 1947. *Agricultural Finance- Principles and Practices of Farm Credit*. Iowa State College Press.
9. Nakkira S. 1980. *Agricultural Financing and Rural Banking in India- An Evaluation*.
10. Pandey U K. 1990. *An Introduction to Agricultural Finance*. Kalyani Publishers.

11. Reddy Subba S and Raghuram P. 2005. *Agricultural Finance and Management*. Oxford & IBH Publishing Company.

Introduction to Genetics and Plant Breeding 2 (1+1)

Objectives

i. To understand the principles of genetics and their application in plant breeding
ii. To learn about breeding techniques used to improve crop traits such as yield, disease resistance, and quality
iii. To explore the importance of genetic diversity and its role in crop improvement and adaptation to changing environments
iv. To develop skills to evaluate and select superior plant genotypes for breeding programs aimed at enhancing agricultural productivity and sustainability

Theory

History of Genetics and Plant Breeding, Study of Chromosome- Structure, functions, cell division. Mendel's laws of inheritance, Mode of inheritance- monogenic, polygenic, cytoplasmic. Modes of reproduction in plants: sexual and asexual, differences between self- and cross-pollinated crops. Male sterility and their significance in plant breeding. Breeding for self-pollinated (Mass, pure line, pedigree and bulk methods), cross-pollinated (Ear to row, Backcross, Development of synthetics, composites and hybrids), vegetatively propagated crops (Clonal selection).

Practical

Mendelian ratios- Problems related to segregation and independent assortment and polygenic inheritance. Study of linkage, crossing over percentage, map distance. Study of floral structure and biology of important cereals, pulses, oilseeds and commercial crops. Study of plant breeder's kits, selfing and crossing techniques. Male sterility: A, B and R lines and their utility. Pollen fertility study and its importance. Layout of field experiments, principles, data recording and elementary statistics and analysis of data. Visit to different crop breeding schemes.

Suggested Readings

1. J F Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, William M Gelbart.2000. *An Introduction to Genetic Analysis*. W. H. Freeman,
2. Poehlman J M.1997. Breeding Field Crops. Avi Publishing Company.
3. Strickberger Monroe W.1976. *Genetics.* Macmillan.
4. Sharma J R.1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill Pub.
5. R W Allard.1999. *Principles of Plant Breeding*. (1st and 2nd Edition). John Willey and Sons Inc., New York.

Principles and Practices of Seed Science and Technology 2 (1+1)

Objectives

i. To understand the principles of seed science, including seed development, physiology, and quality

ii. To learn about seed processing, storage, and testing techniques used to maintain seed viability and vigour

iii. To explore the role of seed technology in ensuring the availability of high-quality seeds for sustainable crop production

iv. To develop skills to manage seed resources effectively, ensuring the successful establishment and productivity of crops

Theory

Introduction: Importance of improved seed in Indian Agriculture, quality seeds and its characteristics. History: Development of seed industry in India. Seed Program: Types of seed program, development of seed program, basic strategy for organizing seed production, different classes of seeds, generation system of seed multiplication, seed replacement rate (SRR), varietal replacement rate (VRR), agencies involved in seed program. Principles of seed production: Factors affecting genetic purity and varietal deterioration, methods / safeguards to maintain genetic purity during seed production, study of improved production practices for higher seed yield and quality. Economic principles: Study of SMR, importance of SMR, SMR in different crops. Hybrid seed production: Requirements of hybrid seed production, methods of hybrid seed production and types of hybrids. Varietal and hybrid seed production (Foundation and Certified seed classes) in maize, rice, sorghum, bajra, sunflower, red gram, cotton, castor, chilli, tomato and okra. Varietal seed production in wheat, soybean, chickpea, black gram. Seed processing and packaging: Seed processing-its importance and methods seed packaging and seed branding. Seed testing: Seed testing procedures in different crops, minimum seed standards for certification. Seed storage, different types of storage conditions. Seed legislation: Seeds Act 1966, Seed Rules 1968, Seed (Control) order 1983, New policy on seed development 1988, PPVFRA 2001, Seeds Bill 2004, OECD Seed certification and its importance. Seed marketing: Seed demand forecasting, factor affecting seed marketing, seed supply systems, sale promotional activities for seed marketing, seed marketing organizational structures. International seed trade, developing seed entrepreneurship. Importance of account keeping in seed business. Cost estimation and pricing of seed.

Practical

Identification of seeds of field and horticultural crops, study of seed structure in monocot and dicot seeds. Study of floral biology of important self, cross and often cross pollinated agriculture and horticulture crops. Working of SRR, VRR and SMR Types of isolation, determination of isolation distance, requirements, study of isolation requirements in different crops for foundation and certified seeds. Study of hand emasculation, hand pollination and detasseling techniques. Study of distinguishing morphological characters in varieties and parents of hybrids. Study of synchronization techniques for hybrid seed production, planting ratio. Supplementary pollination techniques, border rows for hybrids seed production. Study of seed cleaning and grading technique, and equipment. Seed packing and seed treatment techniques. Practicing seed testing in different crops seeds. Vigour tests in different crop seed lots. Studying of safe seed storage techniques. Working out cost of seed production, seed pricing. Account keeping books. Visit to seed production plots of public and private sector companies. Visit to seed production organization to understand account keeping and working of seed prices in seed business.

Suggested Readings

1. Agarwal P K and M Dadlani. 1987. *Techniques in Seed Science and Technology*. South Asian Publishers, New Delhi.
2. Agarwal V K. 2003. *Seed Health*. International Book Distributing Co.
3. Agrawal R L. 1996. *Seed Technology*. Oxford and IBH Publicity Company, New Delhi.
4. Bhale M S. 2013. *A Handbook of Seed Certification*. Vardhman Books and Periodicals.
5. Joshi A K and Singh B D. 2003. *Seed Science and Technology*. Kalyani Publishers. Ludhiana.
6. Khare D P. 1994. *Stored Grain Pests and their Management*. Kalyani Publishers. Ludhiana.
7. Kulkarni G N. 2002. *Principles of Seed Technology*. Kalyani Publishers. Ludhiana.
8. Nema N P. 1986. *Principles of Seed Certification and Seed Testing*. Pub. Allied Publishers Private limited, New Delhi.
9. Paul Neergaard. 1977. *Seed Pathology, Vol. - I and II.* McMillan Press, London.
10. Sen Subip and Ghosh Nabinanda. 2002. Seed Science and Technology. Kalyani Publishers. Ludhiana.
11. Singhal N C. 2002. *Hybrid Seed Production.* Kalyani Publishers, Ludhiana.
12. Tunwar N S and Singh S V. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, New Delhi.

Livestock, Poultry and Fish Production Management 2 (1+1)

Objectives

i. To understand the principles of livestock, poultry, and fish production management
ii. To learn about breeding, nutrition, health, and housing practices for optimizing animal productivity and welfare
iii. To explore sustainable management strategies to improve efficiency, profitability, and environmental sustainability in animal production systems
iv. To develop skills to address challenges related to disease prevention, feed efficiency, and market demands in livestock, poultry, and fish production

Theory

Role of livestock, poultry and fisheries in the national economy. Classification of breeds of cattle, buffalo, sheep, goat and poultry. Principles of housing system for different species of livestock and poultry. Classification of feeds and fodder for livestock and poultry. Preparation of concentrate mixture. Conservation and enrichment of fodder. Signs of Estrus. Artificial insemination and its importance Feeding and management of calves, heifers, pregnant, milch animals and bullocks

Brooding management in poultry. Management of broilers, growers, layers and backyard birds. Management of sheep and goats. Prevention and control of important diseases of livestock and poultry. Marketing and economics of livestock and poultry. Introduction to fish and fisheries in India. Fisheries resources of India and importance of inland aquaculture. Important cultivable fishes and their production

Practical

Introduction to University Livestock Farms and Common Terminologies of Animal Sciences. Study of external body parts of livestock. Study of different breeds of Indian and Exotic Livestock. Study of housing for Livestock. Estimation of age of animals. Methods of identification of animals. Judging and culling of animals and poultry. Physical and chemical properties of milk, Clean milk production. Estimation of specific gravity of milk. Estimation of fat of milk. Estimation of total solids and SNF of milk. Detection of milk adulterants and Preservatives. Egg structure, chemical composition and grading. Study of common feeds and fodder. Conservation of Fodder and computation of ration for livestock. Common equipment used in livestock farms. Economics of Livestock Units. Visit to aquaculture and seed production fish ponds.

Suggested Readings

1. Banerjee G C. 2018. *Textbook of Animal Husbandry*. Oxford and IBH Publishing.
2. Felix S, T V Anna Mercy and Sawain S K 2013. *Ornamental Aquaculture Technology and Trade in India*. Daya Publishing House.
3. ICAR. 1997. Handbook *of Animal Husbandry*, ICAR.
4. Jadhav N V. 2007. *Handbook of Poultry Production and Management.* Jaypee Brothers Medical Publishers.
5. Prasad Jagadish. 2001. *Animal Husbandry and Dairy Science*. Kalyani Publishers.
6. Prasad Jagadish. 2012. *Principles and Practices of Dairy Farm Management*. Kalyani Publishers.
7. Prasad Jagadish. 2007. *Sheep, Goat and Swine Production*. Kalyani Publishers.
8. Shreenivashaiah PV. 2006. *Scientific Poultry Production.* International Book Distributing Company
9. Sastry N S R and C K Thomas. 1990. *Livestock Production Management*. Kalyani Publishers.

Environmental Studies and Disaster Management 3 (2+1)

Objective

To expose and acquire knowledge on the environment and to gain the state-of-the-art-skill and expertise on management of disasters.

Theory

Introduction to environment; environmental studies. Definition, scope and importance, multidisciplinary nature of environmental studies. Segments of environment, spheres of earth; lithosphere, hydrosphere, atmosphere. Different layers of atmosphere. Natural resources; classification. Forest resources. Water resources. Mineral resources. Food resources. Energy resources. Land resources. Soil resources. Ecosystems. Concept of an ecosystem; structure and function of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and value of biodiversity. Biodiversity hot spots. Threats and conservation of biodiversity.

Environmental pollution. Definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, light pollution.

Solid waste management; classification of solid wastes and management methods, composting, incineration, pyrolysis, biogas production, causes, effects and control measures of urban and industrial wastes. Social issues and the environment. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics; issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment protection act. Air (prevention and control of pollution) act. Water (prevention and control of pollution) act. Wildlife Protection Act. Forest Conservation act. Human population and the environment; environment and human health. Human rights, value education. Women and child welfare. Role of information technology in environment and human health.

Disaster management; disaster definition, types, natural disasters, floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves. Man-made disasters, nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and national strategy for disaster reduction. Concept of disaster management, national disaster management framework, financial arrangements, role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control. Armed forces in disaster response. Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets (river/forest/grassland/hill/mountain). Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of *E. coli* in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Suggested Readings

1. De A K. 2010. *Environmental Chemistry*. 384 p. New Age International Publishers, New Delhi. ISBN:13–978 81 224 2617 5.
2. Dhar Chakrabarti P G. 2011. *Disaster management - India's Risk Management Policy Frameworks and Key Challenges.* 36p. Centre for Social Markets (India), Bengaluru.
3. Erach Bharucha. 2020. *Textbook for Environmental Studies.* University Grants Commission, New Delhi.
4. Parthiban K T, Vennila S, Prasanthrajan M, Umesh Kanna S. 2003. *Forest, Environment, Biodiversity and Sustainable Development*. Narendra Publishing House, New Delhi (In Press).
5. Prasanthrajan M, P P Mahendran. 2008. *A Textbook on Ecology and Environmental Science.* Agrotech Publishing Academy, Udaipur. ISBN 81-8321-104-6. First Edition: 2008.
6. Prasanthrajan M. 2018. *Objective Environmental Studies and Disaster Management*. 146p. Scientific Publishers, Jodhpur, India. ISBN 9789387893825.

7. Sharma P D. 2009. *Ecology and Environment*. Rastogi Publications, Meerut, India.
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage Learning Publication, Belmont, USA.

National Cadet Corps II (NCC-II) 1 (0+1)

Objectives

i. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
ii. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

Practical

Arms Drill - Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice-versa. Guard mounting, guard of honour, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme II (NSS-II) 1 (0+1)

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in program, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical

- Importance and role of youth leadership: Meaning, types and traits of leadership, qualities of good leaders, importance and roles of youth leadership
- Life competencies: Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication

- Youth development programs: Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation: Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid
- Youth and yoga: History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Personality Development **2 (1+1)**

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B behaviours, Personality and organizational behaviour.

Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception, Attribution theory and case studies on perception and attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behaviour, Learning and training, Learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation - theories and principles, teamwork and group dynamics.

Practical

MBTI personality analysis, Learning styles and strategies, Motivational needs, Firo-B, Interpersonal communication, Teamwork and team building, Group dynamics, Win-win game, Conflict management, Leadership styles, Case studies on personality and organizational behaviour.

Suggested Readings

1. Andrews Sudhir. 1988. *How to Succeed at Interviews. (21st Reprint).* New Delhi.Tata McGraw-Hill.
2. Heller Robert. 2002. *Effective Leadership*. Essential Manager Series. DK Publishing.
3. Hindle Tim. 2003. *Reducing Stress. Essential Manager Series*. DK Publishing.
4. Lucas Stephen. 2001. *Art of Public Speaking*. New Delhi. Tata - Mc-Graw Hill.
5. Mile D J 2004. *Power of Positive Thinking*. Delhi. Rohan Book Company.
6. Pravesh Kumar. 2005. *All about Self- Motivation*. New Delhi. Goodwill Publishing House.
7. Smith B. 2004. *Body Language*. Delhi: Rohan Book Company.
8. Shaffer D R. 2009. *Social and Personality Development. (6th Edn).* Belmont, CA: Wadswor.

SEC-3: Seed Production and Seed Testing 2 (0+2)

Objectives

i. To understand the principles and techniques of seed production for various crops
ii. To learn about seed testing methods to ensure seed quality and viability
iii. To explore the regulations and standards governing seed production and testing
iv. To develop skills to manage seed production processes effectively, from planting to harvesting and testing, to ensure the availability of high-quality seeds for farmers

Practical

Book keeping of records and accounts of Seed Production. Assessment of market demand and selection of varieties/ hybrids including their parents of the chosen crops grown in the region. Acquaintance of seed classes, seed sources, labels, purchase norms, field and seed standards, quality tests required under certification scheme. Planning and layout of seed production plot under field conditions. Application and amplication of land and isolation requirements as per certification standards. Preparation of land and application of manures and fertilizers, etc. Preparation and raising of nursery beds/seedling raising in polythene bags, etc. Acquaintance of different methods of sowing / transplanting - use of pre-sowing seed treatments-growth regulators/chemicals / rhizobium /other microbial inoculants, etc. Application of planting ratios and border rows and marking of parental rows, Block method of planting in hybrid seed production plot. Application of staggered sowings and manipulation of fertilizers/ growth regulators/micronutrients, etc. on synchrony of parental flowering in hybrid seed production. Application of cultural and nutrient managements for control of physiological shredding of floral buds/fruits/ pods, etc. Timely management of after care operations at various growth stages. Diagnostic identification and management of pest and disease attacks at various growth stages. Diagnostic identification and characterization of A, B, R lines in hybrids of different crops viz. sorghum / sunflower / bajra / red gram / okra / chilli, etc. and their maintenance. Carrying out detasseling operation in maize hybrid seed production. Carrying out hand emasculation and hand pollination operations in hybrid seed production of cotton /tomato /brinjal /chilli /okra, etc. Application of supplementary pollination methods at flowering time to enhance hybrid seed setting and yield, Provision of honey bee colonies, etc. in sunflower, etc.-Observations on seed setting on female parental line. Acquaintance and application of roguing index based on diagnostic morphological characters at pre- and post-harvest stages. Acquaintance of different methods of conducting field inspections by taking field counts to conform to prescribed field standards at different growth stages. Acquaintance of manual apical bud pinching in okra - nipping of vegetative branches of female plants after crossing period in cotton, etc. Determination of physiological maturity and application of different methods of harvesting/ picking in varietal and hybrid seed production. Acquaintance of manual method of sorting and grading in cobs /pods /fruits, etc as per minimum certification standards and procedures. Acquaintance of different methods of shelling /seed ginning / seed extraction and recovery, etc. Management of different methods of threshing/ drying/ processing/ treating/ packaging/ labeling/ sealing/ storing, etc., as per minimum certification standards and procedures. Acquaintance of working designs of threshers, cleaners, driers, processing and packaging machineries, etc. Management of storage pests by different seed treatment methods – fungicides/ insecticides/ botanicals, etc.

