SIXTH DEANS' COMMITTEE REPORT

NAVSARI AGRICULTURAL UNIVERSITY

Course Curriculum and Syllabus

B. Sc. (Hons.) Forestry

College of Forestry

Navsari Agricultural University
Navsari - 396 450 (Gujarat)

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

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सत्यमेव जयते
डॉ. हिमांशु पाठक
सचिव (डेयर) एवं महानिदेशक (भाकृअनुप)
Dr HIMANSHU PATHAK
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 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 online) 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 online 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 DARE & DG ICAR. All Deputy Director General (DDGs) & Assistant Director General (ADGs) of education suggested the changes which were incorporated. 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 of which the course curriculum and credit framework was restructured includes Agriculture, Agricultural Engineering, Biotechnology, Dairy Technology, Fisheries Science, Food Technology, Forestry, Community Science, Horticulture, Food Nutrition and Dietetics, Sericulture with inclusion of 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 banking system (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 Dr Bimlesh Maan, ADG (EP&HS); Dr Seema Jaggi, ADG (HRD); Dr Vanita Jain, Dr Smita Sirohi, 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 (HRM) (Natural Framing); 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 6th Deans' Committee ICAR

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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 Agriculture 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.

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, traditional responses to the demand for 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 on from then on. 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

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 recognized 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/ze 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 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/ 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, 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 farmland 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 recognize 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.

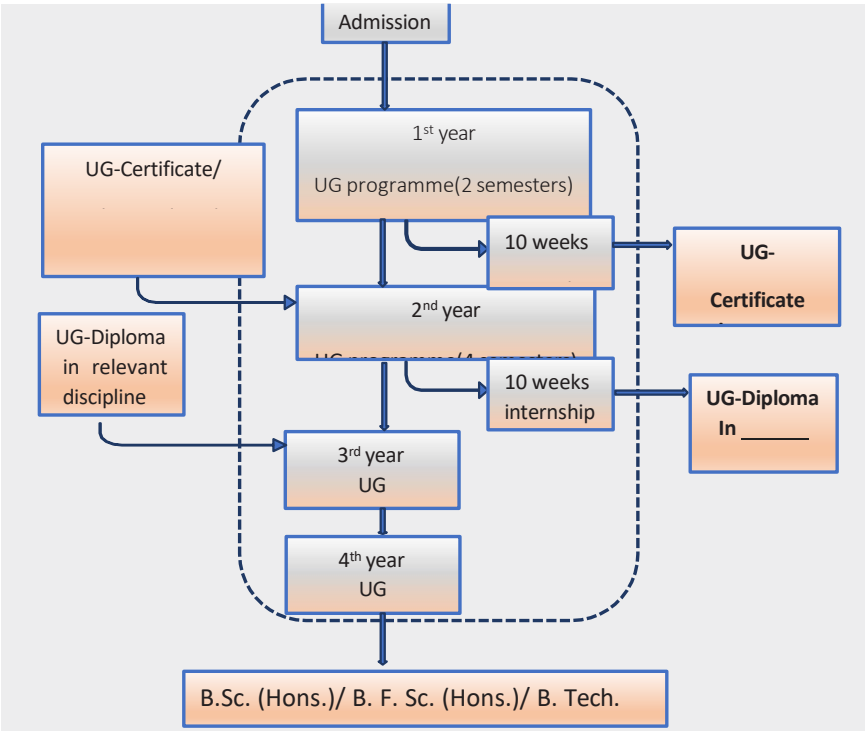

Fig. 4.1 Framework of Undergraduate Programmes

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 Course (Major + Minor)	Multidisciplinary Course (MDC)	Value Added Course	Ability enhancement course (AEC)	Skill Enhancement Course	Internship/ Project/ Student READY	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3 (2)		1 (3) + 2 (4)	4	-	22	2 (1)	10
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	-	
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**	

(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) Agriculture 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 online 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 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

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 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: Experiential Learning/Hands on Training/Skill development/ RAWE/ Industrial attachment/IPT/ student project and 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 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 Universality/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

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

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 farmland 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.

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.

4.13 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 vary from 166-174 considering the specific need of the professional courses. 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 pleasurable and learning 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 10^{th}) 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 10^{th} in related disciplines) will be entitled to take admission in the 2^{nd} year (3^{rd} 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/ze 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/ze 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

	External theory	**Internal theory (Mid-term)**	**Quiz/ progressive assessment**	**Final Practical**
For courses having both theory and practical components	40%	20%	20%	20%
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 mind-

term and one after. 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.

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

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

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

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 5thDeans' 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

FC 1.1 Deeksharambh (Induction-cum-Foundation Programme) 0+2 (NG)

Objective

- 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
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

FRM 1.1 Farming based Livelihood Systems 3 (2+1)

Objective

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. and A. Gulliver with D. Gibbon. (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.; 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. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
5. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
6. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
7. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna 800 014, Bihar.

8. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
9. Evenson, R.E. 2000. Agricultural Producitivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
10. 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.

MDC 2.1 Entrepreneurship Development and Business Management 3 (2+1)

Objective

1. To provide student an insight into the concept and scope of entrepreneurship.
2. To expose the student to various aspects of establishment and management of a small business unit.
3. 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 & 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.

MDC 4.1 Agriculture Marketing and Trade 3 (2+1)

Objective

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. 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, Micro Economic Theory.
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.

VAC 4.1 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.
i) 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 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. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory A g r i Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.
6. Russell, Stuart, Artificial Intelligence: A Modern Approach, Pearson Edition 2013.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa.

VAC 2.1 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 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. 384 pp
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. 36 pp.
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, USA.

AEC 1.2 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 Miffiin 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.

AEC 2.1 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) Andrews, Sudhir. 1988. How to Succeed at Interviews. 21st (rep.) 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) Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House 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) Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
7) Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.

AEC 3.1 Physical Education, First Aid, Yoga Practice and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. 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.

AEC 1.1	**NCC-I**	**1 (0+1)**

Objective

1. 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.
2. 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.

AEC 2.2	NCC-II	1 (0+1)

Objective

1. 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.
2. 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.

AEC 1.1	**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.

AEC 2.2	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.

FORESTRY

Course Curricula for Undergraduate Program in UG- Certificate (Forestry) UG-Diploma (Forestry) B.Sc. (Hons.) (Forestry)

INTRODUCTION

Forests are an integral part of the society and played a significant role in socio-economic development of the country due to its role in providing wood and wood products. The forest management in India has witnessed a paradigm shift in management from production oriented to a conservation-oriented system. The growing population, industrialization, urbanization and the increasing interest in housing and energy sector have accelerated the demand for forest-based products. The production, protection, management and the associated service roles played by forests demand professional man power in order to manage the complex ecosystem sustainably. Considering this significance professional forestry education started in the country in 1985 and over three decades of forestry education has witnessed potential contribution by providing professional man powers to manage both natural and planted forests. However, with the changes in policy and legal issues coupled with the growing concerns and climate change, increasing demand for wood products have all necessitated transformation in forestry education towards meeting the changing demands for professionals.

Under such circumstances, the GoI through its National Education Policy -2020 has directed complete restructuring and revamping of curricula and syllabi as per the requirement of regional, national and global man power demand. The NEP has directed to ensure higher education for all sections of society at levels. The policy also advocated imparting skill and choice-based education to cater to the demands of graduating scholars. The policy envisaged light but tight academic frame work coupled with flexibility in education through multiple entry and exit activities. For this purpose, the policy directed to restructure and reframe completely the educational activities.

With this direction, the Indian council of Agricultural Research (ICAR) has mandated restructuring of syllabus and curricula in the entire courses falling under agriculture discipline. Against this back drop, forestry syllabus has been restructured taking into consideration the directives from National Education Policy-2020 and the guidelines indicated by the Education Division of ICAR. Accordingly, the draft frame work of forestry syllabus has been conceived and the frame work has been discussed with almost all Forestry Colleges across India both through online and offline. Similarly, the syllabus has been presented to all levels of stakeholders like wood-based industries, farmers, NGOs, members of consortium of industrial agroforestry and agroforestry incubator. Besides, the framed syllabus has been presented to students and alumni of Forestry Colleges.

Based on these consultations and deliberations coupled with the directives from Deans' Committee, the syllabus has been redesigned and finally the frame work of syllabus has been designed and presented in this syllabus frame work. This syllabus has been conceived and designed in such a way that its satisfies the requirement of various nomenclatures of Forestry education like UG Certificate in forestry, UG Diploma in Forestry, UG Degree and UG Degree with Hons or research specialization program as per the provisions of NEP 2020. The syllabus

has been framed in such a way that it will extend all entrepreneur skill and provides the students the required professional employment opportunities at all levels of entry and exit system.
In a holistic analysis and approach, the syllabus has been framed and presented to attract higher education in forestry sector towards managing and conserving the natural forests, extending technology based industrial plantations, create employment opportunities through skill-based courses and augment the ethics and value system in forestry education. I take this opportunity of thanking all stake holders for their suggestions and timely support in designing the Forestry Education curricula and syllabi as per the provisions of NEP 2020.

HIGHLIGHTS

- The forestry syllabus is restructured as per the direction of ICAR and also as per the needs and provision of NEP taking into consideration the current development in regional, national and global scenario.
- The 4-year under-graduate program in Forestry is designed with 167 core credits + 10 credits for MOOC course/ online courses preferred by the student as per his/ her choice.
- The course is designed judicially incorporating the fundamental and basic aspects of forestry coupled with management and technology orientation courses. Skill development courses are also incorporated at various levels along with Entry and Exit options to facilitate the students as per his/her/ze professional requirement.
- The skill development courses are incorporated in first two years (Semesters 1 to 4). Students have been given flexibility and choice in selection of skill development courses from a basket of multiple skill development modules offered in all the four semesters of first two years.
- Students will be given 4 credits of skill-based courses each in first and second semester, and 2 credits each in third and fourth semester respectively, 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/ze opts to exit.
- After completing the courses of first year (Total 45 credits), if a student wishes to exit, he/she/ze will be eligible for award of UG-Certificate after completing an extra 10 weeks of internship (10 credits). The internship can be taken in 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 1st year. Similarly, after completing the courses for first two years (total 85 credits) and 10 weeks' internship, the student becomes eligible for UG-Diploma on exit. The students continuing further for award of B.Sc. degrees need not take the internships after 1st and 2^{nd} 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 in proper amalgamation of theory and practicals to provide them hardcore knowledge of the Forestry discipline. In third year, the student will be taught intensive core courses of forestry to get the needed skill and expertise on the subject.

- In 4th year, the VII semester is designed exclusively for elective courses to inculcate the art of professional skill development of the graduating scholars. The elective courses are designed in such a way to develop skill on specific area of current forest development. Accordingly, four electives namely Plantation forestry, Multi-functional agroforestry, High yielding short rotation forestry and Forest product development and utilization have been designed and incorporated the new syllabus to cater to the needs of current regional, national and global development.
- In eighth semester of the degree program, the students will have to undergo Student READY Program to cover 20 credits. The Student READY Program may judicially incorporate internship attachment with wood-based industries/Forest department/Police/Special Task Force/Incubation centre/KVK/ Any research organization. Ideally it is recommended to have Internship with Forest Department (Administrative Skill) for 5 weeks, Internship with wood-based industries (Technical Skill) for 2 weeks, Internship with Police/ Special Task Force (STF) for Jungle survival for 1 week and Internship with incubation centres/KVKs for 2 weeks.
- The new courses like Trees outside Forests, Forest Biomass Energy and Biofuels, Arboriculture, Forest Landscape Restoration, Forest Business Management and Industrial Agroforestry are designed as per the requirement of current national and international development in forestry sector, which will create enough skill and expertise on the graduating scholars.
- 10 credits of non-credit courses are at the discretion of students. Students have the choice of MOOC to groom their passion to enhance their knowledge and competency beyond prescribed courses. Student also has flexibility to complete these non-credit elective courses of 10 credits throughout the span of the degree program.

Entry and Exit Options

The entry and exit options for the UG programs in Forestry are shown in the Figure-1

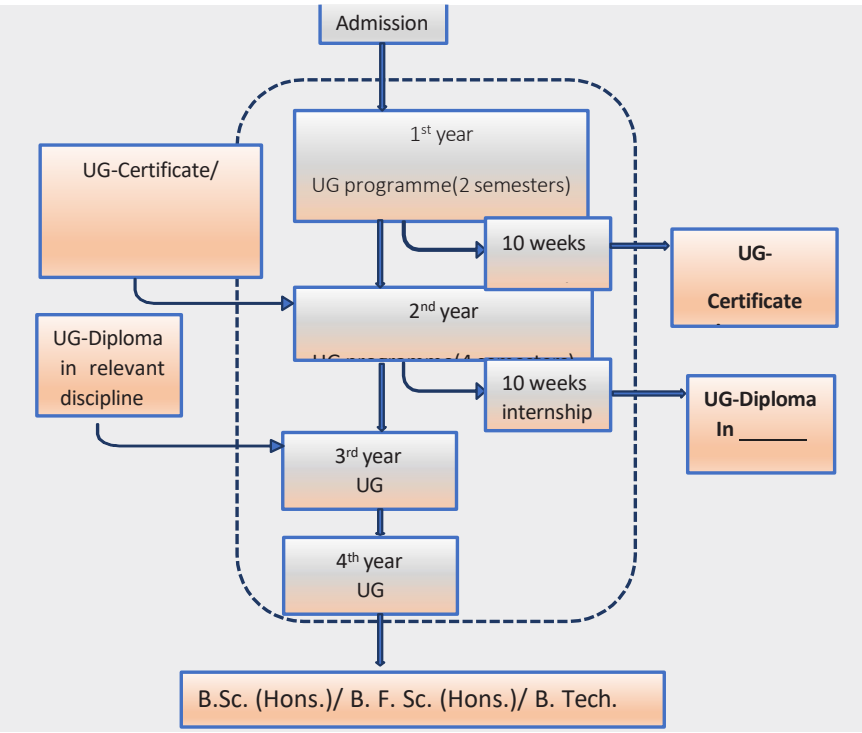

Fig.1 Entry and Exit options for the UG programs in Forestry

Exit options

UG-Certificate in Forestry (Exit after first year and completion of 10 weeks' internship)
UG-Diploma in Forestry (Exit after second year and completion of 10 weeks' internship)
B.Sc. (Hons.) Forestry (On successful completion of four-year degree requirements)

Admission Criteria

10+2 Intermediate with PCM/PCMB/Agriculture (P-Physics, C –Chemistry, M-Mathematics, Biology) from a recognized board/university.

ACADEMIC PROGRAM

Semester wise course distribution

Sr. No.	Course number	Course Title	Credit Hours	Total Credit Hours
	First Year			
	Semester - I			
1.	FC 1.1	*Deeksharambh* (Induction-cum-Foundation Program)	2 (0+2) (Non gradial)	**22 (11+11) (+2 NG)**
2.	FRM 1.1	Introduction to Forest Resources	3 (2+1)	
3.	FBTI 1.1	Forest Plant Biology	3 (2+1)	
4.	SAF 1.1	Silviculture – Principles and Practices	3 (2+1)	
5.	SAF 1.2	Agroforestry Systems and Management	3 (2+1)	
6.	SEC I	Skill Enhancement Courses (SEC-I)*	4 (0+4)	
7.	MDC 1.1	Farming Based Livelihood Systems	3 (2+1)	
8.	AEC 1.1	NCC-I/NSS-I	1 (0+1)	
9.	AEC 1.2	Communication Skills	2 (1+1)	
	Semester - II			
1.	FBTI 2.1	Tree Seed and Nursery Technology	3 (1+2)	**23 (10+13)**
2.	FBTI 2.2	Fundamental of Forest Genetics	2 (1+1)	
3.	FPU 2.1	Wood Anatomy and Identification	2 (1+1)	
4.	FRM 2.1	Forest Measurements and Inventory	3 (2+1)	
5.	AEC 2.1	Personality Development	2 (1+1)	
6.	VAC 2.1	Environmental Studies and Disaster Management	3 (2+1)	
7.	SEC II	Skill Enhancement Courses (SEC-II) **	4 (0+4)	
8.	AEC 2.2	NCC-II/NSS-II**	1 (0+1)	
9.	MDC 2.1	Entrepreneurship Development and Business Development	3 (2+1)	
	Post- II Semester Internship (Only for exit option for award of UG-Certificate)			
1.	FINTS 2.1	Internship (10 weeks)	10 (0+10)***	**10 (0+10)*** **
	Second Year			
	Semester III			
1.	SAF 3.1	Silviculture of Trees	2 (2+0)	**21 (11+10)**
2.	FPU 3.1	Wood Science and Technology	2 (1+1)	
3.	FRM 3.1	Forest Microbiology	2 (1+1)	
4.	FRM 3.2	Forest Soil and Nutrient Management	2 (1+1)	
5.	FRM 3.3	Forest Survey and Engineering	2 (1+1)	
6.	WLS 3.1	Wildlife Sciences	3 (2+1)	
7.	FRM 3.4	Forest Health and Protection	2 (1+1)	
8.	SAF 3.2	Arboriculture	2 (1+1)	
9.	AEC 3.1	Physical Education, First Aid, Yoga practices and Meditation	2 (0+2)	
10.	SEC III	Skill Enhancement Courses (SEC-III)****	2 (0+2)	

	Semester IV			
1.	FPU 4.1	Commercial Forest Products and Utilization	3 (2+1)	**20 (12+8)**
2.	FRM 4.1	Forest Ecology and Management	3 (2+1)	
3.	FPU 4.2	Tree Harvesting and Ergonomics	2 (1+1)	
4.	FRM 4.2	Forest Policy and Legislation	2 (2+0)	
5.	FRM 4.3	Statistical Methods	2 (1+1)	
6.	MDC 4.1	Agricultural Marketing and Trade	3 (2+1)	
7.	VAC 4.1	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8.	SEC IV	Skill Enhancement Courses (SEC-IV)*****	2 (0+2)	
	Post- IV Semester Internship (Only for exit option for award of UG-Diploma)			
1.	FINTS 4.1	Internship (10 weeks)	10 (0+10)***	**10 (0+10)*** **
	Third Year			
	Semester V			
1.	FBTI 5.1	Tree Physiology	2 (1+1)	**21 (13+8) + 2 NG**
2.	SAF 5.1	Plantation Forestry	3 (2+1)	
3.	FBTI 5.2	Tree Improvement	3 (2+1)	
4.	FRM 5.1	Forest Resource Management	2 (1+1)	
5.	FPU 5.1	Non-Timber Forest Products	3 (2+1)	
6.	FRM 5.2	Forest Pest and Diseases	3 (2+1)	
7.	FBTI 5.3	Forest Biotechnology	3 (2+1)	
8.	SAF 5.2	Industrial Agroforestry	2 (1+1)	
9.	FST 5.1	Study tour	2 (0+2) Non-Gradial	
	Semester VI			
1.	WLS 6.1	Wildlife and Protected Area Management	3 (2+1)	**20 (13+7)**
2.	FRM 6.1	Forest Economics and Marketing	2 (1+1)	
3.	FRM 6.2	Watershed Planning and Management	2 (1+1)	
4.	FRM 6.3	Forest Tribology, Ethno-medicine and Extension	3 (2+1)	
5.	FRM 6.4	Remote Sensing and GIS	2 (1+1)	
6.	FRM 6.5	Forest Business Management	2 (1+1)	
7.	FRM 6.6	Forest Landscape Restoration (FLR)	2 (2+0)	
8.	FPU 6.1	Forest Biomass Energy and Biofuels	2 (1+1)	
9.	SAF 6.1	Trees Outside Forests	2 (2+0)	
	Fourth Year			
	Semester VII			
	Elective Courses (Any of the following courses may be taken as electives)			
1.	EC 7.1	Plantation Forestry	20	20
2.	EC 7.2	Multifunctional Agroforestry	20	
3.	EC 7.3	High Yielding Short Rotation Forestry	20	
4.	EC 7.4	Forest Product Development and Utilization	20	
5.	EC 7.5	Forest Resource Management and Utilization	20	

	Semester VIII			
1.	**Internship/ Project / Students READY Program**		20	**167 + 10******* (MOOC) + 4 (NG)**
	FSRP 8.1	Students READY Program	0+10	
	FINTS 8.2 FPR 8.3	Internship **OR** Project	0+10	
		On-line courses (MOOC)	10	

*From the bouquet of available SEC-I modules
**From the bouquet of available SEC-II modules
*** Mandatory requirement for UG-Certificate. (On exit, the students will be eligible to be awarded UG-Certificate in Forestry)
****From the basket of available SEC-III modules (2 credits)
*****From the basket of available SEC-III modules (2 credits)
******Compulsory Internship for students exercising exit option (UG-Diploma) after IIndYear
*******On-line courses (MOOC); NG-Non Gradial

Department / Section Wise Course Breakup (Appendix I)

Sr. No.	Course Title	Course Number	Credit hours	Total Credit Hours
	A) CORE COURSES			
	Silviculture and Agroforestry			
1.	Silviculture – Principles and Practices	SAF 1.1	3 (2+1)	**17 (12+5)**
2.	Silviculture of Trees	SAF 3.1	2 (2+0)	
3.	Plantation Forestry	SAF 5.1	3 (2+1)	
4.	Agroforestry Systems and Management	SAF 1.2	3 (2+1)	
5.	Industrial Agroforestry	SAF 5.2	2 (1+1)	
6.	Arboriculture	SAF 3.2	2 (1+1)	
7.	Trees Outside Forests	SAF 6.1	2 (2+0)	
	Forest Biology and Tree Improvement			
1.	Forest Plant Biology	FBTI 1.1	3 (2+1)	**16 (9+7)**
2.	Tree Seed and Nursery Technology	FBTI 2.1	3 (1+2)	
3.	Fundamental of Forest Genetics	FBTI 2.2	2 (1+1)	
4.	Tree Physiology	FBTI 5.1	2 (1+1)	
5.	Tree Improvement	FBTI 5.2	3 (2+1)	
6.	Forest Biotechnology	FBTI 5.3	3 (2+1)	
	Forest Products and Utilization			
1.	Wood Anatomy and Identification	FPU 2.1	2 (1+1)	**15 (9+6)**
2.	Wood Science and Technology	FPU 3.1	2 (1+1)	
3.	Commercial Forest Products and Utilization	FPU 4.1	3 (2+1)	
4.	Tree Harvesting and Ergonomics	FPU 4.2	2 (1+1)	
5.	Non-Timber Forest Products	FPU 5.1	3 (2+1)	
6.	Forest Biomass Energy and Biofuels	FPU 6.1	3 (2+1)	
	Wildlife Sciences			
1.	Wildlife Sciences	WLS 3.1	3 (2+1)	**6 (4+2)**
2.	Wildlife and Protected Area Management	WLS 6.1	3 (2+1)	
	Forest Resource Management			
1.	Introduction to Forest Resources	FRM 1.1	3 (2+1)	**40 (24+16)**
2.	Forest Measurements and Inventory	FRM 2.1	3 (2+1)	
3.	Forest Ecology and Management	FRM 4.1	3 (2+1)	
4.	Forest Health and Protection	FRM 3.4	2 (1+1)	
5.	Forest Resource Management	FRM 5.1	2 (1+1)	
6.	Forest Tribology, Ethno-medicine and Extension	FRM 6.3	3 (2+1)	
7.	Forest Landscape Restoration (FLR)	FRM 6.6	2 (2+0)	
8.	Forest Policy and Legislation	FRM 4.2	2 (2+0)	
9.	Forest Soil and Nutrient Management	FRM 3.2	2 (1+1)	
10.	Forest Economics and Marketing	FRM 6.1	2 (1+1)	
11.	Forest Business Management	FRM 6.5	2 (1+1)	

12.	Remote Sensing and GIS	FRM 6.4	2 (1+1)	
13.	Forest Microbiology	FRM 3.1	2 (1+1)	
14.	Forest Survey and Engineering	FRM 3.3	2 (1+1)	
15.	Forest Pest and Diseases	FRM 5.2	3 (2+1)	
16.	Watershed Planning and Management	FRM 6.2	2 (1+1)	
17.	Statistical Methods	FRM 4.3	2 (1+1)	
	ELECTIVE COURSES			
	i) Plantation Forestry – EC 7.1			**Student can take 20 credits from any one elective**
1.	Commercial tree seedling production	EC 7.1.1	3 (1+2)	
2.	Commercial plantation development and management	EC 7.1.2	3 (2+1)	
3.	Forest growth modelling	EC 7.1.3	2 (1+1)	
4.	Marketing and certification of wood products	EC 7.1.4	2 (1+1)	
5.	Restoration of degraded lands	EC 7.1.5	3 (2+1)	
6.	Dendro-biomass and energy plantation	EC 7.1.6	3 (2+1)	
7.	Plantation and climate change mitigation	EC 7.1.7	3 (2+0)	
8.	Plant Biochemistry	EC 7.1.8	2 (1+1)	
9.	Research Methodology	EC 7.1.9	2 (1+1)	
10.	Statistical Packages for Data Analysis	EC 7.1.10	1 (0+1)	
11.	Internship with forest plantations-based institutions/plantation companies	EC 7.1.11	2 (0+2)	
	ii) Multi-Functional Agroforestry – EC 7.2			
1.	Agroforestry system	EC 7.2.1	3 (2+1)	**Student can take 20 credits from any one elective**
2.	Interactions in Agroforestry Systems	EC 7.2.2	2 (1+1)	
3.	Agroforestry and Climate Change Mitigation	EC 7.2.3	2 (2+0)	
4.	Industrial agroforestry	EC 7.2.4	3 (2+1)	
5.	Ecotourism	EC 7.2.5	3 (2+1)	
6.	Dendro-biomass and energy plantation	EC 7.2.6	3 (2+1)	
7.	Introduction to Agronomy and Crop Production Technology	EC 7.2.7	3 (2+1)	
8.	Plant Biochemistry	EC 7.1.8	2 (1+1)	
9.	Research Methodology	EC 7.1.9	2 (1+1)	
10.	Statistical Packages for Data Analysis	EC 7.1.10	1 (0+1)	
11.	Agroforestry business incubation	EC 7.2.8	2 (1+1)	
12.	Internship with agroforestry-based institutions/industries	EC 7.1.11	2 (0+2)	
	iii) High Yielding Short Rotation (HYSR) forestry – EC 7.3			
1.	Applied Tree Improvement	EC 7.3.1	3 (2+1)	**Student can take 20 credits from any one elective**
2.	Reproduction biology of tree crops	EC 7.3.2	3 (2+1)	
3.	Biometrical genetics in tree breeding	EC 7.3.3	2 (1+1)	
4.	Marker assisted breeding in forestry	EC 7.3.4	3 (2+1)	
5.	Tissue culture application in forestry	EC 7.3.5	3 (1+2)	
6.	Controlled breeding in tree crops	EC 7.3.6	2 (0+2)	
7.	Tree seed orchards	EC 7.3.7	3 (2+1)	
8.	Forest genetic resources	EC 7.3.8	2 (2+0)	

9.	Clonal Forestry	EC 7.3.9	2 (1+1)	
10.	Plant Biochemistry	EC 7.1.8	2 (1+1)	
11.	Research Methodology	EC 7.1.9	2 (1+1)	
12.	Statistical Packages for Data Analysis	EC 7.1.10	1 (0+1)	
13.	Internship with tree breeding and biotechnology-based institutions/ industries	EC 7.1.11	2 (0+2)	
	iv) Wood and NWFPs Product Development and Utilization – EC 7.4			
1.	Wood identification	EC 7.4.1	2 (0+2)	**Student can take 20 credits from any one elective**
2.	Wood physics and chemistry	EC 7.4.2	3 (2+1)	
3.	Forest products laboratory techniques	EC 7.4.3	2 (0+2)	
4.	Wood seasoning and preservation	EC 7.4.4	3 (1+2)	
5.	Wood working and carpentry	EC 7.4.5	2 (0+2)	
6.	Composite wood technology	EC 7.4.6	3 (2+1)	
7.	Non-wood forest products and value addition technology	EC 7.4.7	3 (2+1)	
8.	Ethnobotany, Medicinal and Aromatic plants	EC 7.4.8	3 (2+1)	
9.	Certification of Forest Products	EC 7.4.9	2 (2+0)	
10.	Plant Biochemistry	EC 7.1.8	2 (1+1)	
11.	Research Methodology	EC 7.1.9	2 (1+1)	
12.	Statistical Packages for Data Analysis	EC 7.1.10	1 (0+1)	
13.	Internship with forest products and technology-based institutions/ industries	EC 7.1.11	2 (0+2)	
	v) Forest Resources Management and Utilization – EC 7.5			
1.	RS and GIS Application for Forest Resource Management	EC 7.5.1	3 (2+1)	**Student can take 20 credits from any one elective**
2.	Ecosystem Services and Valuation of Forest Resources	EC 7.5.2	3 (2+1)	
3.	Entrepreneurship in value chain improvement of Forest Resources	EC 7.5.3	3 (2+1)	
4.	Joint Forest Planning and Management	EC 7.5.4	2 (1+1)	
5.	Climate Change Mitigation	EC 7.5.5	3 (2+1)	
6.	Ecotourism	EC 7.5.6	3 (2+1)	
7.	Restoration of Degraded Lands	EC 7.5.7	3 (2+1)	
8.	Urban Ecology and Environment	EC 7.5.8	3 (2+1)	
9.	Plant Biochemistry	EC 7.1.8	2 (1+1)	
10.	Research Methodology	EC 7.1.9	2 (1+1)	
11.	Statistical Packages for Data Analysis	EC 7.1.10	1 (0+1)	
12.	Internship with Forest Business Unit/RS-GIS Company or Organization	EC 7.1.11	2 (0+2)	
	B) MULTI-DISCIPLINARY COURSES			
1.	Farming based livelihood systems	MDC 1.1	3 (2+1)	**9 (6+3)**
2.	Entrepreneurship Development and Business Management	MDC 2.1	3 (2+1)	
3.	Agriculture Marketing and Trade	MDC 4.1	3 (2+1)	

	C) VALUE ADDED COURSES			
1.	Environmental studies and Disaster Management	VAC 2.1	3 (2+1)	**6 (4+2)**
2.	Agricultural Informatics and Artificial Intelligence	VAC 4.1	3 (2+1)	
	D) ABILITY ENHANCEMENT COURSE			
1.	National Cadet Corps (NCC)/National Services Scheme (NSS)	AEC 1.1 AEC 2.2	2 (0+2)	**8 (3+5)**
2.	Communication Skills	AEC 1.2	2 (1+1)	
3.	Personality Development	AEC 2.1	2 (1+1)	
4.	Physical Education, First Aid and Yoga practices	AEC 3.1	2 (1+1)	

Sr. No.	**Course Title**	**Course Number**	**Credit hours**	**Total Credit Hours**
	E) FORESTRY – SKILL ENHANCEMENT COURSES (SEC)			
1.	**Skill Enhancement Courses (SEC-I)**	**SEC I**	**4 (0+4)**	**12 (0+12)**
	Commercial Seedling Production	SEC 1.1		
	Forest Machine Learning Technology	SEC 1.2		
	Commercial Forestry	SEC 1.3		
	Landscape Management and Restoration	SEC 1.4		
	Wildlife Photography	SEC 1.5		
	Ecotourism	SEC 1.6		
	Para-taxonomy	SEC 1.7		
	Ornithology	SEC 1.8		
	Herpetology	SEC 1.9		
	Design and development of wood and bamboo products	SEC 1.10		
2.	**Skill Enhancement Courses (SEC-II)**	**SEC II**	**4 (0+4)**	
	Clonal Seedling Production	SEC 2.1		
	Commercial tree seed production	SEC 2.2		
	Forest Based Industrial Training	SEC 2.3		
	Urban Forestry Designing and Planning	SEC 2.4		
	Wood Working and Carpentry	SEC 2.5		
	Wood seasoning and Preservation Technology	SEC 2.6		
	Zoo Management	SEC 2.7		
	Wild and Commercial Beekeeping	SEC 2.8		
	Mining Afforestation	SEC 2.9		
	Advanced Wood Working	SEC 2.10		
	Lac and Tassar Cultivation	SEC 2.11		
3.	**Skill Enhancement Courses (SEC-III)**	**SEC III**	**2 (0+2)**	
	Timber Conversion	SEC 3.1		
	Value addition of NTFPs	SEC 3.2		
	Briquetting Technology	SEC 3.3		
	Forest Fire Management	SEC 3.4		