Management of seed store sanitation. Visit to farmer's seed production plots undertaken by NSC /KSSC / Private Sector Seed Companies/ UAS Seed Unit, etc. Visit to UAS Seed plots /ARS Farms / Crop schemes/ Poly houses/ High tech Hort., etc. Visit to GOT farms of KSSC /KSSCA/ Seed Unit, etc. Visit to NSC /KSSC/KSSCA/ Seed Dealer, etc. Visit to Seed Processing Units/ Seed Testing Laboratory /Seed ware houses/ Cold storage units, etc.

Estimation of cost and returns/ Economics of Seed Production /cost benefit ratio. Estimation of Investment Capital requirements and operational costs. Preparation of Balance Sheet Income and Cash flow statements. Market Survey for estimation of demand and sources of supply. Identification of market channels and the estimation marketing costs and margins. Report writing and submission, Examination.

Suggested Readings

1. Agarwal P K and Dadlani M. 1987. *Techniques in Seed Science and Technology.* South Asian Publishers. New Delhi.
2. Agrawal R L. 1996. *Seed Technology.* Oxford and IBH Publicity Company, New Delhi.
3. Agarwal V K. 2003. *Seed Health.* International Book Distributing Co.
4. Bhale M S. 2013. *A Handbook of Seed Certification.* Vardhman Books and Periodicals.
5. Joshi A K and Singh B D. 2003. *Seed Science and Technology.* Kalyani Publishers, Ludhiana.
6. Khare D P. 1994. *Stored Grain Pests and their Management.* Kalyani Publishers, Ludhiana.
7. Kulkarni G N. 2002. *Principles of Seed Technology.* Kalyani Publishers, Ludhiana.
8. Nema N P. 1986. *Principles of Seed Certification and Seed Testing.* Allied Publishers Private limited, New Delhi.
9. Paul Neergaard. 1977. *Seed Pathology, Vol. I, II,* McMillan Press, London.
10. Sen Subip and Ghosh Nabinanda. 2002. *Seed Science and Technology.* Kalyani Publishers, Ludhiana.
11. Singhal N C. 2002. *Hybrid Seed Production.* Kalyani Publishers, Ludhiana.
12. Tunwar N S and Singh S V. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, New Delhi.

SEC-4: Livestock Production and Management 2 (0+2)

Objectives

i. To understand the principles of livestock production, including breeding, nutrition, and health management.
ii. To learn about efficient management practices to optimize animal welfare, productivity, and profitability.
iii. To explore sustainable livestock production systems to minimize environmental impact and ensure long-term viability.
iv. To develop skills to address challenges such as disease control, feed management and breeding strategies in livestock farming.

Practical

Orientation. Maintenance of 10 dairy animals (5 cattle and 5 buffaloes). Routine management practices such as cleaning, grooming, colostrum feeding, deworming, vaccination schedule, dehorning/disbudding; methods of identification; dentition; selection and culling of livestock; Record maintenance; assisting during calving; care of pregnant animals. Clean Milk Production: Milking, Different milking methods, Machine milking, Milk packaging. Feeding management; Feeding of calves, heifers, lactating dairy cows and buffaloes, and bulls. Preparation of concentrate mixture, maintenance of equipment required for feed mixing; Feed ingredients; Fodder production: Preserving fodder: Silage preparation: Dry fodder enrichment; Azolla Production; Hydroponics; Feed additives. Use of different farm equipment and their maintenance, e.g., Chaff Cutter, milking machine. Identification of animals in heat and presenting for artificial insemination. Farm waste Management; composting; vermicomposting; biogas production. Sheep and Goat Rearing. Routine management practices for rearing of sheep and goat: cleaning of sheds, watering, feeding, preparation of feed supplements, Deworming, monitoring growth by measurements of regular body parts and weights. Laboratory analysis of milk for quality, feed and fodder samples. Economics of dairy and Sheep/goat farming. Maintaining the register for income and expenditure on the animals allotted to work out the economics. Health Management of Livestock; First Aid.

Suggested Readings

1. Banarjee D C. 2021. *Textbook of Animal Husbandry.* CBS Publishers & Distributors Pvt. Ltd.
2. De Sukumar.1980. *Outline of Dairy Technology*. Kalyani Publishers. New Delhi.
3. ICAR.2015. *Handbook of Animal Husbandry*. ICAR Publication
4. Jadhav N V and Siddiqui M F. 2007. *Handbook of Poultry Production and Management*. (2nd Edn.) Jaypee Brothers: Medical Publisher
5. Prasad Jagadish. 2007. *Sheep Goat and Swine Production*. Kalyani Publishers, New Delhi.
6. Prasad Jagadish. 2012. *Principles and Practices of Dairy Farm Management*. Kalyani Publishers, New Delhi.

Semester III

Food Business Management 2 (2+0)

Objectives

i. To understand the principles of food business management, including production, distribution, and marketing
ii. To learn about food safety regulations, quality control, and supply chain management
iii. To explore strategies for developing and launching food products, managing operations, and meeting consumer demands
iv. To develop skills to analyze market trends, develop business plans, and manage resources effectively in the food industry

Theory

Introduction to food, food business and food business management, Types and classification of Foods, Food Business, Institutions involved in Food preparation, Marketing and Exporting. Present status of food industry in India – Current market size and future potential – Key drivers for growth. Recent advances in food processing, Quality management in food industry- Food Safety and standards (ISO and Codex). Food quality certification- AFS, BRC, HACCP, BFSI. Food traceability. Food preservation methods - Food Packaging and Labelling - Improved food grain storage structures. Logistics management at different stages of marketing the food products. Food business environment and policy. IPR in Food Industry, Entrepreneurship opportunities in food business. Food Economics and Policy, Innovation in food business at domestic and international, Food Business Marketing. Successful business organizations. Food business Environment and Policy, Government, Regulations/Guidelines for food sector. Food Waste management. Food Retailing, Formats of Food Service Industry, Policies related to Food Processing and Markets, Institutions enabling food processing sector, Food Safety and Standards Authority of India.

Suggested Readings

1. Mahtab S. 1996. *Textbook of Human Nutrition.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Srilakshmi B. 2006. *Food Science.* New Age International (Ltd) Publishers, New Delhi.
3. Srilakshmi B. 2007. *Nutrition Science*, New Age International (Ltd) Publishers, New Delhi.
4. Swaminathan M. 1997. *An Advanced Textbook on Food and Nutrition.* Vol. I. The Bengaluru Printing and Publishing Co. Ltd., Bengaluru.
5. Swaminathan M. 1997. *An Advanced Textbook on Food and Nutrition.* Vol. II. The Bengaluru Printing and Publishing Co. Ltd., Bengaluru.

Value Chain and Retail Management in Agribusiness 2 (1+1)

Objectives

i. To understand the dynamics of value chains in agribusiness, from production to retail
ii. To learn about supply chain management, distribution, and logistics in agricultural products
iii. To explore retail management strategies, including branding, marketing, and customer relationship management
iv. To develop skills to optimize value chain efficiency, reduce costs, and meet consumer preferences in agribusiness retail

Theory

Meaning of value and value chain. Concept of value chain. Difference between supply chain and value chain. Components of value chain. Value chain governance. Value chain methodology. Economics of value chain. Financing of agricultural chain. Market linkages in value chain. Mapping of value chain. Potters value chain. Introduction to Retail Management. Retailing in India. Types of retailers. Retail formats. Online and offline retailing. Organised and unorganized retailing. Retail location and layout. Retail strategies. Store management. Merchandise and inventory management. Retail marketing mix, role of IT in retail management. E-tailing.

Practical

Presentation and Discussion on above topics. Visit to retail formats. Visits to processing units. Visit to logistics, godowns, warehouses etc.

Suggested Readings

1. Narendra Agrawal, Stephen A Smith. 2009. *Retail Supply Chain Management: Quantitative Models and Empirical Studies (International Series in Operations Research and Management Science, 122)*. (1st Edn.). *Softcover reprint of hardcover.*
2. James B Ayers and Mary Ann Odegaard. 2017. *Retail Supply Chain Management*. Hardcover
3. *The Retail Value Chain: How to Gain Competitive Advantage through Efficient Consumer Response (ECR) Strategies. Sami Finne, Hanna Sivonen. Kogan Page Publishers, 03-Dec-2008-* Business and Economics-384 pages.

Introduction to Accountancy 3 (2+1)

Objectives

i. To understand the basic principles and concepts of accounting
ii. To learn the fundamentals of financial statements preparation and analysis
iii. To explore the role of accounting in business decision-making and financial management
iv. To develop skills to record, classify, and interpret financial transactions accurately and effectively

Theory

Introduction to accountancy: Meaning and importance of accounting. Meaning and definition of book keeping. Accountancy objectives of book keeping: branches of accounting. Accounting cycle. Generally Accepted Accounting Principles (GAAP)-concepts and conventions. System of book keeping: Single entry and Double entry system of keeping, Classification of accounts. Golden rules of accounting; Books of accounts: Journal and Ledger –journalizing, ledger posting, and preparation of ledger accounts. Subsidiary books-Kinds of subsidiary books- Day books: purchase book, sales book, returns book, Bill books, journal proper, Cash books - nature and objectives of cash book, types of cash book, petty cash book; Bank reconciliation statement; Preparation of Trial balance-Methods of trial balance; Final accounts - Trading account, Profit and loss account and Balance sheet; Single entry system of accounts - preparation of statement of affairs, profit or loss statement, advantages and disadvantages. Non-trading organizations. Preparation of accounts relating to non-trading organization. Concepts of revenue and capital expenditure and income, Receipts and payment account, Income and expenditure account, and Balance sheet.

Practical

Preparation of journal and recording the business transactions in journal, Preparation of ledger and ledger posting, Preparation and solving of problems relating to subsidiary books, Preparation of cash book with single column, Preparation of cash book with double column, Preparation of cash book with triple column and contra entries, Preparation petty cash book in imprest system, Preparation of bank reconciliation statement, Preparation of trial balance, Preparation of final accounts- trading, profit and loss accounts and balance sheet, Preparation of profit and loss account

and balance sheet under single entry system. Preparation of non-trading accounts receipts and payment accounts. Preparation of non-trading accounts -income and expenditure accounts and balance sheet.

Suggested Readings

1. Jain S P and Narang K L. 2008. *Advanced Accountancy.*

Soil and Water Management 2 (1+1)

Objectives

i. To understand the principles of soil and water management in agriculture

ii. To develop skills to sustainably manage soil and water resources to enhance agricultural productivity and environmental sustainability

Theory

Concept of soil, meaning and definition; soil components and important soil physical (soil texture, structure density, porosity, soil water; soil air, soil temperature and soil colour) and chemical (pH, EC, CEC and base saturation) properties in brief, Organic matter, Land capability classification and suitability. Soils of India and respective state, Soil quality and soil health, Distribution of waste land/degraded lands and problem soils in India, problems associated and management of salt affected soils, calcareous soils, acid soils, acid sulphate soils, eroded and compacted soils, flooded / water logged soils, physically constrained soils, polluted soils. Alternate land use strategies for management of problematic soils including bioremediation/phytoremidation. Irrigation water-quality and standards, utilization of poor quality water in agriculture.

Practical

Soil sample collection and it's preparation for analysis. Determination of soil colour, density, porosity and moisture content. Determination of soil texture by feel method. Determination of infiltration rate. Determination of aggregate stability. Determination of soil reaction (pH) and total soluble salts content (EC) in soil. Determination of organic matter in soil. Determination of lime requirement of acid soils. Determination of water soluble cations. Determination of water soluble anions. Determination of exchangeable cations (Ca, Mg, Na and K) and computation of ESP. Determination of gypsum requirement of sodic soils. Determination of quality of irrigation water (pH, EC, SAR, RSC, boron, chlorides etc.)

Suggested Readings

1. Brady Nyle C and Ray R Well. 2014. *Nature and Properties of Soils*. Pearson Education Inc., New Delhi.

2. Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. IARI, New Delhi.

3. Thiyageshwari S, M V Sriramachandrasekharan and D Selvi. 2015. *Fundamentals of Soil Inventory, Problem Soils and Irrigation water*. Jaya Publishing House, New Delhi (ISBN: 978-9384337-438).

General Horticulture 2 (1+1)

Objectives

i. To understand the basic principles of horticulture, including plant biology, propagation, and cultivation

ii. To learn about the cultivation techniques and management practices for various horticultural crops

iii. To explore the importance of pest and disease management, as well as environmental factors affecting horticultural production

iv. To develop skills to apply horticultural knowledge in the production of fruits, vegetables, ornamental plants, and herbs for both commercial and personal use

Theory

Horticulture- Definition, branches, importance and scope. Methods of plant propagation - sexual and asexual. General principles and practices of cultivation of important fruits-mango, banana, citrus, grape, guava, sapota. Importance of vegetables, kitchen garden, etc. General principles and practices involved in cultivation of important vegetables solanaceous crops, cole crops, cucurbits, peas and beans. Importance of floriculture and different components of ornamental garden and cultivation of important flower crops. Medicinal and aromatic plants: active principle, medicinal properties and aromatic principles.

Practical

Visit to orchards and gardens; Plant propagation methods; Study of varieties, cultural practices, plant protection of important fruits; Study of varieties, cultural practices, plant protection of important vegetables; Study of culture of medicinal plants; Study of culture of aromatic plants; Study of different components of ornamental garden - annuals, shrubs, trees, climbers, hedges and edges; Study of culture of flower crops.

Suggested Readings

1. ICAR. 2002. *Handbook of Horticulture*. ICAR Publication.
2. Peter K V. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.
3. Pradeepkumar T, Suma B. Jyothibhaskar and Satheesan K N. 2008. *Management of Horticultural Crops*. New India Publ. Agency.
4. Rajan S and Baby L M. 2007. *Propagation of Horticultural Crops*. New India Publication Agency.

Protected Cultivation and Secondary Agriculture 2 (1+1)

Objectives

i. To understand the principles and techniques of protected cultivation, such as greenhouse and polyhouse farming

ii. To learn about secondary agriculture practices like value addition, processing, and post-harvest management

iii. To explore methods to optimize production, quality, and profitability in controlled environments

iv. To develop skills to integrate protected cultivation and secondary agriculture techniques to enhance yield, quality, and market value of agricultural products

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in green houses, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero and hydrodynamic properties of cereals, pulses and oilseeds. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of green houses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of greenhouse equipments. Visit to various Post-Harvest Laboratories. Determination of Moisture content of various grains by oven drying and infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Suggested Readings

1. Ghosh Aruprathan. 2024. *Green House Technology*. Kalyani Publishers, New Delhi.

2. Radha Manohar K and Igathinathane C. 2019. *Green House Technology and Management.* BS Publications, Gujarathi Galli, Sultan Bazar, Koti, Hyderabad, A.P.

Agricultural Marketing and Trade 3 (2+1)

Objectives

i. To understand the fundamentals of agricultural marketing and trade

ii. To analyze the factors influencing supply and demand in agricultural markets

iii. To explore different marketing channels and strategies in agriculture

iv. To examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types,

marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- NAFED, TRIFED, NCDC, APEDA, CWC, SWC, FCI, CACP, DMI, Commodity Corporations and Boards – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya S S and Agarwal N L. 2004. *Agricultural Marketing in India*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna S S. 2017. *Agricultural Economics and Indian Agriculture*. Kalyani Publishers, New Delhi.
3. Salvatore Dominic. 2023. *Microeconomic:* Theory and Application. Oxford University Press.
4. Kohls Richard L and Uhl Josheph N. 2002. *Marketing of Agricultural Products.* Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong. 2010. *Principles of Marketing*. Pearson Prentice-Hall.
6. Lekhi R K and Singh Joginder. 2023. *Agricultural Economics*: An Indian Perspective. Kalyani Publishers, Delhi.

7. Memoria C B. Joshi R L and Mulla N I. 2003. *Principles and Practice of Marketing in India.* Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali. 2004. *Rural and Agricultural Marketing.* International Book Distributing Co. Ltd, New Delhi.
9. Sharma R. 2020. *Narain's Export Management.* Laxmi Narain Agarwal, Agra.

Physical Education, First Aid, Yoga Practice and Meditaion 2 (0+2)

Objectives

i. To make the students aware about Physical Education, First Aid and Yoga Practices
ii. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education. Training and Coaching, meaning and concept. Methods of training; aerobic and aerobic exercises. Calisthenics, weight training, circuit training, interval training, Fartlek training. Effects of exercise on muscular, respiratory, circulatory and digestive systems. Balanced diet and nutrition; effects of diet on performance. Physiological changes due to ageing and role of regular exercise on ageing process. Personality, its dimensions and types. Role of sports in personality development. Motivation and achievements in sports. Learning and theories of learning. Adolescent problems and its management. Posture, postural deformities. Exercises for good posture.

Yoga; history of yoga, types of yoga, introduction to yoga. Asanas, definition and importance, Padmasan, Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan. Suryanamaskar, Pranayama (Definition and Importance), Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari. Meditation, definition and importance, Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh. Mudras, definition and importance, Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra. Role of yoga in sports. Teaching of asanas, demonstration, practice, correction and practice.