	Activated Carbon Technology	SEC 3.5		
	Wood carving through CNC Technology	SEC 3.6		
	Bur lapping Technology	SEC 3.7		
	Micro Forest	SEC 3.8		
	Import and Export of Forest Products	SEC 3.9		
	e-Timber Market	SEC 3.10		
	Community Forest	SEC 3.11		
	Human Animal Ecosystem Interface	SEC 3.12		
	AR/VR Module Creation in Forestry	SEC 3.13		
	Forest Resource Assessment	SEC 3.14		
	Multifunctional Agroforestry	SEC 3.15		
	Biofuels Technology through forestry	SEC 3.16		
4.	**Skill Enhancement Courses (SEC-IV)**	**SEC IV**	**2 (0+2)**	
	Wildlife Forensic Sciences	SEC 4.1		
	Dendroenergy Generation	SEC 4.2		
	Big Data Management	SEC 4.3		
	Artificial Intelligence in Forestry Operation	SEC 4.4		
	Specialty Seedling Production	SEC 4.5		
	Woodlot Establishment and Management	SEC 4.6		
	Tools for Consulting Forester's	SEC 4.7		
	Application of Drone in Forestry	SEC 4.8		
	Forest Certification	SEC 4.9		
	Arboriculture	SEC 4.10		
	Forest Project Designing and Analysis	SEC 4.11		
	Wood Mechanics	SEC 4.12		
	Mulberry and Non-mulberry based Silk Production	SEC 4.13		
	Internet of Things (IoT) in Forestry	SEC 4.14		
	Marketing and Economics of NTFPs	SEC 4.15		
	Carbon financing projects	SEC 4.16		
	F) Internship/ Project / Students READY Program			
1.	Internship/ Project / Students READY Program		20 (0+20)	**20 (0+20)**
	Students READY Program	FSRP 8.1	0+10	
	Internship OR Project	FINTS 8.2 FPR 8.3	0+10	
	G) NON-GRADIAL			
1.	Deeksharambh (Induction-cum-Foundation Program)	FC 1.1	2	**4 (NG)**
2.	Study Tour	FST 5.1	2 (0+2)	
	H) MOOC Courses			
1.	Online Courses		10	**10**

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
Internship / Student READY	:	20
**MOOCS/ Online Courses	:	10 (Non-gradial)
Grand Total		**167+10****

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	17	----		2 (8)	2	-	21			
IV	12	3 (9)	3 (10)	----	2	-	20	-	10 (13)	
V	21	-	-	-	-	-	21	2 (11)		
VI	20	-	-	-	-	-	20	-		
VII	20	-	-	-	-	-	20	-		
VIII	-	-	-	-	-	20	20	-		
Total	**112**	**9**	**6**	**8**	**12**	**20**	**167**	**4**		

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/NSO
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. Agriculture 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

Detailed Syllabi

Semester I

FC 1.1 Deeksharambh (Induction-cum-Foundation Program) 0+2 (NG)

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

- 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.
- 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

FRM 1.1 Introduction to Forest Resources 3 (2+1)

Objective

- To impart knowledge about the basic concepts of Forestry and familiarize the students about developments in the field of forestry.

Theory

Forests; definitions, role, benefits; direct and indirect. History of Forestry- Forestry- definitions, divisions and interrelationships. Classification of forests- Forest types. Agricultural lands and forests- Agroforestry systems; differences in nutrient cycling, diversity etc. Social forestry, joint forest management; programs and objectives. Important acts and policies related to Indian forests. Global warming; forestry options for mitigation and adaptation- carbon sequestration. Introduction to world forests- Geographical distribution of forests and their classification- Factors influencing world distribution of forests- productivity potential and increment of world forests. Forest resources and forestry practices in different regions of the world; Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan, and China. General problems of forest development and economy. Forest based industries

in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry. Important events/dates related to forests and environment - Themes and philosophy.

Practical

Identification of important farm grown trees. Identification of tree seeds and seedlings. Visit to various forest types, viz., thorn forest, dry deciduous forests, moist deciduous forests, Shola grass land ecosystem, semi evergreen forests and wet evergreen forests to study the factors of locality and species composition. Visit to different forest plantations, Agroforestry plantations and other woodlots. Identification of wood and non- wood forest products. Visit to forest-based institutes and industries.

Suggested Reading:

1. Beazley, M. 1981. The International Book of Forest. London
2. Champion and Seth. 1968. Forest types of India.
3. Grebner, D.L., Bettinger, P. and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
4. Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi.
5. Mather, A.S. 1990. Global forest resources. Belhaven, London
6. Mitchell Beazly.1981. The International Book of the Forest. Mitchell Beazly Publishers, London.
7. Parthiban, K.T, N. Krishnakumar, B. Palanikumaran, R. Thirunirai Selvan and N. Kanagaraj. 2022. FAQ'S on Forestry for IFS Aspirants. Scientific Publishers, Jodhpur (ISBN No.: 9789392590061)
8. Parthiban, K.T, N. Krishnakumar and M. Karthick. 2018, Introduction to Forestry, Scientific Publisher, Jodhpur. 350p
9. Persson, R. 1992. World forest resources. Periodical experts, New Delhi.

FBTI 1.1 Forest Plant Biology 3 (2+1)

Objective

- To inculcate the fundamentals of botany and taxonomy of gymnosperms and angiosperms

Theory

Plant classification and systematic. Botanical Nomenclature – ICBN (International code of Botanical Nomenclature) - Rules and Codes of ICBN, Binomial and Polynomials. Systems of classification - Natural, Artificial and Phylogenetic classification. Principles of systematics. Demerits and merits of plant classification as given by Engler and Prantl, Hutchinson, Bentham and Hooker, Angiosperm Phylogenic Group (APG) and Other modern classifications. Morphology as a tool for tree identification - Field characters - Branching pattern, Leaf, Fruit and Bark. Role of reproductive characters - Flower types, floral formulas and floral diagrams. Reproductive morphology of plants with reference to description and identification of reproductive parts - General form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of bark of common Indian trees - Types of exfoliation patterns in bark. Methods of Floristic survey and need for botanical

explorations. Herbarium techniques -Collection, processing and preservation of plant material. General study of herbarium, arboretum, Palmetum, Fruticetum, Bambusetum and Xylarium. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora of families of Gymnosperms viz., Pinaceae, Taxaceae, Coniferae. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora for the families of Angiosperms viz., Annonaceae, Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Fabaceae, Meliaceae, Salicaceae, Lauraceae, Apocynaceae and Betulaceae. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora for the families of Angiosperms viz., Fagaceae, Moraceae, Tiliaceae, Euphorbiaceae, Dipterocarpaceae, Bixaceae, Cupressaceae, Guttiferae (Clusiaceae), Myrtaceae, Rubiaceae, Sterculiaceae, Bignoniaceae and Combretaceae.

Practical

Morphological description of plant parts with special reference to identification. Study on types of leaves, phyllotaxy and venation, Inflorescence, Bark with suitable examples. Methods of plant collections and herbarium preparation. Laboratory and field identification of important forestry species using vegetative and reproductive characteristics of Magnoliaceae, Ebenaceae, Fabaceae, Meliaceae, Salicaceae, Tiliaceae, Taxaceae, Pinaceae, Myrtaceae, Rubiaceae, Sterculiaceae, Bignoniaceae and Combretaceae. Visit to Botanical Garden and Arboretum for identification of trees.

Suggested Readings

1. Bhatnagar, S.P. and Alok Moitra. (2000). Gymnosperms. New age International (P) Ltd.
2. Bor, N. L. (1990). Manual of Indian Forest Botany. Periodical Expert Book Agency. New Delhi.
3. Brandis. Revised by R. D. Jakarti. (2010). Indian Trees. Dehradun.
4. Charles McCann. (1966). 100 Beautiful Trees of India. D. B. Taraporevala Sons and C. Pvt. Ltd. Mumbai. (Available online PDF)
5. Dasgupta, S. (1998). Systematic Botany for Foresters. Khana Bandhu Publ., New Delhi, India.
6. Datta, S.C. (1999). Systematic Botany. New Age International (p) Ltd. Publ. New Delhi, India.
7. Eric A. Bourdo Jr. (2001). The Illustrated Books of Trees. A Visual Guide to 250 species. Published by Salamander Books Pvt. Ltd. London. (Available online PDF)
8. Jain, S. K. and Rao, R. R. (1977). Handbook of Field and Herbarium Methods. Today and tomorrow's Printers and Publishers. New Delhi.
9. Krishnen, Pradip. (2013). Jungle Trees of Central India. Published by Penguin Books India Pvt. Ltd. New Delhi.
10. Kumar, Ashok. (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
11. Mishra, S. R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd. New Delhi.
12. Mishra, S.R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd.
13. Naqshi, R. (1993). An Introduction to Botanical Nomenclature. Scientific Publishers.

Jodhpur.
14. Pandey, S. N. and Mishra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
15. Parker, R. N. (1933). Forty Common Indian Trees and How to know them. (Available online PDF)
16. Randhawa, M. S. (1957). Flowering Trees in India. Sree Saraswati Press Ltd. Kolkata.
17. Sahni, K. C. (2000). The Book of Indian Trees. Bombay Natural History Society. Mumbai.
18. Santapau, Father H. (1966). Common Trees. (Available online PDF)
19. Singh, Gurucharan. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
20. Tewari, N. (1992). Tropical Forestry in India. International Book Distributors, Dehradun.

SAF 1.1 Silviculture – Principles and Practices 3 (2+1)

Objectives

1. To develop basic understanding on forest and factors influencing forest growth and development
2. To develop skill for the artificial and natural regeneration of forest
3. Exposing students to develop skill on raising and maintaining plantation
4. To impart knowledge on tending operations followed in forest with preliminary information on succession in forest

Theory

Definition and classification of Forest and Forestry - Branches of forestry and their relationships - Trees and their distinguishing features. Forest Reproduction - Flowering, fruiting and seeding behaviour. Site factors - Climatic, edaphic, physiographic, biotic and their interactions. Classification of Climatic Factors - Role of light, temperature, rainfall, snow, wind, humidity and evapotranspiration in relation to forest vegetation. Bioclimatic and Micro climate effects. Edaphic factors - Influence of biological agencies, parent rock, topography on the soil formation - Soil profile - Physical and chemical properties, mineral nutrient. Physiographic factors - influence of altitude, latitude, aspect and slope on vegetation. Biotic factors - Influence of plants, insects, wild animals, man and domestic animals on vegetation. Forest types of India - Basis and systems of classification - Major groups - Revised classification of forest types of India - Tropical, Montane sub-tropical, Montane temperate, Subalpine and Alpine - Sub groups - Types - Species composition and distribution. Forest types of Tamil Nadu. Regeneration of forests - Objectives, ecology of regeneration - Natural and Artificial regeneration. Natural regeneration - Seed production, seed dispersal, germination and establishment. Requirement for natural regeneration. Dieback in seedling with examples. Advance growth, coppice - Root sucker. Regeneration survey - Natural regeneration supplemented by artificial regeneration. Artificial regeneration - Object of artificial regeneration - Advantages. Factors governing the choice of regeneration techniques. Choice of species and factors that govern. Sowing v/s planting - Preparation of planting material - Field planting and techniques - Plant protection and sanitation measures - Forest

nutrition and irrigation in trees.

Practical

Study about habits of plants and developmental stages of tree growth and its structure. Study about tree morphology - Stem, crown and root characters. Assessment of forest composition. Study about stand structure. Assessment of natural regeneration. Planting pattern and planting technique for afforestation and reforestation. Exercise on Seed and nursery practices. Planting pattern and planting technique for afforestation and reforestation. Field preparation, marking, alignment and stacking, pit making and planting. Plant protection and sanitation measures. Study of afforestation and reforestation success.

Suggested Readings

1. Champion, H.G. and S.K. Seth. 1968. A revised survey of the forest types of India. Manager of Publication, Delhi.
2. David M. Smith. 1989. The Practice of Silviculture. EBD Educational Pvt. Ltd., Dehradun. P.526
3. Dwivedi, A. P. 2006. A Text book of Silviculture. International Book Distributors, Dehra Dun. 505 p.
4. Haig, I.T., M.A. Huberman and U. Aung Din. 1986. Tropical Silviculture. Periodical Experts Book Agency, New Delhi. Vol. 1, p. 190.
5. Khanna, L.S. 2000. Principles and practice of Silviculture. Milton Book Company, Dehra Dun. 473
6. Luna, R. K. 1989. Plantation forestry in India. International Book Distributors, Dehra Dun. P. 476
7. Parthiban, K.T, R.J. Sudhagar, S. Umesh Kanna, S. Vennila, I. Sekar and K. Baranidharan. 2016. Forestry: A Subjective Guide for IFS Aspirants. Scientific Publishers - Competition Tutor, Jodhpur (ISBN No.: 9789386102096)

SAF 1.2 Agroforestry Systems and Management 3 (2+1)

Objectives

1. To develop basic understanding on agroforestry in different agro-climatic zones.
2. To develop skill on various agroforestry systems and carbon sequestration in agroforestry systems.
3. Exposing students to develop skill on Industrial Agroforestry

Theory

Agroforestry systems in different agro climatic zones – Tropical agroforestry, temperate agroforestry, arid and semi-arid agroforestry and humid agroforestry - components, production and management techniques. Alley cropping- functional and structural attributes of alley cropping, soil management, choice of species - productivity of various Agroforestry systems. High-density short rotation plantation systems – choice of species, design, development and management - Silvicultural woodlots/energy plantations - choice of species, design, development and management. Different types of agroforestry systems – silvi-agriculture - shelterbelts and windbreaks - design, aerodynamics and management - silvopastoral systems - live fences; fodder trees and protein banks and Agri- silvopastoral

systems – home gardens, hedge rows, Multistorey system and their mangement; Special systems - Apisilviculture, silvisericulture, aquaforestry etc. Agroforestry for wasteland development. Canopy management - Lopping, pruning, pollarding, and hedging. Diagnosis and design methods and approaches. Biophysical and ecological functions of agroforestry: Nutrient cycling and role of agroforestry in soil and water conservation - micro-site enrichment by trees, N fixation, improvement in soil physico-chemical properties and soil organic matter status, litter and fine root dynamics, nutrient pumping; beneficial effects of species mixture - rhizosphere and phillosphere effects. Carbon Sequestration-Climate change mitigation and phytoremediation. Adverse effects of trees on soils - competition, allelopathy – Causes and mechanisms. Industrial Agroforestry – scope and potential in India – major wood based industries - People's participation, rural entrepreneurship through Agroforestry and industrial linkages – contract farming – types and systems – successful contract farming models – timber transit rules for farm grown trees - Financial and socio-economic analysis of Agroforestry systems. Evaluation of tangible and intangible benefits – Agroforestry research and development in India - National Agroforestry Policy 2014 – objectives and strategies.

Practical

Study characteristics of trees/shrubs/grasses for agroforestry – Designing and development of multifunctional agroforestry model - Survey agroforestry practices in local/ adjoining areas - Visit to prominent agroforestry systems, other plantation crop combinations, Homegardens, other integrated multitier agroforestry systems and study their structural and functional attributes- Establishment and management of fodder bank – Studies on Integrated Farming System - Establishment and assessment of Industrial agroforestry plantations - Volume and biomass estimation- Carbon sequestration assessment- Crown measurement, light interception, leaf area index measurements in agroforestry systems. Annual crops/grass growth measurements and yield estimation – Determination of cost and returns of various agroforestry systems.

Suggested Readings

1. Chundawat D.S. and S. K. Gautham. 2017. Textbook of Agroforestry. Oxford and IBH Publishing, (ISBN: 9788120408326)
2. Divya M. P. and K. T. Parthiban. 2005. A Textbook on Social Forestry and Agroforestry. Satish Serial Publishing, New Delhi (ISBN: 9384988952).
3. Nair P. K. Ramachandran. 1993. An Introduction to Agroforestry. Springer Dordrecht (ISBN: 978-0-7923-2134-7)
4. Parthiban, K.T. and A. Keerthika. 2021. A Textbook of Agroforestry – Principles, Practices and Application. Agro Bios (India), Jodhpur. (ISBN: 9788197377689)
5. Parthiban, K.T. and R. Seenivasan. 2017. Plantation and Agroforestry: Pulpwood Value Chain Approach. Published by Scientific Publisher, Jodhpur. Pp: 517.
6. Parthiban, K.T., et al., 2018. Multifunctional Agroforestry – Ecosystem services. Narendra Publishers. New Delhi. Pp: 419.
7. Parthiban, K.T., R. Umarani, S. Umesh Kanna, I. Sekar, P. Rajendran, and P. Durairasu. 2014. Industrial Agroforestry Perspective and Prospectives. Scientific Publisher. Jodhpur. Pp.396.

SEC I	Skill Enhancement Course (Indicative SEC- I Courses)	4 (0+4)

- Commercial Seedling Production
- Forest Machine Learning Technology
- Commercial Forestry
- Landscape Management and Restoration
- Wildlife Photography
- Ecotourism
- Para-taxonomy
- Ornithology
- Herpetology
- Design and development of wood products

MDC 1.1 Farming Based Livelihood Systems 3 (2+1)

Objectives

1. To make the students aware about farming-based livelihood systems in agriculture
2. 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 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; Volume 7. [Google Scholar]
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 A. Gulliver with D. Gibbon. 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. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 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 U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

AEC 1.2 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 Miffiin 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

AEC 1.1 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.

AEC 1.1 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 skilfull 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. 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

FBTI 2.1 Tree Seed and Nursery Technology 3 (1+2)

Objectives

1. To impart knowledge on production, collection, processing, quality control and storage of tree seeds and its application in production and conservation of forests.
2. To impart knowledge on quality nursery stock and clonal technologies for production of quality planting stock in forest trees.

Theory

Introduction - Seed technology and its role in forestry - Seed quality. Seed biology - Seed structure, Fertilization and Seed development. Seed germination - Types and stages of seed germination - Factors affecting seed germination. Seed dormancy - Types - Causes - Merits and demerits. Production of quality seeds - Candidate tree, plus tree and elite tree. Seed production areas.

Establishment and management of SPA. Seed orchards - Types of seed orchard - Establishment and management of seed orchards. Factors affecting tree seed production - Influence of provenance and seed source. Seed collection - Planning and organizing seed collection - Methods and factors affecting choice of seed collection. Seed extraction - Methods of extraction in different types of fruits. Seed treatment - Pre-sowing seed treatments - Priming - Pelleting - Dormancy breaking treatments.

Pre-storage treatments. Seed storage - Orthodox and recalcitrant seeds - Natural longevity of tree seeds - Factors affecting longevity in storage - Storage conditions - Methods and containers. Seed testing. Classes of seeds - Seed quality control mechanism - Certification procedure- Classes of tree seeds - OECD procedure for tree seed certification - Plant quarantine - International organizations involved in seed quality control - Seed Legislation in India. Forest Nurseries - Types, selection of site, nursery layout and nursery area. Potting mediaseedbeds and containers (Poly bags and root trainers). Propagation - Types - Sexual and Asexual Propagation - Vegetative and Tissue Culture Techniques - Media and Potting Mixtures.

Practical

Tree Seed Technology: Identification and study on external and internal structure of tree seeds and physiological maturity tests. Visit to seed production area. Physical purity analysis, Determination of seed moisture, Seed germination test, Seed viability test, TTZ test, Hydrogen peroxide test, Seed vigour test, Conductivity test, Accelerated ageing test and Seed health testing. Tree Nursery Technology: Nursery technology for quality nursery stock production in small seeded species - Big seeded species - Recalcitrant seeds - Endangered tree species. Nursery techniques for large size seedlings for avenue planting and problem soils. Clonal forestry – Potting media – Plant growth substances – Propagation methods through cuttings, grafting, layering and budding.

Suggested Readings

1. Agrawal, R.L. 1986. Seed Technology. Oxford - IBH Publishing Co. New Delhi.
2. Bedell, P.E. 1998. Seed Science and Technology: Indian Forestry Species. Allied

Publishers, New Delhi.
3. Bewely, J.D and Black, M. 1985. Seed- Physiology of development and germination.
4. Chin, H.F. and Roberts, E.H. 1980. Recalcitrant Crop Seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia.
5. Hannah Jaenicke. 2007. Good Tree Nursery Practices. International Centre for Research in Agro forestry, Kenya.
6. Hartmann, H.T and Kester, D.E. 1968. Plant propagation – principles and practice prentice – Hall of India Private Limited, New Delhi.
7. ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland.
8. Leadem, C.L. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.
9. Napier, I. and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu.
10. Ram Prakash. 2007. Plantation and nursery techniques of forest trees. International Book Distributers, Dehra Dun.
11. Ramamoorthy and K. Sivasubramanian. 2006. Seed Legislation in India. Agrobios, Jodhpur.
12. Renugadevi, J., P. Srimathi, P.R. Renganayaki and V. Manonmani. 20101. Seed Testing. Agrobios, Jodhpur.
13. Sharma R.R and Manish Srivastava. 2007. Plant propagation and nursery management. International Book Distributers, Dehra Dun.
14. Umarani, R. 2006. Tree Seed Technology. Scientific Publishers, New Delhi.

FBTI 2.2 Fundamentals of Forest Genetics 2 (1+1)

Objective

- To understand the fundamental concepts of Genetics and Cytogenetics

Theory

Definition of genetics, heredity, inheritance, cytology, cytogenetics; Brief history of developments in genetics and cytogenetics. Physical basis of heredity. Structure and function of cell and cell organelles – Differences between Prokaryotes and Eukaryotes. Cell division – mitosis- meiosis and their significance - Gametogenesis and syngamy in Plants. Chromosome structure, chemical composition, nucleosome, centromere, telomere, euchromatin, heterochromatin, NOR, satellite chromosome, karyotype, ideogram. Types of chromosomes based on position of centromere, Chromosomal aberration: Variation in chromosome structure – deletion, duplication, inversion and translocation – genetic and cytological implications. Chromosomal aberration: Variation in chromosome number – euploid, aneuploid, types of aneuploids and their origin; Klinefelter syndrome and Turner syndrome; Polyploid - auto and allopolyploids, their characters; meaning of genome; evolution of wheat, triticale, cotton, tobacco, Brassica. Mendel's experiments and laws of inheritance. Rediscovery of Mendel's work. Terminologies: gene, allele, locus, homozygous, heterozygous, hemizygous, genotype, phenotype, monohybrid, dihybrid, trihybrid, polyhybrid. Allelic interactions – Dominance vs

recessive, complete dominance, codominance, incomplete dominance, Non allelic interaction with modification in Mendelian ratio – (i) Dominant epistasis (12:3:1). (ii) Recessive epistasis (9:3:4). (iii) Duplicate and additive epistasis (9:6:1). (iv) Duplicate dominant epistasis (15:1). (v) Duplicate recessive epistasis (9:7). (vi) Dominant and recessive epistasis (13:3); Summary of epistatic ratios (i) to (vi). Lethal genes, Pleiotrophy, penetrance and expressivity, Multiple alleles, blood group in human, coat colour in rabbits, pseudo alleles, isoalleles. Polygenes – transgressive segregation, comparison of quantitatively and qualitatively inherited characters; modifiers; Linkage - coupling and repulsion; Crossing over – significance of crossing over; Factors controlling crossing over. Strength of linkage and recombination; Two point and three points test cross. Double cross over, interference and coincidence; genetic map, physical map.

Sex determination: Autosomes and sex chromosomes - chromosomal theory of sex determination different types –Sex determination in plants. Cytoplasmic inheritance and maternal effects – features of cytoplasmic inheritance, chloroplast, mitochondrial - plastid colour in *Mirabilis jalapa.* cytoplasmic male sterility. Watson and Crick model. Models of DNA replication; steps involved in DNA replication. RNA types - mRNA, tRNA, rRNA. Protein synthesis, Mutation – characteristics of mutation – micro and macro mutation, Transition and transversion; major physical and chemical mutagens.

Practical

Study of microscopes – Preparation of fixatives and stains – Pretreatment of materials for mitosis and meiosis – study of mitosis and meiosis. Study of genetic ratios of – monohybrid, dihybrid – incomplete dominance. Gene interaction - multiple alleles and multiple factors. Study of linkage, Estimation of strength of linkage and recombination frequency in three points test cross data and F2 data – Drawing of genetic map – interference and coincidence. Studies on sex linked inheritance in Humans and Drosophila.

Suggested Readings

1. Benjamin Lewin. 2005. Genes IX Oxford University Press, Oxford.
2. Daniel Sundararaj, G. Thulasidas and M. Stephen Dorairaj, 1997. Introduction to Cytogenetics and Plant Breeding. Popular Book Depot, Chennai –15.
3. Gupta P.K., 1997. Cytogenetics. Rastogi Publications, Meerut.
4. Pundhansingh. 2014. Elements of Genetics. Kalyani Publishers.
5. Russel, P.J. 2000. Fundamentals of genetics. Addition Wesley Longman Publishers, USA.
6. Singh, B.D. 2004. Fundamentals of Genetics, Kalyani Publishers, Chennai.
7. Stansfield, W.D.1990. Theory and problems of genetics. Mc-Graw Hill Book Co., New York.
8. Strickberger. M.W. 1996. Genetics. Prentice-Hall of India Pvt. Ltd. New Delhi.
9. Verma, P.S. and V.K. Agarwal. 2007. Genetics. S. Chand and Company Ltd. / New Delhi.

FPU 2.1 Wood Anatomy and Identification 2 (1+1)

Objective

- To develop basic understanding on wood identification, anatomical characterisation of

both Gymnosperms and Angiosperms

Theory

Basics and introduction of wood anatomy - Classification of plant kingdom - Gymnosperms versus angiosperms - Kinds of woody plants. The plant body - a tree and its various parts. Meristems-Promeristem, primary meristem, secondary meristem. Simple tissues - Parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body - Typical stems and roots of dicots and monocots. Basic process in tree growth - Vascular cambium – Expansion of cambium layer – Duration of cambial activity - Secondary growth in woody plants. Mechanism of wood formation - Special reference to typical dicot stem. Ray initials and fusiform initials -Anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood-Sapwood, heartwood, pith, early wood, late wood, growth rings, dendrochronology, wood rays, Knots, Grain orientation etc - Sapwood versus heart wood - Anatomical differences. Transformation of sapwood to heartwood - Factors affecting transformation. Prosenchymatous elements, tracheids, vessels, fibers, parenchyma and rays, resin canals, gum canals, latex canals and infiltrants in wood. Three dimensional features of wood - Transverse, tangential and radial surfaces. Elements of wood cell walls. Structure and arrangement of cells - Simple pit and bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers - Classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood. Reaction wood. Bark structure - Composition and functions.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (Woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers and examination of wood samples. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Tamil Nadu.

Suggested Readings

1. Brown, H.P. 1995. Text Book of Wood Technology, Vol I and II International Books and Periodical supplement service, New Delhi.
2. Haygreen, J.G and Bowyer, J.L. 1982. Forest Products and Wood Science-An Introduction. The Iowa State University press, America P.495.
3. Hoadley, B. 2000. Identifying Wood-Accurate results with simple tools. Taunton Press, Newtown, USA. 223p.
4. Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th edn. McGraw-

Hill. New York, USA: 722p.
5. Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

FRM 2.1 Forest Measurements and Inventory 3 (2+1)

Objectives

1. To impart various methods of measurements on standing, felled trees, crops and determining the volume of trees
2. To inculcate knowledge on volume table preparation for trees

Theory

Forest Mensuration - Definition and objectives - Scales of measurement - Units of measurements - Precision, bias and accuracy aimed and reasons. Diameter and girth measurements - Breast height measurements - instruments used. Measurement of height - Definitions - Methods of measurement of height - Ocular - non instrumental and instrumental methods. Sources of error in height measurement - Height measurement of leaning trees. Tree stem form - Metzger's theory - Form factor - Types of form factor - Form height, form quotient - Form class. Area measurement in trees and timber - Cross sectional and basal area. Volume measurement of standing trees – Volume of felled logs - Branch wood. Volume table - Definition - Preparation of volume tables - Graphical, regression equation and alignment chart method. Forest inventory - Sampling techniques and methods - Measurement of crops - Sample plots. Increment - CAI and MAI - Increment Percent - Instruments and methods - Increment Borer. Stump analysis - Stem analysis - Increment Boring. Tree crops - Measurements - Objects - Crop diameter, crop height, crop age and crop volume. Yield table and stand table.

Practical

Determination of length - Measurements of diameter. Girth and basal area of trees using Callipers, Tape, Ruler, Penta Prism, Tree Calliper, etc. Measurement of height using non instrumental method - Shadow method and Single pole method. Measurement of tree height using instrumental methods - Haga altimeter - Clinometer - Blume leiss Hypsometer - Laser Hypsometer. Volume determination of standing and felled trees. Exercise on Stump analysis and Stem analysis. Annual ring counting in trees using ring borer. Preparation of volume tables - Local volume table. Yield Table - Preparation and Application. Point sampling - Theory - Wedge prism. Total enumeration and partial enumeration - Kinds of sampling and elementary statistical computations.

Suggested Readings

1. Chaturvedi, A. N. and L. S. Khanna. 1982. Forest Mensuration. International Book Distributors, Dehradun.
2. Manikandan, K and S. Prabhu. 2014. Indian Forestry. A breakthrough approach to Indian Forest Service. Jain Brothers, New Delhi.
3. Eugene, T. Forest Mensuration. McGraw Hill Company.

4. Panwar and Bharadwaj. Handbook of Practical Forestry. Updesh Purohit for Agrobios (India), Jodhpur.

AEC 2.1 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 Behaviors, personality and Organizational Behavior.
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 (rep.) 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. Kumar, Pravesh, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
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: Wadswor.

VAC 2.1 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 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. 384 pp
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. 36 pp.
3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. (In Press). Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India.
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 - 313 002. First Edition: 2008
6. Prasanthrajan M, 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
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

MDC 2.1 Entrepreneurship Development and Business Management 3 (2+1)

Objectives

- To provide student an insight into the concept and scope of entrepreneurship
- To expose the student to various aspects of establishment and management of a small business unit
- 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. Hous
4. Grover, Indu, 2008, Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Gupta CB, 2001, Management Theory and Practice. Sultan Chand and Sons.
6. Khanka SS, 1999, Entrepreneurial Development. S. Chand andCo.
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 PC and Reddy PN, 1991, Principles of Management. Tata McGraw Hill.

SEC II Skill Enhancement Course (Indicative SEC Courses II) 4 (0+4)

- Clonal Seedling Production
- Forest Based Industrial Training
- Urban Forestry Designing and Planning
- Wood Working and Carpentry
- Wood seasoning and Preservation Technology
- Zoo Management
- Wild and Commercial Beekeeping
- Mining Afforestation
- Advanced Wood Working
- Lac and Tassar Cultivation

AEC 2.2 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 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.

AEC 2.2 National Service Scheme (NSS-II) 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.

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.

- 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

FINTS 2.1 Internship (Only for exit option for award of UG-Certificate) 10 (0+10)-10 Week

General objective

- 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.

Specific objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills in the job interview process
5. 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 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 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

SAF 3.1 Silviculture of Trees 2 (2+0)

Objective

- To impart basic knowledge on silviculture and regeneration of broad leaved and conifer tree species.

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Acacia nilotica, Acacia catechu, Azadirachta indica, Dalbergia sissoo, Shorea robusta, Tectona grandis, Terminalia* species, *Anogeissus latifolia, Pongamia pinnata, Bassia latifolia, Calophyllum inophyllum, Simarouba glauca* and *Albizia lebbeck*-Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Bambusa* species, *Calamus* species, *Dendrocalamus strictus* and *Melocanna bambusoides.* Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of Northern region trees: *Abies pindrow, Celtis australis, Diospyros* species, *Grewia* species, *Picea smithiana, Pinus wallichiana, Populus* spp., *Quercus* species, *Robinia pseudoacacia, Eucalyptus* spp. and *Salix* spp. Eastern trees region trees: *Neolamarckia cadamba, Chukrasia tabularis Cryptomaria japonica, Dipterocarpus* species, *Mesua ferrea, Morus laevigata, Pinus kesiya, Shorea assamica* and *Terminalia myriocarpa*. Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of *Acacia* spps. (Wattles), *Anacardium occidentale, Casuarina* spp., *Dalbergia latifolia, Pterocarpus* spp., *Eucalyptus* spp., *Santalum album, Swietenia mahogany* and *Tamarindus indica*. Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices, pest and diseases and economic importance of the following conifer species: Tropical pines, *Abies pindrow, Picea smithiana, Cedrus deodara* and *Pinus roxburghii.*

Suggested Readings

1. Champion, H.G. and A.L. Griffith. 1989. Manual for General Silviculture for India.
2. Dwivedi, A.P. 1993. A Text Book of Silviculture, International Book Distributors, Dehradun.
3. Luna, R.K. 2005. Plantation trees International Book Distributors, Dehradun.
4. Troup, K.S. 1984. The Silviculture of Indian Trees- Volume I, II and III. Controller of Publications, New Delhi.
5. Ralph D. Nyland. 1996. Silviculture concepts and applications. McGraw-Hill, New York.