History of sports and ancient games. Governance of sports in India. Important national sporting events. Awards in sports. History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, Football, Table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First aid equipment and upkeep. First aid techniques. First aid related with respiratory system. First aid related with heart, blood and circulation. First aid related with wounds and injuries. First aid related with bones, joints, muscle related injuries. First aid related with nervous system and unconsciousness. First aid related with gastrointestinal tract. First aid related with skin, burns. First aid related with poisoning. First aid related with bites and stings. First aid related with sense organs. Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Suggested Readings

1. Coulter David. 2024. *Anatomy of Hatha Yoga*: *A Manual for Students, Teacher and Practitioners.* Motilal Banarsidass Publication.
2. Prentice William E. 2010. *Essentials of Athletic Injury Management.* McGraw Hill
3. American National Red Cross. 2011. First Aid/CPR/AED Participant's Manual. Red Cross Store, USA
4. Physical Best (Program) Suzan F. Smith-Ayess. 2011. *Physical Education for Lifelong Fitness*: The Physical Best Teacher's Guide. Human Kinetics.
5. Stephens Mark. 2010. *Teaching Yoga*: Essential Foundations and Techniques. North Atlantic Books.

SEC-5: Poultry Production Technology 2 (0+2)

Objectives

i. To understand the principles of poultry production, including breed selection, nutrition, and housing
ii. To learn about disease prevention, biosecurity measures, and vaccination protocols in poultry farming
iii. To explore efficient management practices to optimize growth, egg production, and overall flock health
iv. To develop skills to address challenges such as market fluctuations, welfare concerns, and environmental sustainability in poultry production

Practical

Orientation. Rearing of backyard poultry chicks (local and Improved e.g., Giriraja). Setting and management of broiler poultry farm. Management of poultry for egg production (layers). Brooding and Management of Chicks; Setting up of brooder house, handling of chicks, vaccination. Feeding and Watering and lighting management. Management of Poultry birds; light management, vaccination, debeaking, feeding and watering. Egg collection and storage. Quality egg production. Factors affecting egg quality. Assessment of egg quality. Preparation of poultry feed. Factors affecting feed quality. Storage of feed ingredients. Record Maintenance. Management of farm equipment. Farm waste management; composting; vermicomposting; biogas production Economic analysis of poultry production. Maintaining the register for income and expenditure on the animals allotted to work out the economics. First Aid and flock health management.

Suggested Readings

1. Forrest J C. Aberle E D, Harlod B H Max D J and Robert A M. 1975. *Principles of Meat Science, W.H. Freeman and Company*, San Francisco.
2. Sharma B D. 2005. *Meat and Meat Production Technology (including poultry production technology)*. Jaypee Brothers Medical Publishers (Pvt.) Ltd., New Delhi.

Semester IV

Business Laws and Ethics 2 (2+0)

Objectives

i. To understand the legal framework governing business operations and transactions
ii. To learn about ethical principles and practices in business decision-making and conduct
iii. To explore the implications of business laws and ethics on organizational behaviour, corporate governance, and social responsibility
iv. To develop skills to navigate legal and ethical challenges, ensuring compliance and fostering trust in business relationships

Theory

Introduction to Indian legal system: Legislative Powers of the States and the Union. Scope and importance of Business laws. Contracts – meaning, significance, types and essentials of a valid contract. The Indian Contract Act-1872. The Indian Partnership Act, 1932 - General Nature, Registration of Partnership, Partnership Deed, Types of Partners, Rights and Duties of Partners. The Companies Act, 1956 and 2013 - General Nature, types of companies, incorporation of a Company, Memorandum of Association and Articles of Association, management of a company. Provisions of important Acts enacted over time related to business environment: Industries (Regulation and Development) Act, 1951; Income tax Act, 1961. Central Excise Act, 1944; Foreign Exchange Regulation Act (FERA), 1973; Foreign Exchange Management Act (FEMA), 1999; Monopolistic and Restrictive Trade Practices (MRTP), Act, 1969; Competition Act, 2002; Food safety and standards Act, 2006; Customs Act, 1962 and Goods and Service Tax, 2011. FDI Policy of GoI. Business Ethics - Nature and importance of ethics and moral standards. Scope of business ethics in business functional area. Governance mechanism. Companies Act Amendment 2023, OPC, FPC, Section 8.

Suggested Readings

1. Business Law and Ethics- Concepts, Methodologies, Tools, and Applications 2015. Editor: Information Resources Management Association.
2. Business Law and Ethics: Concepts, Methodologies, Tools, and Applications. Vol. I. Business Science Reference, 2015.

International Trade and Policy in Agriculture 2 (2+0)

Objectives

i. To understand the principles and mechanisms of international trade in agricultural commodities
ii. To learn about agricultural trade policies, agreements, and their impacts on global markets
iii. To explore strategies for market access, trade negotiations, and resolving trade disputes in agriculture
iv. To develop skills to analyze international trade trends, assess market opportunities, and navigate regulatory frameworks to facilitate agricultural exports and imports

Theory

International Trade - meaning, definition, nature and scope. Salient features of international trade, differences between internal trade and international trade, advantages and disadvantages of international trade.

Theories of international trade - mercantilism, theory of absolute cost advantage, theory of comparative cost advantage and modern theory of international trade. Terms of trade - meaning and types. Free trade - meaning, advantages and disadvantages, free trade agreements.

Protectionism - meaning, advantages and disadvantages of protectionism, types of protection - tariffs, quotas, subsidies, dumping, cartels and commodity agreements. Balance of Trade (BoT) and Balance of Payments (BoP) - meaning, differences between BoT and BoP, India's BoT and BoP position. Foreign exchange – meaning, foreign exchange rate, types of foreign exchange rate, mechanisms of determining foreign exchange rate. Foreign exchange market – meaning and functions, instruments of international payments, foreign exchange control and foreign exchange reserves.

WTO – origin, structure, objectives and functions. Agreement on Agriculture - domestic support, market access and export subsidies. FAO / WHO Codex Alimentarious and SPS measures.

Export procedures and documentations, types of export - direct export and indirect export, export houses – objectives and types. Agricultural export promotion organizations - APEDA, MPEDA, Commodity Boards and State Export Promoting Agencies. India's agricultural exports and imports – composition and trading countries. India's foreign trade policy – meaning and objectives.

Suggested Readings

1. Ajami Riad A. 2020. *International Business*. (2nd Edn). Theory and Practices.
2. Dominick Salvatore. 2019. *International Economics*. John Wiley & Sons.
3. Cherunilam Francis. 1996. *International Trade and Export Management*. Himalaya Publishing.
4. Haberler G. 1936. *Theory of International Trade*. William Hodges.
5. Charles W L and Jain Arun Kumar. 2014. *International Business*. McGraw Hill
6. Jhingan M L. 1997. *International Economics*. Vrinda Publications.
7. Justin Paul. 2013. *International Business*. (6th Edn.) PMI Learning Pvt. Ltd.
8. Mithani D M. 2012. *Money, Banking, International Trade and Public Finance*. Himalayan Books.
9. K. Aswathappa. 2008. *International Business*. Tata McGraw Hill Education.
10. Vaish M C and Singh Sudham. 1975. *International Economics*. (3rd Edn). Oxford & I B H Publishing.
11. Venkateshwaran N. 2005. *International Business Management*. New Age International (P) Ltd.
12. Cherunilam Francis. 1999. *International Economics*. Tata McGraw Hill Education.

Agricultural Marketing Regulations 3 (2+1)

Objectives

i. To understand the regulatory framework governing agricultural marketing at local, national, and international levels

ii. To learn about marketing laws, policies, and regulations affecting the sale and distribution of agricultural products

iii. To explore the role of government agencies and industry organizations in enforcing marketing regulations and ensuring fair trade practices

iv. To develop skills to navigate compliance requirements, understand market access regulations, and mitigate legal risks in agricultural marketing activities

Theory

Evolution of market legislation. Need and scope for market legislation. Review of Agricultural Produce Market Acts in India and Karnataka. Distribution of legislative powers between parliament and state assemblies. Salient features of essential commodities Act-Food Safety and Standards Act 2006, Consumer Protection Bill 2019, Patent Act 2002, Monopolies and Restrictive Trade Practices Act/ Competition Act 2002, Forward Markets Act 1952, Standards of Weights and Measures Act 1976, The Central Warehousing Corporation Act. Provisions of Karnataka Agricultural Marketing (Development Regulation) Act 2007 – Establishment of Market, Constitution of Market Committee (APMC), Special Market, Conduct of Business of the Market Committee, Powers and Duties of Market Committee, Staff of the Market Committee, Regulation of the Contract Farming Trade, Karnataka State Agricultural Marketing Board - Constitution and Functions. Role of state department of Agricultural Marketing and Directorate of Agricultural Marketing and Inspection. Agricultural Marketing Policies of the Government – Administered Price Policies – Commission for Agricultural Costs and Prices (CACP) and its Working. Policies of Procurement, Levy and Public Distribution System. Minimum Support Prices, Ceiling Price and Parity Prices. Floor Price Scheme. Food Security Policy - Procurement, Buffer Stock, Distribution, Subsidies. Food Zone. Agri Export Zones (AEZS)/ Export Oriented Units (EOUS). Introduction and Meaning of Intellectual Property, Brief Introduction to GATT, WTO, Trips and WIPO, Treaties for IPR Protection: Madrid Protocol, Berne Convention, Budapest Treaty, etc. Types of Intellectual Property and Legislations Covering IPR in India: Patents, Copyrights, Trademark, Industrial Design, Geographical Indications, Integrated Circuits, Trade Secrets. Patents Act 1970 and Patent System in India, Patentability, Process and Product Patent, Filing of Patent, Patent Specification, Patent Claims, Patent Opposition and Revocation, Infringement, Compulsory Licensing, Patent Cooperation Treaty, Patent Search and Patent Database.

Practical

Evolution and Historical Perspectives of Agricultural Marketing Legislation, Marketing Tax and Fees, Different Agents Involved in Marketing Practices, Study on Different Agricultural Marketing Models, Review of Agricultural Marketing Policies. Study on Reform in Agricultural Marketing Sectors in India. Presentation and group discussions on above topics, Visits to different APMC's.

Suggested Readings

1. Acharya S S and Agarwal N L. 1994. *Agricultural Prices- Analysis and Policy.* Oxford and IBH, New Delhi.
2. Jagdish Prasad.1999. *Encyclopaedia of Agricultural Marketing- Market Regulation and Development* (Vol. III).
3. Kahlon A S and George M V. 1965. *Agricultural Marketing and Price Policies.* Allied Publishers Private Limited, New Delhi.
4. Sathpal Puliani. 2020. *The Karnataka Agricultural Produce Marketing* (Regulation and Development, Act 1966).

Principles of Management and Organizational Behaviour 2 (1+1)

Objectives

i. To understand the fundamental principles of management theory and practice.
ii. To explore the dynamics of organizational behaviour, including individual and group dynamics, communication, and motivation
iii. To learn to apply management concepts and behavioral theories to solve organizational challenges and improve effectiveness
iv. To develop skills in leadership, decision-making, and conflict resolution to enhance organizational performance and employee satisfaction

Theory

Introduction to Management-Management functions-Management levels-Managerial roles-Management skills-Role of management. Evolution of management thought.

Functions of management: Planning: Nature and importance-types of planning-Steps in planning-Decision making–meaning-types of decisions.

Organizing- meaning-nature and purpose of Organizing-Principles of organizing-Organization structure-Managing Human Resources-human resource planning-recruitment-sources of recruitment -Selection- steps in the selection process-Orientation -Training -Management development program s.

Leading- meaning - Leadership theories - Motivation-Meaning and purpose- Motivational theories - Communication-meaning-objectives-importance-types- barriers.

Controlling-meaning and nature of controlling-essential elements of controlling. Ethics and corporate social responsibility in business.

Organizational Behaviour - definition, importance, historical background of Organizational Behaviour, challenges - the organizational Context-Environment – Technology.

Learning - importance of learning -Process-approaches to learning-the learning organization.

Personality-defining personality-types and traits-personality types-the big five-the development of the self-selection methods.

Perception- meaning, selectivity and organization-perceptual sets and perceptual worlds-factors influencing perception and shortcuts in judging others.

Group Dynamics - meaning, need for joining groups, stages of group development and group decision making techniques. Teams-types, difference between teams and groups. Managing conflicts. Work stress – Types and management strategies. Organizational culture – Definition and creating a culture in organization. Organizational change.

Practical

Study of management structure and organizational pattern of selected business units. Preparation, analysis and presentation of case studies.

Suggested Readings

1. Aaker David, Kumar V and Day George. 2004. *Marketing Research.* (8th Edn.) John Wiley and Sons.
2. Dubrin Andrew J. 2012. *Essentials of Management. Thomson Cengage Learning Southwestern.* (9th Edn).
3. Charles W L Hill and McShane Steven L. 2019. *Principles of Management*, McGraw Hill Education, Special Indian Edition.
4. Harold Koontz and Heinz Weihrich. 2012. *Essentials of Management: An International and Leadership Perspective* (11th Edn.) Tata McGraw- Hill Education.
5. Kerlinger Fred N. 1986. *Foundations of Behavioural Research* (3rd Edn.) Holt Rinehart and Winston.
6. Kotler P. 2001. *Marketing Management*. (10th Edn.) Pearson Education Canada.
7. Koudelka J.1997. *Consumer Behaviour and Marketing*. Grada Publishing.
8. Kamins Michael A and Stewart David W. 1993. *Secondary Research: Information, Sources and Methods, Applied Social Research Methods, Volume 4,* Sage Publications.
9. Samuel C Certo and Tervis Certo. 2012. *Modern Management: Concepts and Skills. Pearson Prentice Hall.* (12th Edn.)

Farm Machinery and Power and Custom Hiring Services 2 (1+1)

Objectives

i. To understand the principles and operation of farm machinery and power equipment
ii. To learn about the selection, maintenance, and efficient use of agricultural machinery for various farm operations
iii. To explore the concept and benefits of custom hiring services in agriculture
iv. To develop skills to optimize farm machinery usage, reduce operational costs, and improve overall farm productivity through efficient machinery management and custom hiring services

Theory

Status of Farm Power in India, Sources of Farm Power, I.C. engines, working principles of I.C. engines, comparison of two stroke and four stroke cycle engines. Study of different components of I.C. engine, I.C. engine terminology and solved problems, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor, Tractor types, Cost analysis of tractor power and attached implement, Familiarization with Primary and Secondary Tillage implement, Implement for hill agriculture, implement for intercultural operations, Familiarization with sowing and planting equipment, calibration of a seed drill and solved examples, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Implements for hill agriculture, Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow. Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and transplanter. Familiarization with different types of sprayers and dusters Familiarization with different inter-cultivation equipment, Familiarization with harvesting and threshing machinery.

Suggested Readings

1. Sahay Jagadishwar. 2006. *Elements of Agricultural Engineering*. Standard Publishers Distributors, New Delhi.
2. Michael A M and Ojha T P 2021. *Principles of Agricultural Engineering (Vol-I)*. (14th Edn). Tata McGraw Hill Publishing Co Ltd, New Delhi.
3. Nakra C P. 2003. *Farm Machinery and Equipments*. Dhanpat Rai and Sons, New Delhi.

Post-harvest Management and Value Addition of Fruits and Vegetables 2 (1+1)

Objectives

i. To understand the principles and techniques of post-harvest management for fruits and vegetables
ii. To learn about value addition processes such as sorting, grading, packaging, and processing
iii. To explore methods to minimize post-harvest losses and extend the shelf life of fruits and vegetables
iv. To develop skills to add value to agricultural produce, increase marketability, and enhance profitability for farmers and stakeholders

Theory

Importance of post-harvest processing of fruits and vegetables; Extent and possible causes of post-harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and

changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, Cold storage, CA, MA and Hypobaric); Value addition concept; Principles and methods of preservation; Minimal processing; Intermediate moisture foods- Jam, Jelly, Marmalade - Concepts and Standards; Fermented and non-fermented beverages; Drying/ Dehydration of fruits and vegetables - Concept and methods; Canning - Concepts and Standards, Packaging of products.

Practical

Containers for shelf life extension; Effect of temperature on shelf life and quality of produce; Chilling and freezing injury in vegetables and fruits; Extraction and preservation of pulps and juices; Preparation of Jam, Jelly, RTS, Nectar, Squash, Wine, Fruit bar, Candy, Tomato products; Quality evaluation of products- physico- chemical and sensory; Visit to processing unit/ industry.

Suggested Reading

1. Bhutani R C. 2003. *Fruit and Vegetable Preservation.* Biotech Books.
2. Mitra S K. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-Tropical Fruits.* CABI.
3. Ranganna S. 1997. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products.* Tata McGraw-Hill.
4. Sudheer K P and Indira V. 2007. *Post Harvest Technology of Horticultural Crops*, New India Publ. Agency.
5. Willis R, McGlassen W B, Graham D and Joyce D. 1998. *Post Harvest: An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*, CABI.