FPU 3.1 Wood Science and Technology 2 (1+1)

Objectives

1. To make students aware about the problems related to wood as basic material to manufacture various useful products
2. To understand the wood treatment requirement

Theory

Wood – Natural defects in wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Wood water relationship - Hygroscopic nature of wood – Free and bound water – Shrinkage and swelling - Fibre saturation point - Equilibrium moisture content. Moisture content determination. Durability and treatability of wood – Natural defects and wood deterioration. Wood seasoning; merits, principles, seasoning of timber – Introduction and history of seasoning in India - purpose and scope -Factors influencing seasoning, Mechanism of drying and types; Selection and preparation of material for seasoning. Air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules; Special seasoning methods, Seasoning defects and their control. Wood biodeterioration. Classification of timbers based on durability and seasoning behavior. Wood preservation; Introduction– Development and progress of wood preservation in India - mechanism of wood preservation. Preparation of wood for preservative treatment principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage, Durability of timbers. Methods of application of wood preservatives-Non pressure Methods-Brushing-Steeping-Hot and cold bath process – Diffusion Process-Momentary Dip Process-Sap displacement method - Boucherie method. Pressure Method-Full cell process - Empty Cell Process-Merits and demerits.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories. Visit to timber depot/saw mill to study the stacking methods and various defects in wood. Determination of moisture content by different methods. Visit to Wood seasoning unit to study the various types of seasoning methods and Safety aspects. Exercise on fixing seasoning schedule for timbers under steam heated kiln and FRI solar heated kiln seasoning method. Visit to wood preservation unit to study the different methods of application of wood preservatives. Study on the environmental health and safety aspects of wood preservatives. Non pressure and pressure methods of application of preservatives. Seasoning and preservative treatments for important tree species.

Suggested Readings

1. Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood

science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.
2. Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.
3. Divya, M.P., Parthiban, K.T., Packialakshmi, M. and S. Krishnamoorthi. 2022. Text Book on Wood Products and Utilization. Scientific Publishers, Jodhpur (ISBN No.: 9789392590795).
4. FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.
5. Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.
6. USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p

FRM 3.1 Forest Microbiology 2 (1+1)

Objective

- To impart basic knowledge about the microbiological associations involved in promoting the growth of trees.

Theory

Forest soil Microbes. Rhizosphere concept- ecto and endo rhizosphere, rhizoplane and rhizosphere effect (R:S ratio); spermosphere - seed surface microflora and phyllosphere - lichens, algae and leaf nodulating microorganisms. Soil microbial biomass in different forests; qualitative and quantitative nature of microorganisms in various forest ecosystems - their role in improving soil nutrient availability and plant growth. Carbon cycle - forest litter / organic matter – types; composition of organic matter / litter. Biochemistry and microbiology of litter / organic matter decomposition under aerobic - tropical, subtropical and temperate forest ecosystem; and in anaerobic conditions – mangrove and swamp forests. Role of autotrophic microorganisms in sequestering carbon in forest soils. Biochemical cycling of nitrogen. Nitrogen fixation - free living, associative and symbiotic diazotrophs. Nitrogen fixing trees- leguminous trees with Rhizobium and non- leguminous / actinorhizal trees with Frankia and their nitrogen fixing capacity. Biochemistry and microbiology of nitrification and denitrification and their impact on nitrogen availability in aerobic and anaerobic forest ecosystem. Biochemical cycling of phosphorus. Microbial transformation of phosphorus – mycorrhizae – types; mycorrhizal status of tropical, sub-tropical and temperate forest trees; nutritional and non-nutritional effects of mycorrhizae; mechanism of enhanced nutrient uptake and plant growth. Phosphate solubilisers - types – mechanism of phosphate solubilization.

Microbial transformation of iron and sulphur. Microbial interactions in soil. Microbial inoculants - mass production, storage methods ISI / BIS standards and quality control; problems and constraints in production and application. Role of microbial inoculants in afforestation program. Generation of biofuels − Development of biological conversion technologies − Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feedstocks prior to production of the Biodiesel − Current

technologies of biodiesel production. Bioethanol – Properties – Feedstocks − Process technology − Pilot plant for ethanol production from lignocellulosic feedstock – Biomethanol − Principles, materials and feedstocks − Process technologies and techniques − Advantages and limitations.

Practical

Isolation and enumeration of rhizosphere and soil microorganisms. Quantification of heterotrophic microbial population and total microbial activity of different forest ecosystem. Isolation of cellulose and lignin degrading microorganisms from forest floor. Isolation of free living diazotrophs - Azotobacter and Beijerinckia from soil. Isolation of Azospirillum and Phosphobacteria. Study of root nodules of leguminous trees. Isolation of Rhizobium from root nodules of tree legumes. Study of root nodules of non-leguminous trees and isolation of Frankia from *Casuarina equisetifolia* / *Alnus nepalensis*. Examination of ecto- and endo-mycorrhizae from different forest soils. Bio composting of leaf litter. Mass culturing of bacterial and fungal inoculants- microbial inoculation techniques.

Suggested Readings

1. Alexander, M. 1985. Introduction to Soil Microbiology. John Wiley and Sons, New York. New Delhi.
2. Paul, E. A. 2007. Soil microbiology, ecology, and biochemistry, 2nd edn. Academic Press
3. Pelczar, M.J., Chan, C.S and Krieg, N.R. 2003. Microbiology, Tata McGraw Hill Pub. Co. Ltd.,
4. Prescott, L.M., Harley, J. P. and Kelin, D.A. 2000. Microbiology, 4th edn, McGraw Hill.
5. Shukla, G. and A. Varma. 2010. Soil Enzymology (Soil Biology), Springer Verlag.
6. Singh, R.P.2010. Microbiology. Kalyani Publishers. Ludhiana.
7. Smith, S.E. and D.J. Read. 1997. Mycorrhizal Symbiosis. 2nd edn. Academic Press, San Diego.
8. Subba Rao N.S and Dommergues, Y.R. 2000. Microbial interactions in Agriculture and Forestry. Vol. II. Oxyford and IBH Publications Co. Pvt. Ltd. New Delhi and Kolkata.
9. Subba Rao, N.S. 1997. Biofertilizers in Agriculture and Forestry. 3rd edn. Oxford and IBH Publishing Co. PVT Ltd., New Delhi. Bombay and Kolkata.
10. Tate, R.L. 1995. Soil Microbiology. John Wiley and sons, Inc New York.
11. Tauro, P. Kapoor, K.K. and Yadav, K.S. 1989. An Introduction to Microbiology, Wiley Pub.

FRM 3.2 Forest Soil and Nutrient Management 2 (1+1)

Objectives

- To impart knowledge about the forest soil fertility and productivity and to enhance the nutrient status in soil.

Theory

Forest soils vs cultivated soils - Soil fertility and productivity - Properties of soils

under different forest ecosystem - Arnon's criteria of essentiality. Classification of nutrients based on Arnon's criteria - Sources of nutrients and forms of nutrients. Nutrient transformations – Mineralization and immobilization - Availability and uptake of nutrients by plants – Fixation and loss of nutrients – Nitrogen, Phosphorus and Potassium cycles in soil. Available forms of secondary nutrients – Ca, Mg and S. Availability of micronutrients. Deficiency and toxicity symptoms and their corrective measures for nutrients. Relationship between nutrient concentrations and plant growth. Deficiency, Hidden hunger, Critical limit, Sufficiency level, Excessive and Toxicity limits. Soil Reaction (pH) and Nutrient availability. Cation exchange – CEC – adsorption, desorption. AEC – calculation of BSP. Significance of CEC and exchangeable cations with respect to soil fertility. Factors affecting CEC in soils. Nutrient Interaction – Definition – Mechanisms, types of interactions between macro and micronutrients, chelates and plant nutrition. Diversity of organisms in the soil – Factors affecting their growth and activity in the soils viz., Organic matter, oxygen, temperature, pH *etc*. Soil Macro organisms - Earthworms, Ants and termites and plant roots, Soil micro animal's nematodes, protozoa etc. and their role in soil. Soil microorganisms- Prokaryotes (Bacteria and archaea), fungi, actinomycetes, Cyanobacteria (Blue-green algae) etc. in the soil ecosystem their distribution. Atmospheric N fixation by organisms and Nitrogen fixing tree species. Mycorrhiza - Types of Mycorrhiza and Beneficial effects on plant nutrition. Concepts of rhizosphere - Rhizodeposition and Phyllosphere. Organic matter decomposition - Factors affecting organic matter decomposition – Stages of organic matter decomposition - C: N ratio of organic matter, its importance and nutrient availability - Role of organic matter in the Forest soil improvement. Nutrient management - Nutrient Use efficiency – Importance. Methods of soil fertility evaluation – Diagnosis of deficiency symptoms, Biological test, Soil testing and Rapid plant tissue analysis and Fertilizers recommendation. Soil fertility management: Optimum, efficient and balanced use of nutrients. INM – SSNM – Fertigation
- Crop rotation, Nutrient management through fortification of fertilizers. Permanent manurial experiments - LTFE experiments. Methods of fertilizer recommendations.

Practical

Available N, available P2O5, available K2O, and micronutrients from the soils and interpretation of their results. Determination of CEC and derivation of ESP. Estimate the gypsum requirement of sodic soils and lime requirement of acid soils. Enumeration of soil micro-organisms -Estimation of N fixing micro-Organisms-Organic matter decomposition.

Suggested Readings

1. Brady, N.C. The Nature and Properties of Soils. Mac Millan Pub. Comp. New York.
2. Burges, A. and Raw, F. 1967. Soil Biology. Acad. Press, New York.
3. Mengel, K. and Kirkby, A. 1978. Principles of Plant Nutrition. International Potash Institute, Switzerland.
4. Pritchett and Fisher R.F. 1987. Properties and Management of Forest Soils. John Wiley, New York.
5. Tisdale, L. S. Nelson, L.W. and Beaton, J. D. 1985. Soil Fertility and Fertilizers. Macmillan Publishing Company, New York.
6. Young, A. 1989. Agroforestry for Soil Conservation. CAB International, U.K.

FRM 3.3 Forest Survey and Engineering 2 (1+1)

Objectives

1. To educate the students on different types of surveying and latest technologies involved in surveying
2. To impart basic knowledge on building materials, construction, roads and bridges, its types and its adoptability in forest areas.

Theory

Surveying – Scales - Measurement of distances - Chains – Cross staff - Chain surveying - Chaining on plain and sloping lands - Chaining around obstacles - Offset – Measurement of angles – Bearings and Meridians. Compass – Types: Prismatic and surveyor's compass. Compass surveying - Traversing – Closed and open - Methods of surveying - Radiation, intersection and traversing. Local attraction - Theodolite surveying – Methods: Repetition and reiteration. Measurement of horizontal angles and distances, vertical angles. Levelling - Utility and scope – Definitions – Methods - Levelling instruments - Dumpy level - Temporary and permanent adjustments. Bench marks – Types. Reduction of levels - Rise and fall method - height of collimation method. Topographical surveying - Methods of contouring - Characteristics and use of contours - Maps and Map Projections – Basics of Total Station – EDM - GPS - Study of minor survey instruments. Aerial Surveying – Concept - Stereo Photogrammetry – Aerial photogrammetry – Overlaps – Scale of photographs – Vertical and titled photographs distortion in aerial photographs – Stereostopic vision – Photo interpretation – Application. GPS Surveying –Basic Concept – Space, control and user segments – Satellite configuration – Signal structure – Orbit determination and representation – Hand held and geodetic receivers – Field work procedures – Data processing and application. Materials for construction – Bricks, Lime and Cement - Mortar – Concrete – Foundation and types -Bearing Capacity of soil – Brick masonry - Stone masonry - Roofs – Floors –Dampness – Anti termite treatment in buildings - Precautions – Safety measures. Estimating and costing - PWD schedule of rates – Preparation of estimate. Road – Introduction, definitions, types, road profile - Demarcation, alignment in plains and hills, curves and drainage. WBM and earthen road, road maintenance and road signs - Retaining wall – Types and construction features - Bridges – Principles of construction, selection of site and types - Culverts – Types.

Practical

Chain surveying –study of different types of chains - chaining on plain and sloping lands - chaining around obstacles - field work – plotting. Cross staff surveying and computation of areas. Compass surveying - radiation, intersection and traversing. Theodolite surveying - measuring horizontal angles and distances, vertical angles. Levelling – study of instruments - reduction of levels - rise and fall method - height of collimation method. Study of coordinate system – Aerial surveying - Total Station – GPS Surveying – Preparation of contour maps - Brick, Lime and cement manufacturing - Visit to Brick and Lime kilns - Design of foundation - Brick and stone masonry – section showing different components of brick and

stone masonry. Types of roofs – trusses – king and queen post truss. Drawings of different types of windows and doors. Preparation of estimates for small structures and measurement book entries.

Suggested Readings

1. Arora, K.R. 2007. Surveying Vol. I and II. Standard Book House, Delhi-6.
2. Basak, N.N. 1994. Surveying and levelling. Tata McGraw hill publications, New Delhi.
3. Deodhar S.V. and Singhal. 2001. Civil Engineering Materials. Khanna Publishers, New Delhi.
4. Duggal, S.K. 2008. Building Materials. New Age International Publishers, New Delhi
5. Masani, N.J. 2001. Forest Engineering without Tears, Nataraj Publication, Dehra Dun.
6. Ram Prakash. 1997. Forest Surveying, International Book Distributors, Dehra Dun.
7. Rangawala, S.C and Rangwala, P.S. 1985. Surveying and Leveling, Character Publishing House, Anand.
8. Rangwala. S.C. 1991. Estimating and costing. Charotar book stall, station road, Anand.
9. Rangwala. S.C. 2000, Building construction, Charotar publishing house, Anand.

WLS 3.1 Wildlife Sciences 3 (2+1)

Objective

- To develop basic understanding on Reptiles, Aves and Amphibians and their ecology, behaviour and the habitat.

Theory

Wildlife – Definition - Types - Free living, Captive, domesticated and feral animals - History of Wildlife studies in India - Evolution of geological time scale - Significance - Classification of Indian Mammals - Phylum Cordata - Typical attributes of Cordates - Classification of Phylum Cordata - Description of Mammal, Reptiles, Aves and Amphibians Basic requirements of wildlife - food, water, shelter, space, limiting factors - Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals - Impact of Water and Temperature; Animal behavior - Systems of perception - Thermo receptors - Tactile receptors - Auditory receptors - Visual receptors - Chemo receptors - Biological rhythms - Circadian - Tidal - Lunar. Kinds of behavior - Innate - learning methods of communication - Mimicry - Aggressions - Social groups - Coronial - Fossorial - Seasonal - Aquatic adaptations. Niche-Territory - Home range - Cursing radius - Edge - Eco tone - Juxtaposition – Interspersion - Carrying capacity - Cover and its types - Habitat analysis and evaluation - Alternate Habitat AnalysisHabitat Improvement - Manipulation of forestry operations - Food and Water development - Cover construction - Shelter improvement.

Practical

Visit to various protected areas and observations on the morphological, behavioural, feeding and reproductive activities of different species of wild animals in India. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera trapping, for identification, determination of age and sexing of animals including the

small mammals. Faecal analysis of wild animals.

Suggested Readings

1. Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.
2. Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.
3. Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA. International Zoo Books, Published by New York Zoological Society, New York
4. Johnsingh, A.J.T. and Manjrekar, N. 2014. Mammals of South Asia. Vol. I. University Press, 614p
5. Johnsingh, A.J.T. and Manjrekar, N. 2015. Mammals of South Asia. II. University Press, 739p
6. Krebs, C. and Davis, N. 1978. Introduction to behavioral ecology. Oxford University Press.
7. Menon, V. 2014. Indian Mammals: A field guide. Hachette. 528p.
8. Mittermeier, R.A., Rylands, A.B. and Wilson, D.E. 2013. Handbook of the Mammals of the World -Volume 3. Lynx Edicions. 952.
9. Prater, S.H. 1971. The Book of Indian Animals. Oxford University press, Bombay. 324p.
10. Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.
11. Wilson, D.E. and Mittermeier, R.A. 2009. Handbook of the Mammals of the World – Volume 1. Lynx Edicions. 728.
12. Wilson, D.E. and Mittermeier, R.A. 2011. Handbook of the Mammals of the World – Volume 2. Lynx Edicions. 886.

FRM 3.4 Forest Health and Protection 2 (1+1)

Objective

- To create professional knowledge on various disturbances, problems and other issues to forest and the associated heath and protection

Theory

Disturbances – Importance and Scope – Causes and kinds of forest disturbances – Problems due to the forest disturbances - Factors that determines the forest protection. Deforestation – Causes of deforestation – Extent and causes of forest and land degradation – Extent of global and national forest cover changes – Effects of deforestation – Strategies to reduce and control deforestation – Preventive and remedial measures. Shifting Cultivation – Causes – Extent of shifting cultivation areas – Methods of shifting cultivation areas – Impact of shifting cultivation - Preventive and remedial measures – Alternative land use practices to shifting cultivation. Forest fires – Characters, Components, Causes, Types – Status of forest fire in Global and Indian scenario – Injuries and Impact – Fire detection methods. Forest fires and its effect on forest ecosystems. Fire suppression – Firefighting equipment – Fire control policy and objectives. Fire fighting in other countries. Post fire suppression operations -Legal

provisions – Economics of fire protection. Encroachment - Types, control of encroachment, illegal felling of trees – Legislation mechanism in encroachment. Damage caused by domestic and wild animals. Defective management – Errors in execution – Preventive measures. Invasive alien species in forests – Its effect on forest ecosystem - management techniques. Community forest protection – Role of forest dwellers and Village Forest committee (VFC). Awareness creation. Community participation in forest protection.

Practical

Visit to deforestation and shifting cultivation areas in nearby forest and study about its causes and prevention. Visit to forest areas with fire damages. Study of fire registers, records and fire monitoring stations. Fire line creation in forest. Study of fire reporting methods and instruments. Visit to fire station - Study and acquaint with machinery used for fire control. Application of recent techniques in fire forecasting, monitoring and mapping. Study of problems in forest encroachment. Field study of role of forest dwellers in forest protection. Visit to Community Forest protection area. Identification of weeds, parasites and epiphytes – Its impact in forest. Tree transplanting techniques and revival packages in wind and cyclone damaged trees. Symptoms of damages, causes their management methods.

Suggested Readings

1. Basher, A.E.S. (1983). Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New Delhi.159p.
2. Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
3. Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.
4. Khanna, L.S. (1988). Forest Protection. Khanna Bandhu, Dehra Dun.206p
5. Parthiban, K.T., M. Suganthy and N. Krishna Kumar. (2019). Forest Protection – Principles and Application. Jain Brothers, New Delhi (ISBN No.: 9788183602952).

SAF 3.2 Arboriculture 2 (1+1)

Objective

- To impart skill and expertise on urban tree management coupled with the knowledge on landscape management

Theory

Arboriculture – Tree identification and principles. Tree anatomy – Structure, function and mechanics. Tree physiology – Environmental factors affecting Photosynthesis, Respiration and Transpiration. Selection of trees – Tree propagation – Tree planting – Various tree planting techniques – Water and Plant Growth – Tree guards. Soil and Tree growth – Fertilizing Trees and Compacted Soils – Soil Nutrition. Tree disorder and Health – Frost protection – Wind damage minimizing – Mulching and watering – Diagnosing and management. Health disorders in trees – Pest and diseases in urban trees – Identification and diagnosing – Integrated pest and disease management. Tree pruning – Techniques, essential and safety – Basic pruning principles of woody plants – Canopy architecture: Crown cleaning, crown reduction, crown lifting. Felling a whole tree and felling in sections. Burlapping

techniques. Arboricultural equipment – Pruning tools: Secateurs, Hand saws, Power tools – Felling tools: Chain saws, Hedge trimmers, Climbing equipment (Ladder, harness, rope, belt, sprus, etc.) – Tool maintenance. Tree surgery – Types of surgery: Cavity treatment, rods, cables, etc. – Propping – Treating bark wounds – Removing large branches. Climbing techniques – Preparing to climb, how to climb and anchoring point. Knots – Tree surgery safety. Workplace safety – Protective equipment: Personal protection, gloves, eyewear, hearing protection, skin protection, etc. Handling tools and machinery safety. Risk management, legal issues, and aesthetic considerations. Landscaping – Principles and elements – Types of landscape designs – Formal: Persian and Mughal designs – Informal: British and Japanese. Landscape components – Plant and other components – Lawn, pergolas, hedges, edges, topiary, balloon, arbours, carpet beds, trees, flower beds, annuals and climbers. Practices of landscaping. Tools and implements for landscaping. Specialised gardens - Butterfly, water, bog or marsh, terrace, roof, sunken, indoor and rock. Planning and planting programs in institutional and industrial complexes, roads, bridges, parking area and other structures.

Practical

Tree Identification and principles – Tree Propagation – Tree planting techniques – Canopy architecture – Tree pruning techniques. Burlapping techniques. Arboricultural equipment – Pruning tools and Feeling tools – Tool maintenance. Tree surgery: Cavity treatment, rods, cables, etc. Climbing techniques – Tree climbing and equipment – Preparing to climb, how to climb and anchoring point. Common Insect pests and diseases to trees and woody plants. Landscaping – Types of landscape designs – Tools and implements for landscaping. Specialised gardens. Visit to different landscapes and gardens. Workplace safety and Protective equipment.

Suggested Readings

1. Harris, R. W. (1992). Arboriculture: integrated management of landscape trees, shrubs, and vines (No. Ed. 2). Prentice-Hall International.
2. Konijnendijk, C., Nilsson, K., Randrup, T., and Schipperijn, J. (Eds.). (2005). Urban forests and trees: a reference book. Berlin, Heidelberg: Springer Berlin Heidelberg.
3. Shigo, A. L. (1991). Modern arboriculture: a systems approach to the care of trees and their associates. Shigo and Trees, Associates.
4. Watson, G. W., and Himelick, E. B. (1997). Principles and practice of planting trees and shrubs (pp. 107-113). Savoy, IL: International Society of Arboriculture.

AEC 3.1 Physical Education, First Aid, Yoga Practices and Meditation 2 (0+2)

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. 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, 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.

SEC III	Skill Enhancement Course (SEC)	2 (0+2)

- Timber Conversion
- Value addition of NTFPs
- Briquetting Technology
- Forest Fire Management
- Activated Carbon Technology
- Wood carving through CNC Technology
- Burlapping Technology
- Micro Forest

- Import and Export of forest Productse-Timber Market
- Community Forest
- Human Animal Ecosystem Interface
- AR/VR Module Creation in Forestry
- Forest Resource Assessment
- Multifunctional Agroforestry
- Biofuels Technology through forestry

Semester IV

FPU 4.1 Commercial Forest Products and Utilization 3 (2+1)

Objectives

1. To develop an understanding on the wood and wood panel related industries
2. To understand the secondary timber species, composite wood products for structural usage, new generation wood composite and improved woods

Theory

Indian Timbers - Growth of wood-based industry in India and its relation to Indian economy – Production of roundwood and engineered wood in global and Indian scenario – National, International trade of important primary timber species – Volume of Import and Export details of wood and wood panels in India – Present status of wood and wood panel industries in India and Global scenario. Description of different forest-based industries – Paper and Pulp, Furniture, Bamboo, Sports Goods, Pencil, Match wood and Splint making and Composite wood industries. Primary conversion: Sawing techniques, kinds of saws – Wood Machining – Wood working tools used in wood working (Parting, Slicing, Shaping, Measuring and marking tools). Various stages in wood working – Wood Joinery – Finger Jointed Lumber – Veneer Production Process – Rotary cutting and Slicing – Types of veneer and their uses – Advantages of the use of veneered panels in wood products – Veneer jointing – Veneer grading – Storage and handling of veneers. Modern technologies for furniture making – Computer Numerical Control (CNC). Production, properties, properties and application of Plywood, Particle board, Sandwich board, Core board, Flake board, Fibre board (LDF, MDF, HDF). Production, properties, properties and application of Glue Laminated Timber (GLT), Structural Composite Lumber (LVL, PSL, LSL). Laminated wood – Multispecies laminates – Types of laminates – Matte finish laminates. Textured laminate, Gloss-finish laminates, Metallic laminate, PVC-finish laminate, Acrylic-finish laminates and Exterior laminates. Laminated wood from bamboo and bamboo laminates. Acoustic panels from laminated wood – Densified laminated panels. Wood adhesives – Types, characteristics and application. Eco friendly wood composites – Lignocellulosic composites – Adhesives for composites – Natural fibres – Wood plastic composites – Reinforced composite structures – Nano based wood composites – Bioactive wood polymer composites, Biotechnological production of wood composites – Wood polymer; Hybrid composite processing. Cross – Laminated Timber (CLT), Wood Plastic Composites (WPCs), Wood Inorganic Composites (WIC) approach. Chemical modification of wood, Thermal modification, acetylation and Furfurylation processes – Nanomaterials – Carbon nanotubes and cellulose nanofibres for wood modification, Impregnation / Polymerisation, microwave modification, Plasma and Laser for wood modification, Enzymatic modification. Scarification of wood – Wood Molasses, alcohol and yeast – Biochar and activated carbon technology

Practical

Visit to saw mill to study primary conversions of wood and Wood working industry for studying basic wood carpentry tools and application - Visit to pulp and paper industry,

furniture industry, industrial plantations, pencil industry, matchwood industry, plywood industry, Briquette making industries and Gasification industries to study the production, manufacturing, grades and training process - Study the production, properties, and application of Particle board, Sandwich board, Core board, Flake board, Fibre board, Glue Laminated Timber, Structural Composite Lumber, Laminated wood, PVC-finish laminate, Acrylic-finish laminates and Exterior laminates. Wood Plastic Composites (WPCs), Wood Inorganic Composites (WIC) approach. Chemical modification of wood - Carbon nanotubes and cellulose nanofibres for wood modification - Scarification of wood - Biochar and activated carbon technology.

Suggested Readings

1. Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd edn. Miller and Freeman Publication, Inc. USA. 388p.
2. FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
3. Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

FRM 4.1 Forest Ecology and Management 3 (2+1)

Objectives

1. Develop basic understanding on ecology and its application in Forest ecology, biodiversity and conservation.
2. Develop a working knowledge on forest ecosystem, productivity and conservation forest bio resources
3. Be able to apply this knowledge base to unknown situations related to forest ecology

Theory

Definitions- interactions of biotic and abiotic components. Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment- major abiotic and biotic components and their interaction, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity. Speciation- sympatric and allopatrty. Population growth models-. Population distribution- Characters of forest communities. Community ecology species interactions. Ecological succession-Definition- terminology, basic concepts, theories of succession- climax vegetation types. Production ecology – primary and secondary production – Paterson's productivity index. Autecology of important tree species. Biodiversity – Definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, World mega biodiversity countries. Biodiversity of Western Ghats and Eastern Ghats. Measurement of diversity and diversity indices. Endemism – categories of endemism Rarity and Extinction of species - threat values of species - categories of existence. Principles of conservation biology, ex-situ and in-situ methods of conservation. Genetic and evolutionary principles in conservation. Sacred groves-concept-uses. Biosphere concept. Conservation – efforts in India and worldwide. - National Biodiversity Authority (NBA) - Salient features of NB Act - Convention on biological diversity (CBD) - Access and benefit sharing (ABS).

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Forest productivity estimation methods through harvest, Leaf area, LAI. Study of succession in field and water bodies; Visit to different ecosystems. Recording light transmission in forest relative to open fields. Estimation of growth and productivity of Plantation/site. Field data processing and Analysis-Calculation of IVI, Diversity indices Assessment of tree volume and carbon sequestration. Visit to ex situ, in situ conservation and Nilgiri biosphere reserve.

Suggested Readings

1. Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p.
2. Kimmins, J.P. 1976. Forest Ecology. MacMillan.
3. Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw- Hill Pub. Co. New Delhi, 404p.
4. Misra, K. C. 1974. Manual of Plant Ecology. Oxford and IBH Pub Co. New Delhi etc. 491p.
5. Montagnini, F. and Jordan, C.F. 2005. Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.
6. Nautiyal, S. and Koul, A.K. 1999. Forest Biodiversity and its Conservation Practices in India. Oriental Enterprise.
7. Odum, E. P. 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p.
8. Saggwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India. 368p.
9. Sharma, P. D. 2013. Ecology and Environment. 11th edn, Rastogi Publications, Meerut.

FPU 4.2 Tree Harvesting and Ergonomics 2 (1+1)

Objective

- To provide an understanding about the tools and implements used for logging mechanism, reduced impact during logging, transportation, grading and storage of felled logs

Theory

Definition, history, objective, and scope of harvesting, harvesting plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction – Phases of harvesting. Tools and Implements used in harvesting operation; traditional and improved tools, axes, saws, types of saws, accessory implements, mechanized felling machines and operations. Felling rules, felling season, felling methods, safety rules Work contracts related to felling and removing (Contract system, convener systems) etc. Conversion, cross cutting, hand and machine sawing, conversion of specialized logs, measurement and description of converted material. Recent trends in timber harvesting. Reduced impact logging (RIL), Concept - scope and objectives – impediments to adoption -

difference between reduced impact logging and conventional logging - Criteria and Indicators - operations and ITTO guidelines - Steps beyond reduced impact logging towards Sustaining timber yield (STY) – Recent developments. Timber logistics; types and means of transport of timber, off and on road transportation; Minor transportation methods carts, dragging, skidding, overhead transport, ropeways, skylines. Major transportation methods, Transport by road and railways. Transport by water; floating, rafting and concept of booms. Grading of timbers - storage and disposal of timber in the depots - Temporary and final storage. Timber Depots; types, layout and management. Protection from plants, animals and insect infestations – Diseases and their prevention. Systems of disposal of timber. Harvesting productivity – Economics of recovery – Cost of production – Constraints and Techniques used in harvest unit. Ergonomics: Definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipment, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Practical

Equipment and tools used in harvesting operations, their uses and their maintenance. Instructions regarding maintenance of various records and registers in harvesting operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipment used and process of conversion. Field exercise on uses of axes (Traditional and improved), saws (Manual and power operated), felling of trees. Field exercise on estimation of felling and conversion waste. Visit to industrial plantation to study the mechanized means of felling and conversion of trees. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to Timber depot to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Visit to Range Office to understand about transit permits for various types of forest produce. Cost of production of timber harvesting. Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of State Forest Department.

Suggested Readings

1. Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.
2. Forest Engineering Technology Program. 1996. Introduction to forest harvesting methods. Vancouver, BC: BCIT.
3. FRI (Forest Research Institute). 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
4. GFC (Guyana Forestry Commission). 2002. Code of practice for timber harvest. 2nd edn. Georgetown, Guayana, 42p.
5. Hakkila, P. 1989. Utilization of residual forest biomass. Springer-Verlag, Berlin. 567p.
6. Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural

Engineering Service, Ithaca, New York. 36p.
7. Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
8. Mehta, T. 1981. A Hand book on forest utilization. IBD, Dehradun
9. Sharma, P.K. 1991. Forest resource and its utilization in India. Mittal Publication, New Delhi
10. Staaf, K.A.G. and Wiksten, N.A. 1984. Tree Harvesting Techniques. DR W. Junk Publishers, Netherlands.
11. Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

FRM 4.2 Forest Policy and Legislation 2 (2+0)

Objective

- To impart knowledge on various policies and acts related to forests

Theory

Necessity of a Forest policy in a country. General basis of formulation, various considerations. National Forest Policies of 1894, 1952 and 1988 their comparative study, basis of their formulation and after effects. Constraints in the implementation of Forest Policy in India. Need based law for implementation of policy. National Forestry Action Program, formulation and constraint in implementation and State Forestry Action Programs. Code of Criminal Procedure, 1973 - Definitions. Position of forest offences - Constitution and powers of Criminal courts and important sections. Code of Civil Procedure 1908 - Summons and discovery. Indian Penal Code, 1860 - Abetment of forest offences - Offences directly connected with forests and its produce and Protection extended by law to Forest Officers. Forest Law: legal definition. Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act. Detailed study of IFA 1927.Forest (Conservation) Act, 1980 and its amendments. The Biological Diversity Act, 2002, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and Environmental Protection Act, 1986. Brief description about other major forest laws of regional, national and international significance. National Green Tribunal.