Entrepreneurship Development and Business Management 3 (2+1)

Objectives

i. To provide student an insight into the concept and scope of entrepreneurship
ii. To expose the student to various aspects of establishment and management of a small business unit
iii. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and

formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

1. Charantimath P M. 2009. *Entrepreneurship Development and Small Business Enterprises*. Pearson Publications, New Delhi.
2. Desai V. 2015. *Entrepreneurship: Development and Management*. Himalaya Publishing House.
3. Desai Vasant. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.
4. Grover Indu. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
5. Gupta C B. 2001. *Management Theory and Practice*. Sultan Chand and Sons.
6. Khanka S S. 1999. *Entrepreneurial Development*. S. Chand and Co.
7. Mehra P. 2016. *Business Communication for Managers*. Pearson India, New Delhi.
8. Pandey M and Tewari D. 2010. *The Agribusiness Book*. IBDC Publishers, Lucknow.
9. Singh D. 1995. *Effective Managerial Leadership*. Deep and Deep Publ.
10. Singhal R K. 2013. *Entrepreneurship Development and Management*. Katson Books.
11. Tripathi P C and Reddy P N. 1991. *Principles of Management*. Tata McGraw Hill.

Agricultural Informatics and Artificial Intelligence 3 (2+1)

Objectives

i. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes,etc.

ii. To provide basic knowledge of computer with applications in agriculture

iii. To make the students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to computers, anatomy of computers, memory concepts, units of memory, operating system. Definition and types, applications of MS-Office for creating, editing and formatting a document, data presentation, tabulation and graph creation, statistical analysis,

mathematical expressions, database, concepts and types, creating database. Uses of DBMS in agriculture, internet and World Wide Web (WWW); concepts and components.

Computer programming: General concepts. e-Agriculture, Concepts, design and development, application of innovative ways to use information and communication technologies (IT) in agriculture, computer models in agriculture. Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops. Computer-controlled devices (automated systems) for agri-input management, smart phone mobile apps in agriculture for farm advice. Market price, postharvest management, etc. Geospatial technology; concepts, techniques, components and uses for generating valuable agri-information. Decision support systems; concepts, components and applications in agriculture. Agriculture expert system, soil information systems, etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File management. Use of MS-Word and MS Power-point for creating, editing and presenting a scientific document, MS-EXCEL-Creating a spreadsheet. Use of statistical tools. Writing expressions, Creating graphs, Analysis of scientific data. MS-ACCESS, creating database, preparing queries and reports, demonstration of agri-information system, Introduction to World Wide Web (WWW) and its components, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA), AR/VR Demonstration.

Suggested Readings

1. Date C J. 2007. *An Introduction to Database Systems.* Addison-Wesley.
2. Dhabal P S and Manoranjan P. 2017. *Concepts and Techniques of Programming in C.* I.K. International Publishing House Pvt. Limited.
3. ITL Education Solutions Ltd. 2006. *Introduction to Information Technology.* Pearson Education.
4. Mahapatra S K, Mishra P and Pradhan J. 2022. *Introductory Agri Informatics.* Jain Brothers.
5. Rajaroman V and Adabala N. 2015. *Fundamentals of Computer.* PHI Learning Private Ltd, New Delhi.

SEC-6: Development of Agribusiness Proposal 2 (0+2)

Objectives

i. Learn to identify viable agribusiness opportunities and formulate innovative project proposals.

ii. Understand the components and structure of a comprehensive agribusiness proposal, including market analysis, financial projections, and risk assessment.

iii. Develop skills to effectively communicate business ideas, secure funding, and implement successful agribusiness ventures.

iv. Gain practical experience in preparing and presenting agribusiness proposals that meet the needs of stakeholders and investors.

Practical

A. Project Planning, Monitoring and Evaluation: Orientation. Hands on experience on preparation of project proposals for horticulture crops, dairy, poultry and agro-processing units. Interaction with staff/experts for midterm corrections and submission of interim report. Hands on experience on preparation of project proposal for bio-fertilizer and bio-pesticides units, irrigation, equipments and machineries, forest plantations, fishery and land development activities. Interaction with staff/experts for midterm corrections and submission of interim report. Hands on experience on ex-ante, concurrent and ex-post appraisal. Hands on experience on discounting procedures like NPV, IRR and BCR, preparation of techno-economic feasibility reports of project. Report writing and examination.

B. Marketing Management: Orientation. Hands on experience on conducting market survey to gain experience on working out consumer profile, competitors, substitutes and their price and features. Designing market strategy. Interaction with staff/experts for midterm corrections and submission of interim report. Hands on experience on forecasting market demand. Pricing methods, creating and organizing an advertising campaign. Various packaging materials used for agro-based products. Product distribution network, marketing cost, marketing planning process. Interaction with staff/expert for midterm corrections and submission of interim report. Hands on experience on marketing research and information system for new product development and options for extending product life cycle. Spot and online marketing. Export- import policies for agriculture sector. Report writing and examination.

C. Financial Management: Orientation. Estimation of funds required – capital investment and operational expenses. Share of owned and borrowed funds in the business. Sources of borrowed funds, terms and conditions of borrowings, repayment schedule, cash inflow and cash outflows of business. Interaction with staff/ experts for midterm corrections and submission of interim report. Hands on experience on accounting methods and procedures. Commonly used account systems, the single and double entry system, recording transactions, journals, figures, trial balance, assets and liabilities. Revenue cost of sales and net profit operating and incidental expenses and inventory. Interaction with staff / experts for midterm corrections and submission of interim report. Preparation of financial statements like balance sheet, income statement, profit and loss statement for the business. Exercise on financial ratio analysis. Report writing and examination.

Suggested Readings

1. David D. Van Fleet and George J. Seperich. 2013. *Agribusiness: Principles of Management*. Delmar, New York.
2. Elizabeth Yeager, Frank J Dooley, Freddie L Barnard, Jay T Akridge and John Charles Foltz. 2012. *Agribusiness Management. Routledge*, London.
3. Hegde P. 2012. *Agribusiness Management. Discovery.* Publishing House, New Delhi.
4. Karthikeyan M and Nakkiran S. 2012. *Co-operatives and Agri-Business*. Discovery Publishing House, New Delhi.
5. Walter David Downey. 1987. *Agribusiness Management*. Tata McGraw-Hill, New Delhi.

Semester V

Grading, Standardization and Quality Management in Agri-food Products 2 (1+1)

Objectives

i. To understand the principles and methods of grading and standardization for agri-food products
ii. To learn techniques to ensure product quality and consistency in the agricultural supply chain
iii. To explore quality management systems and certifications applicable to agri-food products
iv. To develop skills to implement grading, standardization, and quality management practices to meet market requirements and consumer expectations

Theory

Evolution of markets- meaning of market, marketing, Agril. Marketing. Concept of marketing – old concept, new concept and modern concept. Significance / need of Agril. Marketing, creation of utilities. Classification of markets. Marketing functions- Physical functions, exchange functions and facilitative functions. Grading and standardization Meaning-Significance of grading and standardization. Types of grading- fixed grading/mandatory grading, permissive/variable grading, centralized grading/decentralized grading and Grading at producers' level. Criteria for grade standards and advantages of grading. Role of grading in Agril. Products. The agricultural produce (Grading and Marketing) Act, 1937. Quality control of Agril. Products, AGMARK standards, the role of DMI in grading of Agril. Produce, Inspection and quality control, labelling in Agril. Products. Grading of food grains- grading of Rice commercial classification, based on physical characteristics, cooking quality of rice, Rice grading by AGMARK. Special characteristics, general characteristics, safety parameters, determination of quality of rice. Impurities refractions of food grains foreign matter- organic and inorganic, admixtures, damaged and discolored grains, slightly damaged grains and immature and shriveled grains, Chalky, weevils, broken, fragments, other food grains, non-food grains, Smutty grains, whole grains. Inherent and acquired characteristics of food grains. Wheat- quality characteristics of wheat varieties, Wheat- strong wheat flour, medium and medium flour, kinds of wheat. AGMARK quality specifications for wheat, safety parameters and determination of quality of wheat. FAQ standards for Rice, Wheat, Ragi, Maize. Grading of Pulses, AGMARK standards for Green gram (moong), Red gram (tur dal), Bengal gram, Black gram urad dal), Rajma, Peas, Masoor (lentils), Matki (moth). Grading of oil seeds: Groundnut, Sunflower. AGMARK standards of oil seeds. Commercial classification of Groundnut- Coramandal, Bold,

Red natal and Peanuts. Grading of pods and kernels of groundnut. AGMARK grade designation of quality of edible oil. Grading of commercial crops- special and general characteristics of Areca nut, copra, Tobacco and Cotton, chilli. Classification and grading of vegetables: Cole, Tuber, Pod, Salad, Root and Bulb vegetables. Grading of fruits- Tropical fruits, Mango, Banana, Citrus, Grapes, Sapota and Pomegranate. Temperate fruits: Apple, Pears, Plums, Apricots and Peaches. Quality control of manufactured products Indian Standards Institution (ISI): aims and objectives of ISI, granting licenses for ISI, Bureau of Indian Standards (BIS), management systems certification. Spot exchange grade requirements, Mark to identify vegetarian/non vegetarian food, Eco mark. Mark of FPO and ISO standards. Quality control in food- food hygiene, food adulteration and food poisoning. Good Agril. Practices, good manufacturing practices. EUREPGAP Quality management in food: FSS Act 2006, Hazard Analysis and Critical Control Point (HACCP), Codex Alimentarius commission (CODEX), Fair Average Quality (FAQ), General Characteristics and grade designations of processed food- Jaggery, instant food, fruits and vegetables products.

Practical

Study of laboratory equipment, Sampling equipment, scientific grading, instruments and other apparatus, Visit to vegetable and fruit markets, Jaggery market and other food processing units. Visit to Bureau of Indian Standards. Presentations and Group discussions for the above topics.

Suggested Readings

1. Acharya S S and Agarwal N L. 2000. *Agricultural Marketing in India.*
2. Chakravarty A and De D S. 1981. *Post Harvest Technology of Cereals and Pulses.* Oxford and IBH, Calcutta.
3. Jambunathan L R.1984. *Grading of Cotton for Quality: A Scoring System of Instrumental Evaluation for Cotton Hybrid-4.*
4. Mamoria C B. 1976. *Agricultural Problems of India.* Kitab Mahal, Allahabad.
5. Manual on Grading and Standardization, *Directorate of Marketing and Inspection* (DMI), Nagpur.
6. Manual on Standards, Bureau of Indian Standards (BIS), New Delhi.
7. Wader L K and C Murthy. 2003. *Textbook of Agricultural Marketing and Cooperation.* ICAR, New Delhi.

Market Information and Intelligence 3 (2+1)

Objectives

i. To understand the importance of market information and intelligence in making informed business decisions
ii. To learn methods for collecting, analyzing, and interpreting market data and trends
iii. To explore strategies to use market information to identify opportunities, mitigate risks, and gain competitive advantage
iv. To develop skills to effectively utilize market intelligence to optimize marketing strategies, pricing, and product positioning in agribusiness

Theory

Market Information-Meaning, Need for market information, Merits of Market Information, Importance of market information - Types of Market Information- Market Intelligence, Market News and Market Outlook - Essential Characteristics of Good Market Information and means of data collection. Compilation, analysis and dissemination of market information and intelligence in India. Sources of compilation and dissemination of market information-institutional and non-institutional. Deficiencies, problems and reliability of market information. Simple forecasting tools for price and demand estimation: time series analysis (trend, seasonal indices), Consumer surveys, Expert opinion survey methods, Market experiments methods, Graphical methods, smoothing techniques and regression methods. Evaluation of forecasts.

Practical

Price and demand analysis of selected agricultural commodities using time series analysis, Consumers' surveys, Experts' opinion survey methods, Market experiments methods, Graphical methods, smoothing techniques, Delphi method and regression methods. Developing market intelligence and information reports.

Suggested Readings

1. Acharya S S. 1988. *Agricultural Production, Marketing and Price Policy- A study of Pulses.* Mittal Publications, Delhi.
2. Acharya S S and Agarwal N L. 1994. *Agricultural Prices- Analysis and policy.* Oxford and IBH, New Delhi.
5. Gupta A P.1975. *Marketing of Agricultural Production in India.* Voro and Co-Publishers Pvt. Limited, Bombay.
6. Jagadish Prasad. 1966. *Encyclopedia of Agricultural Marketing.* Mittal Publishers Pvt. Limited, Bombay.
7. Kahlon A S and George M V. 1965. *Agricultural Marketing and Price Policies.* Allied Publishers Private Limited, New Delhi.
8. Nayyar H and Ramaswamy P. 1995. *Globalization and Agricultural Marketing.* Rawat Publications, Jaipur.
10. Singhal A K. 1989. *Agricultural Marketing in India.* Anmol Publications. New Delhi.

Capital and Commodity Markets 2 (1+1)

Objectives

i. To understand the functioning and dynamics of commodity markets in agriculture
ii. To learn about price discovery mechanisms, trading strategies, and risk management techniques
iii. To explore the factors influencing supply and demand dynamics in commodity markets
iv. To develop skills to analyze commodity market trends, assess market opportunities, and make informed trading decisions in agricultural commodities

Theory

Capital market instruments – corporate stock and corporate bonds - Capital market instruments – commercial paper, certificate of deposits - Equities - Common Stocks, Restricted Shares- Preferred Stocks - Fixed income capital market instruments – Bonds, debentures, swap and Mortgage-backed securities-Managing Interest Rate Risk - The Yield Curve - Process and procedures of raising equity capital - Types of investors in capital market - Depository services – meaning and functions - Insider trading - Transaction procedures and settlement- Stock Valuation.

History and evolution of commodity markets. Marketing of food grains – cereals and pulses, production, consumption, marketable surplus. Marketing of commercial crops: coffee, tea, rubber, tobacco, Arecanut, coconut, cotton, oilseeds, spices, jute - supply and demand. Marketing practices, market structure, marketing channels and price spread, organizations and institutions, Commodity Boards and their activities. Marketing of horticultural crops – Fruits, vegetables and flowers - demand, supply and utilization, marketing practices, NHB, NHM, APEDA. Role of commodity exchanges-difference between national and regional exchanges. Meaning and types of market participants – Hedgers, Speculators, Arbitragers. Derivatives market – meaning, functions and limitations. Types of derivatives - options, forward, futures and swaps. Factors influencing spot and futures markets. Trading strategies. Pricing of futures. Operational mechanism of commodity markets. Settlement process and delivery mechanisms. Strategies using options to hedge risks, long and short positions. Role of banks and warehousing in commodity markets - Global commodity exchanges dealing with agricultural commodities.

Practical

Compilation of basic statistics on area, production, productivity, consumption, export and import of selected crops. Estimating growth. Graphical representation. Visit to Grain Market, Fruit, vegetable and flowers markets. Futures pay-offs calculation. Pricing of derivatives.

Suggested Readings

1. Carter Colin A. 2003. *Futures and Options Markets: An Introduction.* Prentice-Hall: Upper Saddle River, NJ.
2. Chatnani, Niti Nandini. 2009. *Commodity Markets*, Tata McGraw Hill Education Private Limited, New Delhi.
3. Hull John C. 2005. *Fundamentals of Futures and Options Markets.* (5th Edn.) Prentice Hall: Upper Saddle River, NJ.
4. McDonald and Robert L. 2006. *Derivatives Markets,* (2nd Edn). *Addison Wesley: Boston.*
5. *Wayne Purcell and Stephen Koontz. 1999. Agricultural Futures and Options, Principles and Strategies.* (2nd Edn). Prentice-Hall (ISBN 0-13-779943-8).

Cooperatives and Producers' Organizations 3 (2+1)

Objectives

i. Understand the principles and structures of cooperatives and producers' organizations in agriculture
ii. Learn about the benefits and challenges of cooperative business models for smallholder farmers and producers

iii. Explore strategies for organizing, managing, and governing agricultural cooperatives and producers' organizations effectively

iv. Develop skills to foster collaboration, collective marketing, and value addition through cooperative and producer-led initiatives in agriculture

Theory

Management of cooperative enterprises: Concept, Meaning, definition, unique features–Issues in cooperative management–Cooperative Governance-Human resource development in cooperatives- Professionalization of cooperatives. Co-operative management structure: Role and responsibilities of General Body, Board of Directors, President and Chief Executive Officer. Decision making in cooperatives- Performance evaluation parameters for co-operatives. Capital and cooperatives–Meaning-Purpose of Equity-Equity Management and cooperatives -The Importance of Financial Planning -Equity Types -Equity Management Considerations. Producer Organizations: concept, meaning, types, characteristics and scope. Process guidelines for promotion of FPOs. Steps in Registration of PCs. Management of Producer Companies: Membership, Powers of General Body, powers of Executive Committee, Funds, accounts and audit, appropriation of net profit. Role of central and state governments in supporting FPOs, Role of NABARD in promoting Producer Organizations.