Suggested Readings

1. Chaturvedi, A.N. 2011. Forest Policy and Law. Khanna Bandhu Publishers, Dehradun.
2. Negi, S.S. 1997. Forest Policy and Law, IBD, Dehradun.
3. Dutta, R. and Yadav, B. 2012. Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India
4. Ernakulam Shetty, B. J. 1985. A Manual of Law for Forest Officers, Sharda Press, Mangalore
5. Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths Wadhwa, Nagpur.

FRM 4.3 Statistical Methods 2 (1+1)

Theory

Basic concepts – statistics – variable – types and sources of data – classification and tabulation of data. Diagrammatic and graphical representation of data – simple, multiple, component and percentage bar diagrams, pie diagram – frequency polygon, frequency curve and histogram. Construction of frequency distribution tables. Measures of central tendency: arithmetic mean, geometric mean, harmonic mean, median and mode – merits and demerits. Measures of dispersion: range, quartile deviation, mean deviation, standard deviation, and coefficient of variation – skewness and kurtosis – merits and demerits. Probability – basic concepts – additive and multiplicative laws (without proof). Probability distributions – Discrete distributions: Binomial and Poisson. Continuous distribution: Normal distribution – definitions and properties. Sampling theory – population – sample – parameter and statistic – sampling distribution – sampling vs complete enumeration – Types of sampling – simple random sampling – selection of simple random sample using random number tables. Null and alternative hypothesis – types of errors – critical region and level of significance – degrees of freedom. Large sample test – single proportion and difference between two proportions – single mean and difference between two means. Small sample tests – F-test – t-test for testing the significance of single mean – independent t test and paired t test – chi square test for goodness of fit – chi square test for testing the association of attributes by m × n contingency table – 2 × 2 contingency table – Yates' correction for continuity. Correlation – Scatter diagram – Karl Pearson's correlation coefficient definition – computation – types of correlation and properties. Regression – simple linear regression – fitting of simple linear regression equation – properties of regression coefficient. Analysis of Variance (ANOVA) – assumptions – one way and two-way classifications. Basic principles of experimental designs – Completely Randomized Design (CRD) – Randomized Block Design (RBD) – Latin Square Design (LSD) – lay out, analysis, merits and demerits of the above-mentioned designs.

Practical

Formation of frequency distribution tables – Diagrammatic and graphical representation. Computation of different measures of central tendency and computation of various measures of dispersion for raw and grouped data – calculation of coefficient of variation (CV) – measures of skewness and kurtosis. Simple problems in Binomial distribution, Poisson and Normal distribution – Selection of simple random sampling. Large sample test for single proportion and difference between two proportions and Large sample test for single mean and difference between two means. t-test for single mean – t-test for testing the significance of two means for independent and paired samples – chi square test for goodness of fit and test for independence of two attributes in a contingency table – Yates correction for continuity – calculation of the correlation coefficient – fitting of simple linear regression equation – One way and two-way ANOVA – completely randomized design (CRD) – randomized block design (RBD) – Latin square design (LSD).

MDC 4.1 Agriculture Marketing and Trade 3 (2+1)

Objectives

1. To understand the fundamentals of agricultural marketing and trade
2. To analyze the factors influencing supply and demand in agricultural markets
3. To explore different marketing channels and strategies in agriculture
4. 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 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 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, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
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.

VAC 4.1 Agriculture Informatics and Artificial Intelligence 3 (2+1)

Objectives

1. To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. 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, handling of tabular data, animation, video tools, art tool, graphics, template and designs. 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. Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation, and management of health information through web. Use of smart phones and other devices in agriculture and human health warning systems. Hands on practice on preparation of decision support system for the above-mentioned aspects.

Suggested readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brother Publication.

SEC IV	*Skill Enhancement Course (SEC-IV)	2 (0+2)

- Wildlife Forensic Sciences
- Dendroenergy Generation
- Big Data Management
- Artificial Intelligence in Forestry Operation
- Specialty Seedling Production
- Woodlot Establishment and Management
- Tools for Consulting Forester's
- Application of Drone in Forestry
- Forest Certification

- Arboriculture
- Forest Project Designing and Analysis
- Wood Mechanics
- Mulberry and Non-mulberry based Silk Production
- Internet of Things (IoT) in Forestry
- Marketing and Economics of NTFPs
- Carbon financing projects

Post-IV semester

FINTS 4.1 Internship (only for exit option for award of UG Diploma) 10 weeks 10 (0+10)

General 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-Diploma, they will be able to get proper engagement/ employment and consider having their own startups.

Specific objectives

By the end of the internship, the students should be able to

1. Integrate theory and practice
2. Assess interests and abilities in their field of study
3. Develop work habits and attitudes necessary for job success
4. Develop communication, interpersonal and other critical skills in the job interview process
5. 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

FBTI 5.1 Tree Physiology 2 (1+1)

Objective

- To impart basic knowledge on various functions and processes related to production, mineral nutrition, plant growth regulators and environmental stresses with reference to forestry.

Theory

Introduction to Tree Physiology and cell organelles - Plasma membrane, chloroplast, mitochondria, peroxisome and vacuole, Structure and role of water - Diffusion, osmosis, imbibition, plasmolysis, water potential and its components, Translocation of water, Ascent of sap, Stomata - Structure and function, Stomatal conductance and resistance, Water relations of forest trees, Transpiration from forest canopies – Evapo-transpiration models - Water use efficiency of forest stands. Criteria of essentiality - Classification of nutrients - Macro nutrients, micro nutrients, beneficial nutrients, Mechanism of nutrient uptake - Physiological functions, deficiencies and disorders of macro nutrients and micro nutrients, Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S. Photosystems, Light reaction - Photolysis of water and photo phosphorylation - Z scheme, Red drop and Emerson enhancement effect, Photosynthetic pathways - C3, C4 and CAM - difference between three pathways - Factors affecting photosynthesis - Photorespiration- pathway and its significance - Phloem transport, Munch hypothesis - Phloem loading and unloading – Glycolysis - TCA cycle- Oxidative phosphorylation. Plant Growth regulators – Classification and biosynthetic pathways, Sun plants and shade plants, shade tolerance, Carbon cycling, Carbon balance and dry matter production in forest trees. Classification of stress - Water stress - Mechanism of drought tolerance and drought resistance - Physiological basis of drought avoidance and tolerance – Temperature stress - Temperature influence on forest development - Low and high temperature- Physiological adaptations for high temperature, Salinity stress - Effects on tree growth tolerance mechanisms.

Practical

Preparation of different types of solutions, Measurement of plant water potential by different methods, Estimation of chlorophyll, Estimation of stomatal index- Determination of leaf area of plants, Estimation of transpiration, Estimation of photosynthetic efficiency, Growth analysis – LAI, CGR, LAD etc., Identification of macro nutrients and micro nutrients deficiencies, Measurement of stress tolerance parameters in trees – soluble protein, membrane stability index, chlorophyll stability index, proline content, wax and cuticle thickness, Demonstration of practical applications of PGRs.

Suggested readings

1. Jain, V.K. 2007. Fundamentals of plant physiology, S, Chand and company Ltd., New Delhi.
2. Luttge, U. 2008. Physiological ecology of trophical plants. Springer – Verlag, Germany

3. Lamber, H. Chapin III. F.S and Pons. T.L. 2008 Plant physiological ecology. 2nd edn, Sprinjer, Newyork, USA.
4. Stephen. G. Pallardy. 2008. Physiology of woody plants. 3rd edn, Elsevier Incl. Academic press.
5. Taiz. L. and Zeiger. E., 2010 (fifth edition). Plant physiology. Publishers: Sinauer Associates, Inc., Masachusetts, USA

SAF 5.1 Plantation Forestry 3 (2+1)

Objective

- To acquire knowledge on intensive silvicultural practices for different forest plantations for obtaining higher utilizable biomass

Theory

Plantation - Definition and scope - aims and objectives of Plantation forestry - Historical perspectives in plantation forestry - Indian and global scenario - Role of plantation forestry in meeting the wood demand- purpose of plantations, factors determining scale and rate of plantation. Plantation sites - Choice of species for plantation – Tree species suitable for different sites - Production technology for quality planting materials – Site selection and site preparation – Mechanization in plantation establishment - Planting program, planting season, planting pattern, spacing, planting method. Post planting activities in plantation - Tending operations – Irrigation and nutrient management in plantation – Plantation health management and sanitary measures – Stand dynamics- Stand density management in plantation – Biology of growth and development in plantation. Energy and Industrial plantations – definition and scope - project formulation - planning in plantation - choice of species and spacing - precision silvicultural techniques - Industrial plantation models - captive and agroforestry models. Plantation for specific purpose - timber - paper and pulp - match wood - ply wood - Plantation for NTFPs. High Density Short Rotation Forestry practices - Plantations as potential Carbon sinks- Carbon credits- Afforestation/ reforestation based CDM projects for climate change mitigation. Harvesting in plantation – harvesting types and patterns based on domestic, industrial, and export requirements – Machineries used in harvesting operations – primary conversion at plantation site – Delimbing, bucking, debarking, stacking, in- situ chipping, and transportation. Coppice silviculture – principle, mechanisms and management. Economics of plantation – Scale of finance of plantations.

Practical

Study the tools and equipment in plantation establishment – Visits to small and large plantations and study their management - Exercise on plantation project planning, evaluation and appraisal. Choice of species for various types of plantations - Quality planting material for plantations - Layout of site and stacking - Planting and after care activities for different types of plantations - Irrigation and fertilizer application techniques for plantation – Fertilizer and irrigation schedule for various tree species – Tending operations - Study of Forest Development Corporation plantations – Plantation maintenance – Plantation records and plantation journal - Economic considerations in plantation: Preparation of scale of finance for

various out growers and plantation schemes - Study of government vs. private plantations.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336.
2. Dwivedi, A.P. 1993. A. Text book of Silviculture, International Book Distributors, Dehra Dun.
3. Luna, R. K. 1989. Plantation Forestry in India. International Book Distributors, Dehradun.
4. Ram Prakash, R. 1998. Plantation and nursery technique of forest trees. International Book Distributors, Dehradun.
5. Evans, J. 1982. Plantation forestry in the tropics: Clarendon Press, Oxford, Oxford Science Publications, Oxford University Press.

FBTI 5.2 Tree Improvement 3 (2+1)

Objective

- To develop a balanced and broad understanding of concepts and techniques related to tree breeding and tree improvement strategies.

Theory

Tree Breeding – Tree Improvement – History and development. Essential of Tree improvement – Tree Breeding – Objectives – Advantages – Disadvantages – Limitations. Terminologies commonly used in tree improvement – Important tree breeding program in the Global and India – ICFRE and State Agricultural Universities. Introduction – Domestication. World collections – Centre of origin of cultivated species. Exotic forest species – Advantages – Problems. Reproductive systems – Devices of pollination control – Anthesis – Pollination – Self-pollination and cross pollination – Variation and its uses. Breeding methods – Introduction – Selection - Mass selection - Pure line selection – Plus tree selection – Comparison tree selection. Hybridization – Mutation – Biotechnology based tree breeding. Hybrid – Hybridization – Genetic consequences – Gene character – Relationship - Segregation – Recombination of genes. Hybrid vigour – Heterosis – Luxuriance. Tree hybrids developed in Global and India – Natural hybrids – Definition – Occurrence – Reasons determination of natural hybrids. Hybrids in trees – Crossing in trees – Problems and perspectives – Crossing hybrids and hybrid breakdown – Hybrid nomenclature in trees – Future of hybrids in applied tree improvement. Mating design – Types – Advantages and disadvantages. Heritability - Genetic gain – Genetic advance – Combining ability – Types – GCA and SCA. Genetic tests – Provenance test – Seed source evaluation test – Progeny test – Clonal test. Experimental design – RBD – Analysis of Genetic test – Genotype and environment interaction. Release of tree varieties – Procedure and Protocol – Released tree varieties of regional and national importance. Varietal registration (PPVFRA) – Definition – Breeder's variety – Famer's variety – Traditional variety – Tribal varieties – Essentially derived varieties. Descriptors – development validation. DUS test – Definition, need and importance. Test guide lines – procedures – Conducting DUS test. Tree DUS testing – Development of descriptors for trees

– DUS test centers. Recent developments in tree DUS testing.

Practical

Selection for different tree improvement programs – Hybridization – Inter and Intra specific - Evaluation. Controlled breeding – Phenotypic and genotypic coefficients of variation. Estimation of genetic advance – Heritability - Combining ability – GCA and SCA. Genetic tests – Provenance test – Seed source evaluation test – Progeny test – Clonal test. Experimental design – RBD – Analysis of Genetic test. Seed orchards – Genetical behavior in seed orchard. Forest genetic resource – Visit to progeny evaluation genotypes. Developing descriptors for varietal registration in trees.

Suggested Readings

1. Bruce Zobel and John Talbert. 1984. Applied Forest Tree Improvement. John Wiley and Sons, New York. pp504.
2. Parthiban, K.T., N. Krishna Kumar and P.S. Devanand. 2020. Tree Breeding and Improvement – Theory and Technology. Scientific Publishers (India), Jodhpur, India (ISBN No.: 978-93- 89412-83-3).
3. Surendran, C., R.N. Sehgal and M. Paramathma. 2003. Forest Tree Breeding. ICAR, New Delhi. P. 204.

FRM 5.1 Forest Resource Management 2 (1+1)

Objective

1. To understand the principles and concepts of basic forest management, normal forest, sustainable forest management
2. To acquire knowledge on methodology of working plan preparation

Theory

Forest Management - Definition and scope - Management of forests and its peculiarities - Forest management for environmental conservation - Forest management for soil and water conservation - Principles of forest management and their application. Objects of management: Purpose and policy, Objectives, Owner's attitude and social role of forestry. Sustained yield - Concept and meaning of sustained yield - Progressive yield - Sustained yield in relation to environmental management. Sustainable forest management-criteria and indicators - Increasing and progressive yields. Rotation-definitions-various types of rotations length of rotations - choice of type and kind of rotation. Normal forest – Definitions - Basic factors of normality. Factors governing the yield and growth of forest stand. Growing Stock - General considerations - Distribution of age gradations or classes in regular forests, irregular forests and coppice systems. Growth estimation and reduction factors for density and Quality and price increment. Yield regulation - General principles of yield calculation - Silvicultural system in relation to yield regulation. Methods of yield regulation – Yield regulation in regular forests - By area, reduced area, Hufnagl's modification and By volume and increment methods. Yield regulation in irregular forests - Methods based on growing stock only, Von Mantel's formula and its modifications, Methods based on volume and increment, Austrian method, Method based on number of trees in various age classes and time taken to pass from

one age class to next, Brandis method, Hufnagl's method and Smithies safeguard formula. Application of different methods of yield regulations in forest management in Indian forestry. Management (Working) Plan - Definition, object, scope, sphere, necessity for revisions - Division of forests into various units – Maps - Management (Working) Plan Code. Preparation of Management (Working) Plan - Preliminary Management Plan report - Field work - Stock mapping - Checking of maps - Compartment description - Collection of statistical data and other data.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Yield regulation in regular forests and irregular forest. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan. Writing preliminary working plan report and actual working plan report of a given area. New proposal for writing fire management plan.

Suggested Readings

1. Balakathiresan, S. 1986. Essentials of forest management. Natraj Publishers. Dehradun.
2. Negi, S.S. 1988. Forest working plan. B.S.M. Pal Singh, Dehradun
3. Ramprakash, 1986. Forest Management. IBD Distributors, Dehradun

FPU 5.1 Non-Timber Forest Products 3 (2+1)

Objective

- To impart knowledge on various Non-Timber Forest Products and their harvesting, processing, value addition, marketing and industries involved in NTFPs production

Theory

Non-Wood Forest Products – Definition, scope and present status, survey, economic importance, classification, distribution, marketing. Role of tribal co-operative societies in NWFPs. Recent trends in NWFP. Gums: Occurrence – Origin – Functions – Kinds – Properties – Tapping methods – Processing – Grading – Storage – Factors affecting gum formation - Commercial valuation – Industrial application. Resins and Oleoresins: Occurrence – Origin – Functions – Kinds – Properties – Tapping methods – Processing – Grading – Storage – Factors affecting resin and oleoresin formation - Commercial valuation – Industrial application. Grasses: types – Species – Uses. Various grasses and their uses in village and cottage industries. Bamboos – Distribution, harvesting and uses, raw material scenario in bamboos. Canes - Distribution, harvesting, processing and uses. Fibres: species – Types – Soft, hard and surface fibres – Extraction and uses. Flosses: Species – Distribution – Collection – Extraction – Uses. Essential oils: Species – Types – Grass oils, wood oils, leaf oils, root oils, flower oils and minor essential oils. Tree Borne Oil seeds (TBOs): Collection – Extraction methods – Uses – Value addition. Tan: – Species – Nature and kinds – Occurrence – Function – Collection – Extraction – Uses – Supply and demand. Dyes: Definition – Species – types – Wood dyes – Bark dyes – Flower and fruit dyes – Leaf dyes –

Extraction and uses. Cutch and katha: Species – Extraction methods – Uses. Rubber: Cultivation, and tapping – Processing - Uses of rubber. Lac: Species – Distribution – Improved method of cultivation – Collection and storage – Uses. Shellac: Cleaning and grading – Properties – Uses. Drugs, spices, wild edible plants part like fruits, flowers, roots, tubers, vegetables, leaves and edible products, poisons and bio-pesticides. Bidi leaves - Leaf fodder - Animal products – Honey and wax, collection, processing, storage, silk.