Practical

Case studies on evaluation of the performance of co-operative organisations. Case studies on democratic decisions and ethical dilemma. Assessing capital requirements of a Producer Company, Assessment of financial viability of the business of Producer Companies, Assessing institutional performance of Producer Company.

Suggested Readings

1. Datta Prabir. 2018. *A Guide Book for Producer Organization (PO) and Producer Group (PG)*. LAP Lambert Academic Publishing.
2. Farmer Sector Policy Department & Form Sector Producer Development Department, NABARD. 2015. *Farmer Producer Organisations - Frequently Asked Questions (FAQs)*. National Bank for Agriculture and Rural Development (NABARD) Mumbai.
3. Phansalkar Sanjiv Janardan and Paranjape Avinash. 2021. *Making Farmer Producer Organizations: Achieve Viability: A Practical Guide*. AuthorsUpFront.
4. Phansalkar Sanjiv Janardan, Vedprakash Kumar Anish and Bali Aneesha. 2021. *State of Sector Report - Farmer Producer Organizations in India.* AuthorsUpFront.

Business Research Methods 3 (2+1)

Objectives

i. To understand various research methodologies and their application in business settings

ii. To learn how to formulate research questions, design studies, and collect data for business analysis

iii. To develop skills to critically evaluate research findings and apply them to business decision-making

iv. To gain proficiency in using statistical tools and software for data analysis in business research

Theory

Business Research– Meaning, types, importance and characteristics of good research. Ethics in business research. Research proposal - purpose, types and its importance. Research process – Problem identification. Developing an Approach to the problem. Research design - definition, classification and types. Sampling design- Meaning, steps in sampling design and process. Types of sampling: Probability and Non-probability sampling. Determining sample size. Meaning and types of Sampling error. Data sources – primary and secondary data types. Data Collection Methods: Observations, survey and interview. Focus group discussion and panel data. Measurement and scaling techniques – basic scales of measurement, scaling techniques. Attitude measurement – Likert scale. Data editing, coding, classification, tabulation. Data Analysis – qualitative and quantitative methods. Use of parametric and nonparametric tests: T-test, Z-test, F-test, Chi-square test and ANOVA and its applications – Correlation, simple and multiple regression techniques. Steps in report writing.

Practical

Preparing business research proposal – Problem identification and research questions, formulation of research design, sampling framework and hypothesis. Data mining - Collection of primary and secondary data – Sources. Preparation of interview schedule and questionnaire for primary data collection - Administration of mailed questionnaire and on-line survey. Conducting field level enquiry and data collection. Organizing other methods of data collection - Focus group discussion/panel data collection / observation / case study. Application of scaling techniques in business research. Data editing - coding and tabulation - Application of statistical tools (Descriptive statistics) in business research. Understanding cause and effect and functional relationships among the variables.

Suggested Readings

1. Cooper D R and Schindler P S. 2006. *Business Research Methods.* Tata McGraw Hill Company Ltd.
2. Kothari C R. 2007. *Research Methodology.* New Age International Publishers.
3. Ahlemeyer-Stubbe Andrea and Coleman Shirley. 2014. *A Practical Guide to Data Mining for Business and Industry*. John Wiley and Sons Limited, United Kingdom (e book).
4. Ledolter Johannes. 2013. *Data Mining and Business Analytics with R.* John Wiley and Sons, New Jersey (*e - Book*).

Sustainable Farming Systems and Precision Agriculture 2 (1+1)

Objectives

i. To understand the principles and practices of sustainable farming systems aimed at environmental stewardship and resource conservation
ii. To learn about precision agriculture technologies and their applications for optimizing inputs, minimizing waste, and increasing farm efficiency
iii. To explore strategies to integrate sustainable practices and precision agriculture techniques for improved crop productivity, profitability, and environmental sustainability
iv. To develop skills to implement and manage sustainable farming systems and precision agriculture technologies to address challenges such as climate change, soil degradation, and water scarcity in agriculture

Theory

Farming System-scope, importance, concept and types. Farming systems components, Indicators of Sustainability, adaptation and mitigation, determining production and efficiencies in cropping and farming systems; Sustainable agriculture- problems and its impact on agriculture. Evaluation indices for cropping system. Integrated Farming System- historical background, objectives and characteristics, components of IFS and its advantages, resource use efficiency and optimization techniques. Operational structure of NPOP. Organic certification process and economic considerations. Marketing export potential of organic products.

Precision agriculture: components, concepts and principles, techniques, their issues and concern for Indian agriculture. Global Positioning System (GPS) and Geographical Information System (GIS), Site Specific Nutrient Management (SSNM) for nutrient and irrigation management practices. Comparative yield, quality and farm profits under SSNM practices v/s Variable Rate Technology (VRT) practices. Yield monitoring and mapping.

Practical

Tools for determining production and efficiencies in cropping and farming system, Visit cropping systems and IFS models. Evaluation indices for cropping system. Organic farming guidelines and alternative philosophies. Organic nutrient resources and their fortification, Restrictions on nutrient use, enriched compost, vermi-compost, liquid organic manures, green manuring, crop residue management, biofertilizers/bio inoculants and their quality. ITKs in organic farming. NPOP: certification process and standards of organic farming; processing, labelling, marketing and export of organic products. Economic of Organic production systems. Visit to organic farmer's fields.

Use of GPS for agricultural survey and recording the observations with GPS. Area estimation, navigation and recording elevation points. Conversion of GPS readings, Study of maps, top sheets, cartography, GPS software's, Spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. VRT, Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Use of UAV in agriculture.

Suggested Readings

1. Joshi M and Prabhakarashetty T K. 2005. *Sustainability through Organic Farming* Kalyani Publishers.
2. Palaniappan S P and Anandurai K. 1999. *Organic Farming - Theory and Practice.* Scientific Publishers.
3. Panda S C. 2014. *Cropping and Farming System*. Agrobios (India) Publishers.
4. Reddy S R. 2017. *Geoinformatics and Nanotechnology for Precision Farming*. 140p. Kalyani Publishers.
5. Thomas Lillesand, Ralph W Kiefer and Jonathan Chipman. 2015. *Remote Sensing and Image Interpretation.* (7th Edn.). 736p. Wiley Publications.
6. Wright Richard T and Bernard J Nebel. 2002. *Environmental Science: Towards a Sustainable Agriculture.* Pearson Education.

Intellectual Property Rights 1 (1+0)

Objectives

i. Understand the principles and significance of intellectual property rights (IPRs) in agriculture
ii. Learn about different types of IPRs such as patents, trademarks, and plant breeders' rights
iii. Explore the legal and ethical implications of IPRs in agricultural innovation, research, and commercialization
iv. Develop skills to protect, manage, and utilize intellectual property assets effectively in agricultural enterprises

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Beme Convention, Budapest treaty, etc. Types of intellectual Property and legislations covering IPR in India- Patents, Copyrights, Trademark, Industrial design, Geographical indications, Appellations of origin, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database. Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV and FR Act of India, Plant breeder's rights, Registration of plant varieties under PPV and FR Act 2001, breeders, researcher and farmer's rights. Traditional knowledge- meaning and rights of TK holders. Convention of Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

Suggested Readings

1. Ganguly P. 2001. *Intellectual Property Rights - Unleashing the Knowledge Economy*. Tata McGraw Hill.
2. Erbisch F H and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
3. Rothschild M and Scott N. (Ed.) 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
4. Saha R. 2006. *Intellectual Property Rights in NAM and other Developing Countries: A Compendium on Law and Policie.,* Daya Publ. House.
5. *Ministry of Agriculture, Government of India 2004. State of Indian Farmer. Vol V. Technology Generation and IPR issues.* Academic Foundation.
6. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act,2003.*
7. WIPO Intellectual Property Handbook: 2008. Policy Law and Use. Fields of Intellectual Property Protection, WIPO.

Fundamentals of Plant Biotechnology 2 (2+0)

Objectives

i. To understand the principles and techniques of plant biotechnology
ii. To learn about genetic engineering, gene editing, and other biotechnological methods used in plant breeding
iii. To explore the applications of plant biotechnology in crop improvement, pest resistance, and stress tolerance
iv. To develop skills to critically evaluate the ethical, environmental, and regulatory aspects of plant biotechnology

Theory

Introduction, history, concepts and applications of plant biotechnology, cell, DNA structure and function, gene cloning steps, common enzymes used as molecular tools, vectors, transformation and selection of recombinants, construction of genomic libraries, isolation and cloning of coding parts of eukaryotic genes-cDNA cloning. Gene transfer methods, transgenics and its importance, gene editing, biosafety measures and intellectual property rights. Molecular markers, RAPD, RFLP, SSR, SNP etc, and their applications. Concept of tissue culture, organogenesis and embryogenesis, embryo rescue and its significance, micropropagation, somaclonal variation and its use in crop improvement, synthetic seeds and their significance, somatic hybridization and cybrids and cryo-preservation. Use of tissue culture in biotechnology (transgenics and gene editing).

Suggested Readings

1. Brown T A. 2006. *Gene Ccloning and DNA Analysis: An Introduction.* Blackwell Publishing, Oxford, UK.
2. Chawla H S. 2002. *Introduction to Plant Biotechnology*, Science Publishers.
3. John Singh B D. 2013. Biotechnology, Kalyani Publishers.

Social Entrepreneurship 1 (1+0)

Objectives

i. Understand the concept and principles of social entrepreneurship
ii. Learn about innovative business models that address social and environmental challenges
iii. Explore strategies for creating sustainable social impact while ensuring financial viability
iv. Develop skills to identify social problems, design solutions, and implement projects that benefit communities

Theory

Social Entrepreneurship: concept, meaning, historical perspective of social entrepreneurship. Factors impacting transformation into social entrepreneurship. Characteristics of social entrepreneurs. Differences between business and social enterprise. Forms of social enterprises, Profit and non-profit Proprietorships, partnership and company; Non-Governmental organisation,

Trust and Company. Third Sector Organizations (TSOs) and social enterprises. Similarities and differences with other forms of enterprises. Organisation of social enterprise. Financing of social enterprise. Legal compliance and management of resistance. Management: strategy, finance, HRM and marketing. Governance challenges - accountability, transparency and democracy. Measurement of social outcomes and impact, social accounting, social return on investment. Innovations in social enterprises. Successful social enterprises in India.

Suggested Readings

1. Bornstein David and Susan Davis. 2010. *Social Entrepreneurship: What Everyone Needs to Know?* Oxford University Press, New York.
2. Bornstein David. 2007. *How to Change the World: Social Entrepreneurs and the Power of New Ideas.* Oxford University Press, New York.
3. Doherty Bob, George Foster and Chris Mason. 2009. *Management for Social Enterprise*. Sage Publications, USA.
4. *Journal of Social Entrepreneurship.* 2010. Taylor and Francis.
5. Praszkier Ryszard and Andrzej Nowak. 2011. *Social Entrepreneurship: Theory and Practice.* Cambridge University Press, Cambridge.
6. Yunus, Muhammad. 2010. *Building Social Business: The New Kind of Capitalism that Serves Humanity's Most Pressing Needs.* Public Affairs, New York.

Applied Business Statistics 2 (1+1)

Objectives

i. To understand the fundamental concepts and techniques of statistical analysis in business contexts
ii. To learn how to collect, organize, and interpret data to make informed business decisions
iii. To explore the application of statistical tools and methods in various business functions such as marketing, finance, and operations
iv. To develop skills to use statistical software packages effectively for data analysis and visualization in business settings

Theory

Introduction to Sampling Theory, Sampling versus Complete Enumeration, Methods of Sampling: Probability sampling design –Simple Random Sampling (WR and WOR), Use of Random Number Tables for selection of Simple Random Sample. Concept of Stratified Sampling, Determining sample size for Simple Random and Stratified Sampling under Equal, Proportional, Neyman's and Optimal allocations. Concept of Systematic sampling, Cluster, Multistage and Probability Proportional to Size (PPS) sampling along with their advantage and disadvantages. Non-probability sampling scheme: Judgment, convenience, quota and accident sampling scheme. Time series analysis: Introduction, Spatial, temporal and conditional series, Objectives of time series, components of time series: Trend, Seasonal, Cyclical and Irregular components. Measurement of trend: Graphical, Semi-Average, Moving Averages and Central Moving Averages, Isolation of trend by moving averages, Ordinary Least Squares (OLS), and fitting of trend. Index numbers: Concept and Definition, objectives of index numbers, advantages and limitations. Prerequisites of index

numbers, Types of Index numbers: Price index number (retail and whole sale), Quantity index numbers, Value index numbers. Construction of Simple index numbers under simple aggregative and simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Statistical Quality Control: Definition of control charts, uses of control charts, chance and assignable causes, parts of control charts (central line and control limits). Control charts for variables X-bar and R charts, control charts for fraction defective (p) and control charts for number of defects per unit. Operating characteristic curves for control charts.

Practical

Use of Random Number Tables for selection of Simple Random Sample (WR/WOR). Computing Mean and Variance for Simple random samples. Determining sample size for Simple Random samples. Determining sample size for Stratified Sampling under Equal, Proportional, Neyman's and Optimal allocation. Graphical presentation of various time-series components. Presenting trend line using Graphical and Semi-Average methods. Computation of Moving Average and Central Moving Average, Isolation of trend by moving averages. Fitting of trend line using Ordinary Least Squares (OLS). Construction of Price index number: Retail and Whole sale. Construction of Quantity index numbers and Value index numbers. Construction of Simple index numbers under simple aggregative and simple average of relatives (fixed and chain based) method. Construction of weighted index numbers under weighted aggregative method. Construction of Chain index number, conversion of chain base index number to fixed base index number, fixed base index number to chain base index number. Construction of X bar and R charts for variables. Construction of fraction defective (p) and number of defects per unit. Construction of Operating characteristic curves for control charts.

Suggested Readings

1. Rangaswamy R.1995. *A Textbook of Agril*. Statistics. New Age International.
2. Gupta S P. 1979. *Advanced Practical Statistics*. S. CHAND & Company.
3. Gupta S C and Kapoor V K. 2010. *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.
4. Peter J BrockwelL and Richard A Davis.2016. *Introduction to Time Series and Forecasting.* Springer.
5. Duncan A J. 1952. *Quality Control and Industrial Statistics*. John Wiley.
6. Dodge H F and Romig H G. 1959. *Sampling Inspection Tables*. Wiley.
7. Cochran W G. 1977. *Sampling Techniques.* Wiley.
8. Cowden D J. 1957. *Statistical Methods in Quality Control*. Prentice Hall, Inc.
9. Evgenel Grant and Richard S Leavenworth. 1996. *Statistical Quality Control. Grant*. (7th Edn). McGraw Hill, Inc.
10. Chaudhari A and Stenger H. 2005. *Survey Sampling Theory and Methods.* (2nd Edn.) CRL Press
11. George Box, Gwilym M Jenkins. and Gregory Reinsel. 1994. *Time Series Analysis: Forecasting and Control.* (3rd Edn). Pecoson.

Educational Tour (2 Weeks)- Non-gradial **2 (0+2)**

Semester VI

Corporate Social Responsibility and Managerial Ethics **3 (2+1)**

Objectives

i. To understand the concept and significance of corporate social responsibility (CSR) in business
ii. To learn about ethical theories and principles guiding managerial decision-making
iii. To explore strategies for integrating CSR practices into business operations and stakeholder engagement
iv. To develop skills to analyze ethical dilemmas, make responsible decisions, and promote ethical behavior within organizations

Theory

Introduction to Corporate Social Responsibility (CSR): Meaning and Definition of CSR, History and evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR- overlapping concept. Concept of sustainability. Stakeholder Management. CSR through triple bottom line and Sustainable Business; relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India; models of CSR in India, Carroll's model; drivers of CSR; major codes on CSR; Initiatives in India. International framework for corporate social Responsibility, Millennium Development goals, Sustainable development goals, Relationship between CSR and Millennium Development Goals (MDGs). United Nations (UN) Global Compact 2011. UN guiding principles on business and human rights. Organisation for Economic Co-operation and Development (OECD) CSR policy tool, International Labour Organization (ILO) tri-partite declaration of principles on multinational enterprises and social policy. CSR-Legislation in India and the world. Section 135 of Companies Act 2013. Scope for CSR Activities under Schedule VII, Appointment of Independent Directors on the Board, and Computation of Net Profit's Implementing Process in India. The Drivers of CSR in India, Market based pressure and incentives, civil society pressure, the regulatory environment in India. Counter trends. Performance in major business and Programs. Voluntarism Judicial activism. Identifying key stakeholders of CSR and their roles. Role of Public Sector in Corporate, government Program s that encourage voluntary responsible action of corporations. Role of Non-profit and Local Self-Governance in implementing CSR; Contemporary issues in CSR and MDGs. Global Compact Self-Assessment Tool, National Voluntary Guidelines by Govt. of India. Understanding roles and responsibilities of corporate foundations.

Practical

Review of current trends and opportunities in CSR. Review of successful corporate initiatives and challenges of CSR. Analysis and presentation of case Studies of Major CSR Initiatives.

Suggested Readings

1. Garg CA Kamal. 2023. *Corporate Social Responsibility.* Bharat Law House Pvt. Ltd.
2. Mathur S P, Mathur Nishu.2017. *Business Ethics and Corporate Social Responsibilities*. (1st Edn). New Age International (P) Ltd. Publishers.

3. Andrea Giordani. 2019. *Corporate Social Responsibility*. IntroBooks.
4. Vasishth Neeru and Rajput Namita. 2022. *Corporate Governance Values and Ethics Book for MBA*. Taxmann Publications Pvt. Ltd.

Introduction to Managerial Economics 3 (2+1)

Objectives

i. To understand the application of economic principles in managerial decision-making
ii. To learn how to analyze market conditions, demand, and cost structures to optimize business strategies
iii. To explore the role of managerial economics in pricing, production, and resource allocation within firms
iv. To develop skills to make informed decisions that maximize profitability and efficiency in various business contexts

Theory

Managerial Economics: Definition, scope and significance of managerial economics, Basic economic concepts and principles – firm, industry and economy. Demand estimation: Demand forecasting – meaning, importance and techniques. Production analysis: Cobb-Douglas and CES production functions. Modern Firms: Changing objectives of modern firms and their cost curves, Leaning curve, Meaning, uses and types of cost control, revenue concepts and break-even analysis. Monopoly: Monopoly types, characteristics and degrees of price discrimination under monopoly. Monopolistic Competition: Types, characteristics and pricing and output determination, Pricing strategies of modern firms. Macro-economic equilibrium: Money concept, functions, demand for and supply of money. Inflation: Meaning and types of inflation, price indices, causes, effects and control of business cycles using monetary and fiscal policies.

Practical

Computation of different types of demand function. Computation of elasticity of demand -price, income, cross and promotional. Computation of total, average and marginal revenue under different market conditions. Demand estimation through regression analysis. Demand forecasting using non-quantitative and quantitative techniques - trend method, regression method, leading indicator method, simultaneous equations method. Analysis of important demand forecasting methods. Computation of average product, marginal product and elasticity of output with respect to one variable input. Analysis of optimal factor combination using C-D production function. Computation of elasticity of substitution using C-D and CES production functions. Calculation of optimal output combination of multi-product firms. Derivation of cost functions from production functions and break-even analysis. Determination of market price, market price and normal price. Price determination in perfect competition. Computation of break-even point, learning curve and economies of scope. Calculation of equilibrium price and output under conditions of monopoly and oligopoly. Calculation of market concentration under oligopoly. Price and output determination. Computation of macro-economic equilibrium models.

Suggested Readings

1. Ahuja H L. 2008. *Managerial Economics – Analysis of Managerial Decision Making*. S. Chand and Company Ltd.
2. Chaturvedi D D and Gupta S L. 2012. *Business Economics Theory and Application*. International Book House.
3. Dewett K K .2002. *Modern Economic Theory*. Syamlal Charitable Trust, New Delhi.
4. Seth M L. 2000. *Principles of Economics*. Lakshmi NarainAgarwal Co., New Delhi.

Marketing Management 3 (3+0)

Objectives

i. To understand the principles and theories of marketing management
ii. To learn strategies for product development, pricing, promotion, and distribution
iii. To explore market research techniques to understand consumer behavior and preferences
iv. To develop skills to create and implement effective marketing plans to achieve organizational objectives

Theory

Marketing– meaning, importance, functions. Marketing Management- definition, difference between marketing and selling. Guiding philosophy of Marketing. Marketing planning: importance, steps, nature. Market Segmentation – meaning, bases and advantages; Market Targeting– Approaches. Positioning – meaning and strategies. Marketing environment analysis. Marketing Mix – 4 Ps and 7 Ps; Product. Product classifications and new product development and launching. Product life cycle – stages; Branding – meaning, selecting a brand, advantages and disadvantages of branding, types of brands; Packaging: meaning, importance, and functions of packaging. Pricing Methods and strategies. Marketing channel–meaning, market intermediaries, types of channels and functions of marketing channel; channel management strategies, channels of distribution, channel management decisions, management of retailing and wholesaling. Direct marketing–methods and advantages and disadvantages; Promotional mix: meaning, elements and objectives. Services Marketing–introduction, meaning, characteristics and Service Marketing Mix.

Suggested Readings

1. Andrew J Dubrin. 2012. *Essentials of Management*, Thomson Southwestern. (9th Edn).
2. Chabra and Grover. 2012. *Marketing Management*, Dhanpatrai and Co, New Delhi.
3. Chandrasekar. K S. 2010. *Marketing Management-Text and Cases*, Tata McGraw Hill-Vijaynicole.
4. Charles W L Hill and Steven L McShane. 2007. *Principles of Management.* McGraw Hill Education, Special Indian Edition.
5. Harold Koontz and Heinz Weihrich. 2012. *Essentials of Management: An International and Leadership Perspective* (9th Edn.) Tata McGraw-Hill Education
6. Philip Kortler and Kevin Lane Keller. 2012. *Marketing Management*, PHI (14th Edn).
7. Rajan Sexena. 2005. *Marketing Management.* Tata McGraw-Hill Education.
8. Samuel C. Certo and Tervis Certo. 2012. *Modern Management: Concepts and Skills*, (12th Edn). Pearson Education.

9. Sherlekar. 2013. *Marketing Management.* Himalaya Publishing House, New Delhi.
10. Sontakki. 2005. *Marketing Management.* Kalyani Publishers, New Delhi.

Agribusiness Project Management 3 (2+1)

Objectives

i. To understand the principles and practices of project management specific to the agribusiness sector
ii. To learn to plan, execute, and monitor agribusiness projects effectively, considering factors such as time, cost, and resources
iii. To explore risk assessment and mitigation strategies to ensure successful project outcomes in agricultural settings
iv. To develop skills to lead teams, coordinate activities, and communicate effectively to stakeholders in agribusiness projects

Theory

Meaning and definition of project, general features of projects, importance and objectives of project analysis. Categories of projects based on various criteria. Project cycle, stages of project cycle – conception, formulation, appraisal, implementation, monitoring and evaluation. Criteria for appraising projects – ex-ante and ex-post evaluation. Differences between economic and financial analysis in project evaluation. Costs and benefits of agribusiness projects, comparing costs and benefits of agribusiness projects. Externalities – meaning and definition, positive externalities, negative externalities and internalization of externalities, divergence between social costs and benefits of a project. Undiscounted measures of project worth – Accounting Rate of Return (ARR), ranking by inspection, payback period, proceeds per rupee of outlay and average annual proceeds per rupee of outlay. Time value of money - compounding and discounting, choice of discount rate. Discounted cash flow measures of project appraisal – Net Present Worth (NPW), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR). Risk and uncertainty. Sensitivity analysis, general kinds of sensitivity analyses, social cost benefit analysis, and rationale for social cost benefit analysis. Project management– meaning, importance and triple constraint. Project management structures - functional organization, project organization and matrix organization - meaning, advantages and disadvantages. Project Rating Index (PRI), Work Breakdown Structure (WBS) and Responsibility Assignment Matrix (RAM / RACI). Network analysis – CPM and PERT. Project financing - sources of financing a project. Business incubators - definition, types and their benefits. Project control - monitoring time performance (Gantt Charts, Control Charts), performance index and per cent complete index. Project audit and project closure.

Practical

Generation of agribusiness project ideas, project proposals in agribusiness sector (private and public), exercises on feasibility studies and formulation of detailed project proposals. Investment analysis - undiscounted measures and discounted measures of project worth. Review of case studies pertaining to management of agribusiness projects.

Suggested Readings

1. Austin James. 1992. *Agro Industrial Project Analysis Critical Factors.* John Hopkin University Press, London.
2. Joseph Phillip Hella and Daniel Wilson Ndyetabula. 2012. *Agribusiness Project Appraisal: Theory and Applications.* Intersperses – Tanzania.
3. Prasanna Chandra. 2014. *Projects: Preparation. Appraisal, Budgeting and Implementation*, Tata McGraw Hill.
4. Price Gittinger. J. 1982. *Economic Analysis of Agricultural Projects*. John Hopkins University Press.
5. UNIDO. 1978. *Manual for Preparation of Industry Feasibility Studies*. United Nations.

Strategic Business Management 3 (2+1)

Objectives

i. To understand the concepts and frameworks of strategic management
ii. To learn to analyze internal and external factors influencing business strategy
iii. To develop skills to formulate, implement, and evaluate strategic plans to achieve organizational objectives
iv. To explore strategies for sustainable growth, competitive advantage, and adaptation to dynamic business environments

Theory

Introduction to Strategies: Introduction, Fundamentals of Strategy, Conceptual Evolution of Strategy, Scope and Importance of Strategies. Strategic Management: Introduction, Need, scope, key features and importance of strategic management. Strategists at various management levels, Types of Strategies, Limitations of Strategic Management. Strategy Analysis and its Importance. The External Environment-The General, Industry, and Competitor Environments-External Environmental Analysis -Scanning–Monitoring-Forecasting–Assessing. Segments of the General Environment-The Demographic Segment-The Economic Segment-The Political/Legal Segment-The Socio cultural Segment-The Technological Segment-The Global Segment-Industry Environment Analysis-Competitor Analysis-Ethical Considerations. The Internal Environment-The Nature of Internal Environmental Analysis -The Context of Internal Analysis-Creating Value -The Challenge of Internal Analysis-Resources, Capabilities, and Core Competencies-Building Core Competencies -Value Chain Analysis –Outsourcing-Competencies, Strengths, Weaknesses, and Strategic Decisions. Business-Level Strategy-The Purpose of a Business-Level Strategy -Types of Business-Level Strategies -Cost Leadership Strategy-Differentiation Strategy - Focus Strategies -Integrated Cost Leadership/ Differentiation Strategy. Competitive Rivalry and Competitive Dynamics-Competitor Analysis-Market Commonality -Resource Similarity -Drivers of Competitive Actions and Responses -strategic and Tactical Actions type of Competitive Action.

Corporate-Level Strategy-Levels of Diversification-Value-Creating Diversification: Related Constrained and Related Linked Diversification-Unrelated Diversification-Value-Neutral Diversification: Incentives and Resources-Value-Reducing Diversification: Managerial Motives to Diversify. Acquisition and Restructuring Strategies-Merger and Acquisition Strategies-Reasons for Acquisitions-Restructuring-Downsizing-Downs coping. International Strategy-Identifying

International Opportunities: Incentives to Use an International Strategy-International Business-Level Strategy-International Corporate-Level Strategy-Environmental Trends-Risks in an International Environment-Political Risks -Economic Risks. Cooperative Strategy -Strategic Alliances as a Primary Type of Cooperative Strategy-Business-Level Cooperative Strategy Corporate-Level Cooperative Strategy-International Cooperative Strategy-Network Cooperative.

Practical

Case studies of agribusiness units with respect to their objectives and evaluation of their business strategies, strategic alliances, strategy implementation, implications and challenges.

Suggested Readings

1. Jedrzej George Frynas and Kamel Mellahi. 2015. *Global Strategic Management*.
2. John A. Pearce, Richard B. Robinson, and Amita Mital. 2018. *Strategic Management: Planning for Domestic and Global Competition.*
3. Thomas L. Wheelen J. David Hunger and Alan N Hoffman. 2018. *Strategic Management and Business Policy: Globalization, Innovation and Sustainability.*

Rural Marketing 3 (2+1)

Objectives

i. To understand the unique characteristics and challenges of marketing in rural areas
ii. To learn strategies for reaching and engaging rural consumers effectively
iii. To explore methods for adapting marketing tactics to suit rural market dynamics and preferences
iv. To develop skills to identify market opportunities, create tailored marketing campaigns, and enhance rural market penetration for agricultural products and services

Theory

Definition, Scope and Nature of Rural Marketing. Constraints in Rural Marketing and Strategies to Overcome Constraints. Rural Consumer vs. Urban Consumers, Characteristics of Rural Consumers. Rural Market Environment: (a) Demographics; (b) Economic Factors; (c) Rural Infrastructure. Consumer behaviour: meaning and importance, Rural Consumer Behaviour: Meaning, Factors Affecting Rural Consumer Behaviour – Social Factors, Cultural Factors, Technological Factors, Lifestyle, Personality. Rural marketing strategies: Relevance of Marketing Mix for Rural Market/Consumers. Product Strategies- Rural Product Categories – FMCGs, Consumer Durables, Agriculture Goods and Services; Importance of Branding, Packaging and Labelling. Nature of Competition in Rural Markets, the Problem of Fake Brands. Rural market segmentation – occupational segmentation. Sociological segmentation, Thomson rural Market Index, MICA rural marketing ratings and Lin Quest Data. Pricing Strategies and Objectives, pricing policies - innovative pricing methods for rural markets. Promotional Strategies. Segmentation, Targeting and Positioning for Rural Markets. Distribution Strategies for Rural Consumers: Channels of Distribution- HAATS, Mandis, Public Distribution System, Co-operative Society, Distribution Models of FMCG, Model for Rural Markets (Case Study Based). Communication Strategy: Challenges in Rural Communication, Developing Effective Communication, Determining Communication Objectives, Designing the

Message, Selecting the Communication Channels. Creating Advertisements for Rural Audiences. Rural Media – Mass media, Non-conventional Media, Personalized Media. Innovative Distribution Channels like ITC E-choupal, Godrej Adhar, HUL Shakti. Rural Retail Markets: Understanding the rural retail environment, Emergence of modern retail markets in rural areas. Principles of Innovation for Rural Market Need for Innovation in Rural Market, Role of Government and NGOs in Rural Marketing.

Practical

Studying rural marketing environment, Rural Marketing Research, Process of research in Rural Markets, Sources and Methods of Data Collection, Data Collection Approaches in Rural Markets. Corporate Sector in rural marketing, Rural Specific Promotion Media and Methods. Field visits / case studies: Understanding the Rural Market – A Practical Approach Case Studies.

Suggested Readings

1. Acharya S S and Agrawal N L. 2004. *Agricultural Marketing in India*. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
2. Memoria C B and Joshi R L 2003. *Principles and Practice of Marketing in India.* Kitab Mahal.
3. Pradeep Kashyap. 2012. *Rural Marketing*, Published by Dorling Kindersley (India) Pvt. Ltd.
4. Ramtishen Y. 2002. *Rural and Agricultural Marketing. VES College of Arts, Science and Commerce.* Mumbai. Jacob Publishing House.

Commodity Futures Trading 2 (2+0)

Objectives

i. To understand the fundamentals of commodity futures markets and their role in price discovery and risk management
ii. To learn about trading strategies, including hedging and speculation, to manage price volatility
iii. To explore the regulatory framework and operational aspects of commodity futures trading
iv. To develop skills to analyze market trends, assess risk-reward scenarios, and make informed trading decisions in commodity futures markets

Theory

History and Evolution of commodity markets – Terms and concepts: spot, forward and futures, Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures. Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets. Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features. Important global and Indian commodity exchanges - contracts traded – special features -Regulation of Indian commodity exchanges – SEBI and its role. Fundamental vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

Suggested Readings

1. Acharya S S. *1988. Agricultural Production, Marketing and Price Policy- A Study of Pulses.* Mittal Publications, Delhi.
2. Prasad Jagadish .1966. *Encyclopedia of Agricultural Marketing.* Mittal Publishers Pvt. Limited, Bombay.
3. Kahlon A S and George M V. 1965. *Agricultural Marketing and Price Policies.* Allied Publishers Private Limited, New Delhi.
4. Nayyar H and Ramaswamy P. 1995. *Globalization and Agricultural Marketing*, Rawat Publications, Jaipur
5. Prasad A Shivarama.1985. *Agricultural Marketing in India*. Mittal Publications Delhi.
6. Singhal A K. 1989. *Agricultural Marketing in India.* Anmol Publications, New Delhi.

Semester VII

Electives [Student has to choose a minimum of 20 credits from the list of elective courses notified by the University] 20

ELECTIVE COURSES

(Suggestive, and not Exhaustive List)

1. Agro-Tourism (0+4)
2. Seed Business Management (0+4)
3. Fertilizer Retailing (0+4)
4. Food Retail Business Management (0+4)
5. Supply Chain Management of Agricultural Commodities (0+4)
6. Agri-Export Management (0+4)
7. Hi-Tech Horticulture/Protected Cultivation (0+4)
8. Packaging and Branding of Agricultural Commodities (0+4)
9. e-Commerce in Agribusiness (0+4)
10. Storage and Warehousing of Agricultural Commodities (0+4)
11. Logistics Management of Agricultural Commodities (0+4)
12. Custom Hiring of Agricultural Machinery (0+4)
13. Application of ICT in Agribusiness (0+4)
14. Value Addition to Agricultural Commodities (0+4)
15. Financial Management (0+4)

Note: The Universities/ institutes can offer additional elective courses as per the local needs and facilities available with the respective University.

Agro-tourism 4 (0+4)

Objectives

i. To understand the concept and potential of agro-tourism as a form of rural development
ii. To learn about the principles and practices of sustainable agro-tourism operations.
iii. To explore strategies for integrating agriculture, tourism, and hospitality to create unique visitor experiences
iv. To develop skills to plan, market, and manage agro-tourism enterprises that contribute to local economies and promote cultural exchange

Practical

Agro-tourism: Introduction, importance, scope, forms of agro-tourism, advantages and implementations, introduction to Indian culture. Govt. policies and legislations in respect of tourism and agro-tourism and environment protection laws. Requirements for Agro-tourism. Farm, forest, garden, fish tank/ponds, residential huts, etc. Constraints in operation and management of Agro-tourism activities. Management of resources – Human resources, Natural resources and Garbage management at Agro-tourism centre. Entrepreneurship development: Role and functions, Hospitability: Food and beverages and accommodation services. Communication skill and service; Capital investment, sources and capital budgeting. Project proposal- Preparation and feasibility tests, Accounts and record keeping etc. Marketing strategies for Agro-tourism products and services. Publicity of tourism- Advertisement and use of media.

Suggested Readings

1. Sznajder M, Przezbórska L and Scrimgeour F. 2009. *Agritourism.* CABI Publishing
2. S G Walke, Atul Kumar and Vinaydeep Brar. 2020. *Agrotourism Management: A Complete Practical Guide.* LAP LAMBERT Academic Publishing.
3. Barbara Berst Adams. 2008. The New Agritourism: Hosting Community & Tourists on Your Farm. New World Publishing.

Seed Business Management 4 (0+4)

Objectives

i. To understand the principles of seed business management, including production, marketing, and distribution
ii. To learn strategies for quality control, seed certification, and regulatory compliance in seed industry operations
iii. To explore market analysis and branding techniques to enhance seed sales and market share
iv. To develop skills to develop and implement business plans that ensure profitability and sustainability in the seed industry

Practical

Seed Technology – Role of Seed Technology, Seed Industry in India, National Seed Corporation, State Seed Corporations, National Seed Project and State Farms and their role. Development and Management of Seed Program s – Seed Village Concept, Basic Strategy of Seed Production and

Planning and Organization of Seed Program; Types of Seed Program – Nucleus seed, Breeders seed, Foundation seed and Certified seed etc. Maintenance of genetic purity – Minimum seed certification standard and Management of breeders and Nucleus seed; Management of seed testing laboratory and research and development. Management of seed processing plant, seed storage management; seed packaging and handling. Seed Marketing; GM Crop seed, IPR, PBR, Patents and related issues and their impact on developing countries; Statutory intervention in the seed industry; Seed legislation and seed law enforcement, Seed act; Orientation and visit to seed production farms, seed processing Units, NSC, SSC and seed testing laboratories.

Suggested Readings

1. Acharya S S and Agarwal N L. 2021. *Agricultural Marketing in India*. Oxford and IBH Publishing.
2. Wani Bilal Ahmad. 2021. *Seed Technology and Management*. Kushal Publications and Distributors.
4. Vanangamudi K. 2010. *Vegetable Hybrid Seed Production and Management*. Agro-Bios.

Fertilizer Retailing 4 (0+4)

Objectives

i. To understand the principles of fertilizer retailing, including product knowledge, sales techniques, and customer service
ii. To learn about inventory management, pricing strategies, and distribution logistics in fertilizer retail operations
iii. To explore marketing strategies to attract and retain customers, including promotions and loyalty programs
iv. To develop skills to effectively manage fertilizer retailing operations, optimize sales, and maximize profitability while meeting regulatory requirements and ensuring environmental stewardship

Practical

Fertilizer development – concept, scope, need, resource availability; import and export avenues for fertilizer; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India. Raw material needed and principles of manufacturing of nitrogenous, phosphatic and potassic fertilizers, secondary nutrient sources and micronutrient formulations. Production efficiency and capacity utilization; quality control and legal aspects- fertilizer control order. Testing facilities; constraints in fertilizer use and emerging scenario of fertilizer use; assessment of demand and supply of different fertilizers, fertilizer distribution, fertilizer storage. Field trials and demonstration, fertilizer pricing policy; scope of biofertilizer; environmental pollution due to fertilizer use.

Suggested Readings

1. Justin Sean Myers. 2022. *Growing Gardens, Building Power: Food Justice and Urban Agriculture.* Nature, Society, and Culture.

2. Michael Levy, Barton Weitz and Dhruv Grewal. 2013. *Retailing Management* (9th Edn.) McGraw-Hill Education.
3. Havlin Tisdale, Nelson Beaton. 2016. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management.* Pearson (8th Edn).
4. Rowland Gee, Danny Sloan and Graham Symes. 2019. *The Retail Start-Up Book: Successfully Plan, Launch and Grow a Busines.* Kogan Page Publishers.

Food Retail Business Management 4 (0+4)

Objectives

i. To understand the principles of food retail management, including product assortment, merchandising, and customer service
ii. To learn about inventory management, supply chain logistics, and pricing strategies in food retail operations
iii. To explore marketing techniques to attract and retain customers, including promotions, branding, and store layout optimization
iv. To develop skills to effectively manage food retail businesses, ensure food safety, and meet consumer demands in a competitive market environment

Practical

Introduction to International Food market, India's Competitive Position in World Food Trade, Foreign Investment in Global Food Industry, Retail management and Food Retailing, The Nature of Change in Retailing, Organized Retailing in India, E-tailing and Understanding Food Preference of Indian Consumer, Food Consumption and Expenditure pattern, Demographic and Psychographic Factors Affecting Food Pattern of Indian Consumer. Value Chain in Food Retailing, Principal trends in food wholesaling and retailing, food wholesaling, food retailing, the changing nature of food stores, various retailing formats, competition and pricing in food retailing, market implications of new retail developments, value chain and value additions across the chain in food retail, food service marketing. 4 P's in Food Retail Management, Brand Management in Retailing, Merchandise pricing, Pricing Strategies used in conventional and non-conventional food retailing, Public distribution system, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers. Managing Retail Operations, Managing Retailers' Finances, Merchandise buying and handling, Merchandise Pricing, Logistics, procurement of Food products and Handling Transportation of Food Products. Retail Sales Management Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing, Legal and Ethical issues in Retailing.

Suggested Readings

1. Berman B and Evans J R. 2009. *Retail Management*. Pearson Education, New Delhi, 343p.
2. CII Global Retail Report, Confederation of Indian Industry, New Delhi.

3. Hasty R and Reardon R.1997. *Retail management*. McGraw Hills Education, New Delhi, 339p.
4. Netherlands. *Journal of Retailing*. Elsevier,
5. Singh H. 2014. *Retail Management: A Global Perspective: Text and Cases*. S. Chand and Co Ltd, New Delhi, 871p.
6. Journal of Business and Retail Management Research, Academy of Business and Retail Management, UK.

Supply Chain Management of Agricultural Commodities 4 (0+4)

Objectives

i. To understand the principles and practices of supply chain management specific to agricultural commodities
ii. To learn to optimize the flow of agricultural products from farm to consumer, including procurement, transportation, and distribution
iii. To explore strategies for inventory management, storage, and quality control to minimize waste and ensure product integrity
iv. To develop skills to coordinate and integrate activities along the agricultural supply chain to enhance efficiency, reduce costs, and meet customer demands

Practical

Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM. Demand Management in Supply Chain: Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management. Procurement Management in Agri. Supply chain: Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory Logistics Management: History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology. Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management- Benchmarking: introduction, concept and forms of Benchmarking.

Suggested Readings

1. Groznik A and Xiong Y. 2014. *Pathways to Supply Chain Excellence*. Intech Publishers, USA, 342p.
2. Kaplinsky R and Morris M. 2014. *A Handbook for Value Chain Analysis*. IDRC, UK, 217p.
3. Miller C and Jones L M. 2010. *Agricultural Value Chain Finance: Tools and Lessons*. Food and Agriculture Organization of United Organizations, Italy, 321p.

4. Springer H A. 2007. *Value links: The methodology of value chain promotion*. GIZ LRED, South Africa, 290p.
5. Vermeulen S, Woodhill J, Proctor F and Delnoye R. 2014. *Chain-wide Learning for Inclusive Agri-Food Market Development*. IIED, 398p.

Agri-Export Management 4 (0+4)

Objectives

i. To understand the principles and practices of exporting agricultural products
ii. To learn about international trade regulations, documentation, and logistics specific to agri-exports
iii. To explore market analysis and market entry strategies to identify and capitalize on export opportunities
iv. To develop skills to manage export operations effectively, negotiate contracts, and navigate global markets to maximize returns for agricultural products

Practical

International Trade - meaning, definition, nature and scope. Salient features of international trade, differences between internal trade and international trade, advantages and disadvantages of international trade.

Theories of international trade - mercantilism, theory of absolute cost advantage, theory of comparative cost advantage and modern theory of international trade. Terms of trade - meaning and types. Free trade - meaning, advantages and disadvantages, free trade agreements.

Protectionism - meaning, advantages and disadvantages of protectionism, types of protection -tariffs, quotas, subsidies, dumping, cartels and commodity agreements. Balance of Trade (BoT) and Balance of Payments (BoP)-meaning, differences between BoT and BoP, India's BoT and BoP position. Foreign exchange–meaning, foreign exchange rate, types of foreign exchange rate, mechanisms of determining foreign exchange rate. Foreign exchange market – meaning and functions, instruments of international payments, foreign exchange control and foreign exchange reserves.

WTO–origin, structure, objectives and functions. Agreement on Agriculture - domestic support, market access and export subsidies. FAO / WHO Codex Alimentarious and SPS measures.

Export procedures and documentations, types of export-direct export and indirect export, export houses–objectives and types. Agricultural export promotion organizations-APEDA, MPEDA, Commodity Boards and State Export Promoting Agencies. India's agricultural exports and imports–composition and trading countries. India's foreign trade policy–meaning and objectives.

Suggested Readings

1. Priya Kumari. 2022. *Agricultural Exports of India*. Meena Book Publications
2. Justin Paul and Rajiv Aserkar. 2013. *Export Import Management*. (2nd Edn). Oxford.

3. Karnam Lokanadhan. 2009. *Innovations in Agri-Business Management*. New India Pub. Agency.
4. Rupali Bipin Sheth, Nutan Thoke and Asmita V. Kulkarni. 2022. *Management of Agribusiness and Agri Exports*. Nirali Prakashan.

Hi-Tech Horticulture / Protected Cultivation 4 (0+4)

Objectives

i. To understand the principles and techniques of hi-tech horticulture, including protected cultivation methods
ii. To learn about advanced technologies such as greenhouse and hydroponic systems for optimized crop production
iii. To explore strategies for climate control, irrigation, and nutrient management to maximize yield and quality in protected cultivation
iv. To develop skills to implement and manage hi-tech horticulture practices for sustainable and profitable crop production

Practical

Introduction, importance and scope of hi-tech horticulture in India, Hi-tech nursery management and mechanization of horticultural crops, Micropropagation of horticultural crops, Hi-tech field preparation and planting methods, Protected cultivation: Advantage and constraints, Environmental control in green house- temperature, light, CO_2, relative humidity and ventilation methods and techniques, Micro irrigation systems and its components, EC/pH based irrigation/ fertigation scheduling, Hi-tech canopy management of horticultural crops, High density orcharding in Mango, guava, papaya, citrus, pineapple etc, Remote sensing and geographical information system, Differential geo-positioning system (DGPS), Component of precision farming and application of precision farming in horticultural crops (fruit, vegetables and ornamental crops 2 crops each), Mechanized harvesting produce, Post harvest management for export

Suggested Readings

1. Somuri Prasad, Dharm Singh and Bhardwaj R L. 2010. *Hi Tech Horticulture*. Agro-bios.
2. Adikant Pradhan. 2013. *Protected Cultivation*. Satish Serial Publishing House.
3. Manjunathaswetha B L and Itigi Prabhaka B S. 2020. *Protected Cultivation of Horticulture Crops*. Satish Serial Publishing House.
4. Kumar B Ashok. 2021.*Textbook of Protected Cultivation and Precision Farming for Horticultural Crops*. Jain Brothers.

Packaging and Branding of Agricultural Commodities 4 (0+4)

Objectives

i. To understand the importance of packaging and branding in enhancing the marketability of agricultural commodities
ii. To learn about effective packaging materials, designs, and techniques for preserving product quality and attracting consumers
iii. To explore branding strategies to differentiate agricultural products, build brand equity, and create value for consumers

iv. To develop skills to design, implement, and evaluate packaging and branding strategies that meet market demands and enhance competitiveness in the agricultural sector

Practical

Customer: How to Identify Customer Needs, How to Make Product Development as per the Customer need, Recent Trends in Marketing, Target Customer (Definition and general Info), Psychographics (lifestyle, Hobbies, behavior pattern), Demographics (Age, Education, gender.), Consumer segmentation.

Food Processing: What is Food Processing. Processing stages for Various products, Methods of Food Preservation

Food Packaging: Introduction to food packaging and opportunities for start-ups, Food packaging materials: (Paper, metal, glass, plastics and cardboard), Food Packaging: an important tool for nutrition, safety and effective marketing, Food Packaging Machinery, Selection Criteria for Food Packaging system, Types of Packaging, Advances in food packaging (or A peep into the future of food packaging).

Branding: What is Brand? Communication platform between customer and product, What are their characteristics? Why does the product need branding? How does branding help? What are the drivers? Branding ideas (case studies).

How To Promote Branding: How to get prominence? Visual Merchandising, Retail Merchandising, How does the Branding category help?

Suggested Readings

1. Acharya S S and N L Agarwal. 2021. *Agricultural Marketing in India*. CBS Publishers & Distribuors.
2. Andrew Bevan and David Wengrow. 2016. *Kindle Edition. Cultures of Commodity Branding*. UCL Institute of Archaeology Publications.
3. Singh A. 2011. *From Commodity To Experience - Why Semiconductor Branding Is Important Now?* Kindle Edition.
4. Yahia Elhadi M. 2009. *Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities*. CRC Press.

e-Commerce in Agribusiness 4 (0+4)

Objectives

i. To understand the principles and dynamics of e-commerce within the context of agribusiness
ii. To learn about e-commerce platforms, technologies, and strategies for marketing and selling agricultural products online
iii. To explore the benefits and challenges of e-commerce adoption in agribusiness, including logistics, payment systems, and customer engagement
iv. To develop skills to leverage e-commerce opportunities to reach wider markets, increase sales, and improve efficiency in agricultural trade

Theory

Introduction- meaning and forces behind E-commerce, industry framework, brief history of E-commerce, advantages of E-commerce, Inter-organizational E-commerce, Intra organizational E-commerce, Pure v/s Partial E-commerce. Network infrastructure for E-commerce, the internet, intranets and extranets as E-commerce infrastructure. Encryption- WWW and security encryption, transaction security, secret key encryption, public key encryption, virtual private network, implementation management issues; Electronic payments- overview of E-payments, digital token based electronic payment system, smart cards, credit cards / debit cards based electronic payment system, emerging financial instruments, home banking and online banking. Electronic Data Interchange (EDI), Development of EDI, Application of EDI in business, legal requirements in E-commerce. Introduction of Ecommerce in supply chain management (SCM) and customer relationship management (CRM). E-commerce standards- Introduction, types of standards, document translation standards. E-commerce law- introduction, E-commerce transaction, electronic fund transaction act and regulation, forms of agreement, legal issues in Indian scenario. Mobile commerce introduction to M-commerce, mobile computing application s, wireless application protocols, WAP technology. Web Security- Introduction to web security, firewalls and transaction security, client server network, emerging client server security threats, firewalls and network security.

Practical

E-commerce- case studies of which include six success stories like India times. com, Rediff. com, Baazee. com, SAIL, ITC- E-choupal, AMUL, Digital Marketing- Introduction, the effects of E-business technologies on marketing strategy, First generation marketing tools- Email marketing, online marketing, search marketing, affiliate marketing. Second generation digital marketing tools and viral marketing, Future challenges and opportunities of E-commerce.

Suggested Readings

1. Bairwa Shoji Lal and Chandra Sen and Meena L K and Meera Kumari. 2018. *Agribusiness Management Theory and Practices.* Write and Print Publications
2. Biswas and Giri Mishra. 2019. *Agribusiness Management*. Himalaya Books Pvt. Ltd.
3. Marcus Mulenga and S P Suarker. 2020. *E-Commerce Business: The Essential Guide to E-Commerce Success, Learn All the Valuable Information You Need in Starting a Successful E-Commerce Business* ·

Storage and Warehousing of Agricultural Commodities 4 (0+4)

Objectives

i. To understand the principles of storage and warehousing for agricultural commodities
ii. To learn about storage techniques, facilities, and equipment used to maintain product quality and minimize losses
iii. To explore strategies for inventory management, handling, and distribution to optimize storage efficiency and reduce post-harvest losses

iv. To develop skills to design, manage, and operate storage and warehousing facilities effectively to ensure the availability of high-quality agricultural commodities for market

Practical

Distribution management - storage and warehousing and transportation management for agricultural products; marketing agencies/intermediaries – roles and functions; distribution channels involved in agribusiness.

Suggested Readings

1. Acharya S S and Agarwal N L. 2021. *Agricultural Marketing in India*. CBS Publishers & Distributors.
2. Ashok M V. 2021. *Emerging Trends in Agricultural Marketing in India*. BRILLION Publishing.
3. Groznik A and Xiong Y. 2014. *Pathways to Supply Chain Excellence*. Intech Publishers, USA, 342 p.
4. Elhadi M Yahia. 2019. *Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities*. (1st Edn). CRC Pr I Llc.

Logistics Management of Agricultural Commodities 4 (0+4)

Objectives

i. To understand the principles of logistics management as applied to agricultural commodities
ii. To learn about transportation, inventory management, and supply chain optimization techniques specific to agricultural logistics
iii. To explore strategies for efficient handling, storage, and distribution of agricultural products to minimize costs and maximize value
iv. To develop skills to plan, coordinate, and execute logistics operations effectively to ensure timely delivery and quality preservation of agricultural commodities

Practical

Introduction to physical distribution, Logistics management, Logistics Management and its elements, Modern Concepts in Logistics, Role of logistics in strategy, Inbound and outbound supply chain management, Container – types, Different types of cargo, Packaging and Material Handling, Introduction to supply Chain Management (SCM), Sourcing, Transportation, Indian supply chain architecture, Introduction to warehousing, Warehouse functions, Warehouse types, Warehouse providing value added services, Warehouse internal operations, Warehousing equipment, Inventory, Safety and security in warehouses, Future trends in warehousing, Introduction – recent developments in logistics, Transport and mobility technologies, Green logistics, Cold chain logistics, Block chain and big data analytics in logistics, 3 D printing and wearable devices in logistics, Transport Services, Costing and Performance, Administration and Control and use of IT.

Suggested Readings

1. Ballou R H and Samir K. 2012. *Business Logistics/Supply Chain Management*. Pearson Education, New Delhi, 429p.

2. Groznik A and Xiong Y. 2014. *Pathways to Supply Chain Excellence*. CC Intech Publishers, USA, 342p.
3. Kaplinsky R and Morris M. 2014. *A Handbook for Value Chain Analysis*. IDRC, UK, 217p.
4. Miller C and Jones L M. 2010. *Agricultural Value Chain Finance: Tools and Lessons Food and Agriculture Organization of United Organizations.* Italy,321p.
5. Springer H A. 2007. *Value links: The methodology of value chain promotion*. GIZ LRED, South Africa, 290p.
6. Vermeulen S. Woodhill J and Proctor F and Delnoye R. 2014. *Chain-wide learning for inclusive agri-food market development.* 398p. IIED.

Custom Hiring of Agricultural Machinery 4 (0+4)

Objectives

i. To understand the principles and benefits of custom hiring services for agricultural machinery
ii. To learn about the management and operation of custom hiring centers for efficient machinery utilization
iii. To explore strategies for providing cost-effective machinery services to smallholder farmers and agricultural communities
iv. To develop skills to assess demand, set pricing, and manage logistics effectively in custom hiring operations to support sustainable agricultural practices

Practical

Understand general discipline in the class room and workshop (Do's and Don'ts) Study the scope and importance of Farm Mechanization industry in India Familiarize with different farm machineries' manufacturers and their brands/models Understand the role of a Custom Hiring Service Provider and the progression pathways State the importance of entrepreneurship Select entrepreneurship as an alternate career option State customer hiring centre meaning and its role in promotion Explain the differences between entrepreneurship, self employment and wage employment Discuss case studies, video presentation, group discussion, debates and exercise in entrepreneurship activities Discuss and interact with successful entrepreneurs and business people in a similar field to gain expertise State the role and reward of entrepreneurship Explain the need and importance of market assessment List components and techniques of market survey/assessment Explain demand analysis and assessment of farmers needs Identify possible sources of finance/loan Identify potential customers and maintain customer database Conduct target market assessment and decide positioning of products/ services which is easily accessible to potential buyers List criteria for selection of location for conducting business Understand government laws, local state laws and other regulations for business activity Identify distribution and marketing channels considering the requirements and constraints associated with the same Estimate costing and pricing Calculate risk assessment in business Identify opportunities for scaling up the business Collect information related to various subsidies/funds/ schemes offered by the government, authorized state units and other financial institutions Track and maintain records, and monitor them on a regular basis Explain promotional strategies for the business based on the budget and target segment State minimizing costs and maximizing profits steps Select the machineries for Custom Hiring Centre.

Suggested Readings

1. Review of and recommendations for custom hiring centers for mechanization in Nepal and the Asian region: 2021, by Food and Agriculture Organization
2. Smith. 2020. *Testing, Evaluation of Agricultural Machinery, Equipment*.
3. Sahay K M and Sing K.K. 2004. *Unit Operations of Agricultural Processing.*

Application of ICT in Agribusiness 4 (0+4)

Objectives

i. To understand the role and importance of Information and Communication Technology (ICT) in agribusiness
ii. To learn about various ICT tools and applications for farm management, market analysis, and supply chain optimization
iii. To explore strategies to leverage ICT to enhance productivity, efficiency, and competitiveness in agribusiness operations
iv. To develop skills to implement and integrate ICT solutions effectively to address challenges and capitalize on opportunities in the agricultural sector

Practical

Introduction and scope of ICT in Agriculture, Need for ICT in Agricultural Extension. National Policies on ICT in Agricultural Extension. Role of communications in ICT: Concept, elements and their characteristics. Message: meaning, dimensions of a message characteristics of a good message, message treatment and effectiveness, distortion of message. Methods of communication: meaning and function. Forms of communication. Role of Mass Media in dissemination of farm technology. Modern communication media: electronic video, tele text, tele conference, computer assisted instruction. Telephone/Mobile Technology: Farmer Call Centre, SMS Broadcast Service, m-krishi. ICT initiatives of NGOs and Private Companies. ICT initiatives by ICAR and SAUs, Value Added Services, Fisher Friend Project, SMS Services to farmers by Department of Agriculture. Practices of ICT for Agricultural Extension: aAQUA, Digital Green, e-Agrik (e-Agriculture), e- Sagu (e-cultivation), KISSAN (Karshaka Information Systems Service and Networking), Solutions through Information, VASAT-Virtual Academy for the Semi-Arid Tropics, Touch Screen Kiosk, e-Extension (e-Soil Health Card Program). Village Knowledge Centre (VRC/VRC/CIC): Introduction, concept, process for setting VRC. Warana Wired Village Project, Web Portals: AGRISNET, DACNET, InDG, DEAL, i-KISAN, e- Krishi, ASHA, IFFCO- Agri-Portal, Agriwatch Portal, i-Shakti. ICTs for market information and Agri-Business: AGMARKNET, e-KRISHI VIPNAN, ICT-e-CHOPAL, EID Garry-Indiagriline.

Suggested Readings

1. Sahgal Sujit. 2021. *Agribusiness and Technology: Revolutionizing the Future of Farming*. SAGE Publications.
2. Latief Ahmad and Firasath Nabi. 2021. *Agriculture 5.0: Artificial Intelligence, IoT and Machine Learning.* (1st Edn.) CRC Press.
3. Bhatanagar A B and Bhatnagar Anurag. 2016. *Educational Technology and ICT.* R. Lall; First Edition.

Value Addition to Agricultural Commodities 4 (0+4)

Objectives

i. To understand the importance of value addition in increasing the market value of agricultural commodities
ii. To learn techniques for processing, packaging, and branding to enhance the quality and appeal of agricultural products
iii. To explore strategies to diversify product lines and create new revenue streams through value-added products
iv. To develop skills to identify value addition opportunities, optimize production processes, and meet consumer preferences for higher-quality agricultural commodities

Practical

Food processing and value addition basics, Hygiene and sanitation in food processing Standards for food processing, Sorting and grading of fruits and vegetables, Preparation of fruits and vegetables for processing, Production of fruit marmalade (jam), Production of peanut flour and peanut butter, Solar drying of fruits and vegetables, Milk value addition, Mushroom production, Packaging and packaging material, Branding and labelling.

Suggested Readings

1. Stephen Wachira Kariuki. 2021.*A Comprehensive Manual for Food Technology and Agricultural Value Addition*. Scholars' Press.
2. S S Acharya and N L Agarwal. 2021. *Agricultural Marketing in India*. Oxford and IBH Publishing.
3. Seema Garcha. 2010. *Composting Agricultural Residues for Value Addition*. VDM Verlag Dr. Muller.
4. Adeniyi Oyegbile. 2022. Postharvest, Value Addition and Export: Agricultural Commodity Export and Processing.

Financial Management 4 (0+4)

Objectives

i. To understand the principles of financial management and its importance in business
ii. To learn how to analyze financial statements, manage budgets, and make investment decisions
iii. To explore strategies for financing operations, managing cash flow, and mitigating financial risks
iv. To develop skills to optimize financial performance, enhance profitability, and ensure long-term sustainability in business operations

Practical

Estimation of project cash flows, Evaluation of proposals. Evaluation techniques- Discounting and non-discounting techniques. Risk analysis in capital budgeting. Estimation of working capital requirements; Inventory Management; Appraisal of project proposals using capital budgeting techniques. Computation of costs of borrowed capital, preferred stock, equity capital and retained earnings. Calculation of Operating Leverage, Financial Leverage and Combined Leverage. Valuation of stocks and debentures. Estimation of operating cycle.

Suggested Readings

1. Khan and Jain 2014. *Financial Management.* Tata McGraw Hill.
2. Pandey I M. 2010. *Financial Management* (10th Edn). Vikas Publishing House (P) Ltd, New Delhi.
3. Ravi M K. 2015. *Financial Management: Theory,* Problems, Cases. (8th Edn). Taxman Publications Prentice Hall of India Learning
4. Sharma R K and Sasi Gupta K. 2021. *Management Accounting*, Kalyani Publishers.
5. Vyaptakesh S. 2012. *Fundamentals of Financial Management.* Pearson Publishers.

Semester VIII

Student-READY Program [RAWE/In-plant Training/Industrial Attachment/ Experiential Learning/Hands-on-Training/Project Work/ Internship/ Attachment to R & D Institute/ Laboratory, etc.] **20 Credits**

SKILL ENHANCEMENT COURSES

(Indicative list)

SEC-1: Computer Applications in Agriculture

SEC-2: Production Technology for Bio-Agents and Bio-fertilizers

SEC-3: Seed Production and Seed Testing

SEC-4: Livestock Production and Management

SEC-5: Poultry Production Technology

SEC-6: Development of Agribusiness Proposal

ONLINE COURSES

The student will be free to choose minimum 10 online credit courses (as per UGC guidelines for online courses) as a partial requirement for the B.Sc. (Hons.) Agribusiness Management.

- These can be related to Basic Sciences/ Humanities/ Language/ Communication skills, etc. available on MOOCs/ SWAYAM or any other portal.
- These courses can be taken any time during the degree program as per the choice of the students.
- The courses will be non-gradial (as separate certificates would be issued by the institutes offering the course).
- The MOOC courses taken by the student will be separately registered with the consent of the concerned dean of the College. The final transcript will indicate the title of courses taken by the student and the duration of such courses.

Minimum Standards for Establishing a College of Agri Business Management

- **Degree Nomenclature:** B.Sc. Ag. (Hons.) Agri Business Management

1. **Minimum intake (per year):** 60

2. **Faculty:** A. Core Faculty

Designation	No.	Specialization
Professor	01	Agri Business Management / Agricultural Economics
Associate Professor	02	Agri Business Management
Assistant Professor	13	Agricultural Economics: 01 Marketing Management: 02 Human Resource Management: 02 Finance Management: 02 Quantitative Techniques: 01 Agronomy: 01 Horticulture: 01 Entomology/ Plant Pathology: 01 Seed Technology: 01 Agroforestry: 01

B. Allied Faculty: Faculty for Statistics, Computer Science, English, and other supporting subjects, if any, shall be adjusted from other colleges, Guest faculty, adjunct faculty and part time faculty.

3. **Land requirement (ha):** 5

4. **Essential Instructional Units:**

S. No.		Infrastructure (Square feet)	Facilities
1.	Director's Chamber	612.25	Smart TV, Computer, CCTV Camera Visualizer, Internet Connectivity, Telephone with Wi-Fi and CCTV
2.	P.A. to Director	150	Separate room along with required furniture, Computer, Scanner, Printer, Photocopier, etc.
3.	Teaching Staff	200 (each room)	Separate room for each faculty along with required furniture, Computer, Internet connectivity, Printer, etc.
4.	LDC/UDC/AAO	150 (each room)	Separate room for each ministerial staff along with Computer, Internet connectivity, Printer, etc.
5.	Assistant/Class-IV	120	Separate room attached to Director's office along with required furniture
6.	Placement Cell	378	Placement cell equipped with necessary furniture, video conferencing facility, Big TV screen, phone and wi-fi connectivity. Placement brochure with required details of students
7.	Examination Hall	2365	Examination Hall with required furniture

S. No.		Infrastructure (Square feet)	Facilities
8.	Computer lab	1100	Equipped with 60 desktops, other computer accessories, audio video facility
9.	Conference Hall	2000 (With >100 seating capacity)	Smart Board, 2 electronic screens with wi-fi, Lecture Capture system, latest audio video system podium with controlled environment and necessary furniture
10.	Meeting Room	378	With necessary seating arrangements (>30) with controlled environment, TV Screen for multipurpose, wi-fi, smart podium, white boards, and furniture
11.	Library	4068	With Controlled environment and necessary furniture, internet connectivity, CCTV, computer and printing/photocopier facility
12.	Museum	900	Equipped with necessary furniture, display material and placards
13.	Smart Class Room-I	1100	Smart Board, projector system with lecture capture, white boards with controlled environment and necessary furniture
14.	Smart Class Room-II	1100	Smart Board, projector system with lecture capture, white boards with controlled environment and necessary furniture
15.	Smart Class Room-III	1100	Smart Board, projector system with lecture capture, white boards with controlled environment and necessary furniture
16.	Smart Class Room-IV	1100	Smart Board, projector system with lecture capture, white boards with controlled environment and necessary furniture
17.	Cultural Activity Room	335	Equipped with all major musical instruments
18.	Media cell and Lab	225	Equipped with recording facilities, camera, curtains and controlled environment
19.	Alumni Relations Cell	204	With necessary facilities and furniture
20.	Cafeteria	1175	With required facilities and furniture
21.	Hostels: 02	1. 22077 2. 25113	1. Girls Hostel with the capacity of 75 rooms along with common room, dining hall, 2. visitor's room, and Gym facility 3. Boys Hostel-I with the capacity of 200 rooms along with common room, dining hall, 4. visitor's room, and Gym facility
22.	Store Room	300 (each)	5 rooms for storage of necessary inventory

Annexure-I

Abbreviations

ICAR	Indian Council of Agricultural Research
ABC	Academic Bank of Credit
ABM	Agribusiness management
AEC	Ability Enhancement Courses
AI	Artificial Intelligence
CAU	Central Agricultural University
CCFU	Curriculum and Credits Framework for Undergraduate
CGPA	Cumulative grade point average
CU	Central University
DDG	Deputy Director General
DG	Director General
DU	Deemed University
ELP	Experiential Learning Program
GER	Gross Enrolment Ratio
HAEI	Higher Agriculture Education Institute
MDC	Multi-disciplinary courses
MOOC	Massive Open Online Courses
NAEAB	National Agricultural Education Accreditation Board
NCC	National Cadet Corps
NEP	National Education Policy
NG	Non-gradial
NGO	Non Government Organization
NHEQF	National Higher education Qualification Framework
NSS	National Service Scheme
OGPA	Overall Grade Point Average
PG	Postgraduate
PSSB	Professional Standards Setting Body
RAWE	Rural Agriculture Work Experience
READY	Rural Entrepreneurship Awareness Development Yojna
SAU	State Agricultural University
SEC	Skill Enhancement Courses
UG	Undergraduate
UGC	University Grants Commission
VAC	Value added courses

Annexure III

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