Practical

Identification of non-wood forest products; Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and tree leaves. Study of canes and bamboos and their sources. Study of essential oils and their sources. Visit to oil extraction unit Study of non-essential oils and their sources. Study of gums and resins and their collection. Study of tans and Visit to tannin industry; Study of dyes and Visit to dye extraction unit and their sources. Study of fibers, flosses and their collection from nearby forests. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, spices, wild edible plants, poisons and bio-pesticides and their collection from nearby forests. Visit to a tribal village involved in collection, processing and sale of NTFP's. Visit to nearby extraction units and NTFP museum. Visit to forest range office and study about the permits issued and collection methods of various NWFPs.

Suggested Readings

1. FRI (Forest Research Institute). (1976) Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehra Dun. 941p.
2. Krishnamurthi T. (1993) Minor forest products of India, Oxford and IBH Publishing Co Pvt. Ltd.
3. Krishnamurthi T. (2010) Minor forest products of India (Non- Timber Forest Products), Second edition. BS Publications.
4. Mehta, T. (1981) A Handbook of Forest Utilization, Periodical Expert Book Agency.
5. Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004) An Omnibus of Non- Timber Forest Products of India, Prashant Gahlot at Valley Offset Printers and Publishers, Dehra Dun.
6. Nair, K.K.N. (2000) Manual of Non-Wood Forest Produce Plants of Kerala, Kerala Forest Department, Government of Kerala, Thiruvananthapuram.
7. Nautiyal, S and Kaul, A.K. (2003) Non –Timber Forest Products of India, Jyothi-Publishers and Distributors, Dehra Dun.

FRM 5.2 Forest Pest and Diseases 3 (2+1)

Objective

- To impart the knowledge on basic concepts and management of pest and diseases in forest trees

Theory

Insects - Insect Body regions - Position of Insect in Animal Kingdom - Reasons for insect dominance - Insect Systematics - major orders- Categories of pest - IPM definition – Economic Threshold Level- Economic Injury Level- Components of IPM - Pest Surveillance

– Forecasting - Pest management - methods - Silvicultural - Mechanical - Physical - Host Plant Resistance - Biological (Parasitoid, Predators, Microbials) - forest (insects) biological chain - Legal – Chemical - Classification of Insecticides - Chlorinated Hydrocarbons- Organophosphates- Carbamates - Botanicals - Newer molecules (Photostable) -IBPM. Nursery Pests - Pests of Major trees and their management - Teak, Sandal, Sal, Ailanthus, Bamboo, Gmelina, Eucalyptus, Tamarind, Casuarina, Melia, Silk Cotton, Neem, Pungam - Termites - Termite pests of timbers - Dampwood termites - Drywood termites - Subterranean termites - Termites Castes and Management. Forest pathology - Definition - importance – History of forest pathology- Losses due to forest tree diseases- Etiology, symptoms, mode of spread and management practices for teak, sal, sandal, Gmelina, Dalbergia, Silver oak, Hardwickia, Eucalyptus, Casuarina, Bamboo, Acacia, Ailanthus, *Melia dubia*, Neem and Pungam, Chir pine and Blue pine. Disease assessment- IDM in forest trees- pathogens affecting timber, sap and pulpwood in storage - timber decay, white fibrous rot, white pocket rot, dry rot, brown rot - Stains - blue - sap stain - factors determining different wood decay - IDM practices for decay and wood preservation techniques.

Practical

Study of External structure of Insect; Type species - Grasshopper / Cockroach. Methods of Insect Collection, preservation, display and storage. Types of insect Head, antenna, mouthparts, Legs and Wings and Modifications. Major Orders Orthoptera, Thysanoptera, Diptera, Hymenoptera, Coleoptera, Hemiptera, Lepidoptera. Assessment of Insect and mite damage in nursery and plantations. Observing the characters and identification of Pests on Teak, Sandal, Bamboo, Eucalyptus, Ailanthus, Melia, Casuarina, Tamarind, and Pungam. Insecticide Formulations, Appliances and Applications. Study the symptoms and microscopic observation, Etiology of the diseases of Teak (*Tectona grandis*), Sal (*Shorea robusta*), Sandal, Gmelina, Dalbergia, Silver oak, Hardwickia, Eucalyptus sp., Casuarina sp., Casuarina, Bamboo sp, Ailanthus sp. and *Melia dubia*, Neem, Pungam, Chir pine, Blue pine. Disease assessment in forest trees. Study of fungi infecting timber, sap and pulp wood in storage, wood staining fungi. Study of wood decay and wood preservation technique.

Suggested Readings

1. FRI (Forest Research Institute). (1976) Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
2. Krishnamurthi T. (1993) Minor forest products of India, Oxford and IBH Publishing Co Pvt. Ltd.
3. Krishnamurthi T. (2010) Minor forest products of India (Non- Timber Forest Products), Second edition. BS Publications
4. Mehta, T. (1981) A Handbook of Forest Utilization, Periodical Expert Book Agency.
5. Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004) An Omnibus of Non- Timber Forest Products of India, Prashant Gahlot at Valley Offset Printers and Publishers, Dehra Dun.
6. Nair, K.K.N. (2000) Manual of Non-Wood Forest Produce Plants of Kerala, Kerala Forest Department, Government of Kerala, Thiruvananthapuram.
7. Nautiyal, S and Kaul, A.K. (2003) Non –Timber Forest Products of India, Jyothi-Publishers and Distributors, Dehra Dun.

FBTI 5.3 Forest Biotechnology 3 (2+1)

Objective

- To educate on the principles, tools, possibilities and progress made in biotechnology

Theory

Basics of Plant Tissue Culture Plant tissue culture: Concepts, history and scope – Components of Media and their role; Sterilization techniques ,Culture Conditions and Factors affecting in vitro cultures; Regeneration methods - morphogenesis, organogenesis and embryogenesis; Techniques in plant tissue culture - Micropropagation, meristem tip culture, another culture, pollen culture, ovule culture, embryo culture, callus culture and suspension culture; Somatic embryogenesis and synthetic seed production; Protoplast isolation, fusion and cybrids applications in crop improvement; Soma clonal variation, types, causes and applications; Secondary metabolite production and in vitro germplasm conservation ; National certification and Quality management of TC plants. Biotechnology- Definition, History and scope. Importance of biotechnology in Crop improvement. Genome organization. Structure of nucleic acids-Concept of gene and gene architecture. Central Dogma of molecular biology. Overview of DNA replication, transcription and translation. Regulation of gene expression. Basic techniques in molecular biology-Blotting techniques- Polymerase chain reaction- DNA sequencing methods. DNA manipulation enzymes: Polymerases, restriction endonucleases and ligases - Different types of vectors: plasmids, phagemids, cosmids, BAC,YAC,PAC, Expression, Shuttle, binary and co-integrate vectors - Construction of recombinant DNA molecules- Bacterial transformation - Direct and indirect gene transfer methods in plants: microinjection, electroporation, particle bombardment, Agrobacterium mediated method - Tissue specific promoters, selectable and scorable markers, reporter genes- Molecular analysis of transgenic plants – Transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality- Detection of GMOs – regulations and biosafety. DNA markers - hybridization based markers (RFLP) - PCR based markers: RAPD, SSR, SCAR, AFLP, STS and SNPs - DNA fingerprinting of crop varieties – Development of mapping populations- linkage and QTL analysis- principles, methods and applications of Marker Assisted Selection in crop improvement; Applications of Plant Genomics and genome databases. Micropropagation in forest trees – successful examples – bamboo, sandal wood, eucalyptus, Paulownia and Melia. Bioprospecting industrially useful compounds from forest trees. Application of genetic engineering in forestry sciences – Molecular markers and its applications in forestry, Lignocellulose degrading microorganisms, Cellulose gene in tree species.

Practical

Biotechnology Laboratory organization - safety regulations-Sterilization techniques for aseptic manipulation-Calculations in Biotechnology and preparation of plant nutrient stock solutions- Preparation of plant nutrient medium -Shoot Tip Culture, Meristem Tip Culture, Anther and embryo culture, Callus culture and suspension culture -Hardening and acclimation of in vitro regenerated plants. Isolation of bacterial plasmid DNA - Agarose Gel Electrophoresis - Gene cloning and Bacterial transformation-Genomic DNA extraction -

Quantification of DNA and quality check- Plant genetic transformation- biolistic and Agrobacterium mediated transformation-DNA amplification using PCR -NTSys- Analysis of Diversity in Crop Plants- Visit to a Plant Biotechnology Lab /Commercial Plant Tissue Culture facility.

Suggested Readings

1. Brown, T. A. 2010. Gene Cloning and DNA Analysis: An Introduction, 6th edn, Wiley-Blackwell Companion site
2. Krebs, J.E, Goldstein, E.S, Kilpatrick, S.T. 2017. Lewin's Genes XII. Jones and Bartlett Publishers, Inc., p.838
3. Malacinski, GM (2015) Freifelder's Essentials of Molecular Biology (4th Student edn) Jones and Bartlett Publishers, Inc.
4. Nelson D.L and M.M. Cox. 2017. Lehninger Principles of Biochemistry, (7th edn) W. H. Freeman and Company, New York, USA. p.1328.
5. George, E. F., Hall, M. A. and De Klerk, G. J. (Eds), Plant propagation by tissue culture. Volume 1. The background. 3rd edn. Springer, 2008, 501 p, ISBN 978-1-4020-5004-6.
6. Stewart, Neal Jr. C. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications John Wiley and Sons, Inc ISBN: 978-0-470-04381-3.
7. Singh, B.D. 2012. Plant Biotechnology. Kalyani publishers, Ludhiana.
8. Tomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. Molecular markers and Plant Biotechnology, New Publishers, New Delhi.

SAF 5.2 Industrial Agroforestry 2 (1+1)

Objective

- To develop skill and expertise on Industrial Agroforestry and associated supply and value chain management

Theory

Forests and Agroforestry – Extent of Area - Current status – National and International scenario – Role of Forests in Industrial sector – Industrial raw material – Demand and supply – Indigenous and exotic industrial resources – Policy and legal issues in industrial wood plantations and agroforestry - Major wood-based industries in India – Timber, pulpwood, plywood, panel. match splints, sports and goods, agricultural implements, construction, body building, ship industry, etc. - raw material requirements and procurements – Industrial important NTFPs – Scope and importance - Promotion of industry-based farm and agroforestry – Strategies for promotional activities. Industrial Agroforestry plantations – Status in India – Preferred species – Plantation management and establishment – Precision silvicultural techniques for Timber, pulp and paper, Match, plywood, dendro power– Propagation and plantation techniques – Pest and disease management for major industrial agroforestry tree species. Harvest operation – Mechanization – Yield potential. Value addition – Utilization of plantation and industrial residues – Briquettes and pellets. Supply Chain - Definition – Concept – Supply chain network – Logistic activities – Marketing system – Marketing type and channel – Price patterns of various agroforestry industrial wood products

– Contract farming - Definition – Concept and methods of contract farming – Contract tree farming systems in India – Experiences of wood-based industries in contract farming – buy back– Corporates in Industrial Agroforestry – International corporate involved in Industrial Agroforestry –Success stories - Corporate social responsibilities – Tree Insurance Scheme (TIS) – Felling regulatory mechanism. Consortium of Industrial Agroforestry – TNAU Model for sustaining industrial agroforestry - Agroforestry business innovations and entrepreneurship development - Agroforestry based business incubation opportunities. Impact of Industrial Agroforestry – Economic and Ecological impacts: Climatic, edaphic and biotic– Carbon sequestration – Carbon storage potential of Industrial Agroforestry and carbon trading mechanism of Industrial Agroforestry – Socio-economic impacts – Rural livelihood improvement and economic return – Environmental impact.

Practical

Study of various wood based industries – Preferred species (State specific) – Timber agroforestry -Pulp and paper based agroforestry– Plywood based agroforestry – Matchwood based agroforestry – Dendro energy agroforestry – NTFPs agroforestry - Plantation management – Harvest and mechanization – Value addition Technology – Contract tree farming – Economics – Bankable project preparation - Visit to wood and non-wood based industries – Exposure to Business opportunities –DPR preparation for industrial agroforestry based business model.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336.
2. Parthiban, K.T., R. Umarani, S. Umesh Kanna, I. Sekar, P. Rajendran and P. Durairasu. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
3. Parthiban, K.T. and R. Seenivasan. 2017. Forestry Technologies- A complete Value Chain Approach. Scientific Publishers, Jodhpur. p 629.
4. Parthiban, K.T. and Keerthika, A. 2020. Textbook on Agroforestry – Principles, practices and Applications. Agrobios, Jodhpur, p256

FST 5.1 Study Tour 2 (0+2) Non-Gradial

- To be conducted for 10-12 days during 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 variability of different places/ states and the social and cultural differences existing in the country.
- After the visit, the students will be submitting a report/ make a presentation.

Semester VI

WLS 6.1 Wildlife and Protected Area Management 3 (2+1)

Objectives

1. To impart basics, functional and technical knowledge to the students on the various aspects of management strategies of the wildlife in natural ecosystem and captive conditions
2. To acquire knowledge on principles and concepts of habitat management help to understand a challenge/opportunity in a given protected area and also to understand the global protected area system

Theory

Foundation and basics of protected area management - History of the IUCN protected area categories - Purpose of the protected area management categories. Global and Indian status of protected area management. Biogeographic regions of India - Wild animal distribution pattern in India- IUCN Red data book. Habitat requirements of animals – Components of Habitat - Wildlife habitat assessment – Standard evaluation procedure (SEP) - Advancing the successional process and Setting back successional process - Management of protected areas (In-situ conservation) - National parks - Sanctuaries – Tiger Reserves – Community reserves – Conservation reserves - Zoning and buffering - Framework for preparing a wildlife management plan. Wildlife census - Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect – Scat analysis – Population viability index (PVI) - Statistical analysis- Software's in wildlife management - Special projects for wildlife conservation – Biotelemetry - Transmitters, receivers, analysis of data, visual tagging and marking- Drone based animal monitoring systems - Role of Camera traps and MSTripES App- Role of Remote Sensing and GIS in Wildlife management. Captive wildlife – Zoos, Biological parks and safari parks - Captive breeding program- Conservation breeding program - Central Zoo Authority of India and its function - Wildlife (Protection) Act, 1972 and its amendments. Role of NGOs in wildlife management. Introduction and reintroduction of species - International conventions MAB, CITES, CMS and CBD. Wildlife corridors -. Human Animal Coexistence- Wildlife Damage - Appraisal, Mitigation measures and Management. Healthcare, Disease Management and Nutrition in Wildlife sanctuaries and National parks, Biosphere reserves and Zoos - Major protected areas of India - Wildlife education - Wildlife tourism.

Practical

Exercise on the census methods - Direct method - Total count, block count, water hole count, capture, mark and recapture method, point transect, and line transect method – Use of software for analysis. Indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife. Study on habitat analysis and evaluation. Studying habitat

management and manipulation techniques. Wildlife damage and mitigation measures: Questionnaire survey. Wildlife photography. Wildlife tourism management.

Suggested Readings

1. Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA. International Zoo Books, Published by New York Zoological Society, New York
2. Krebs, C. and Davis, N. 1978. Introduction to behavioral ecology. Oxford University Press
3. Lever, C. 1985. Naturalised mammals of the world. John Wiley, London
4. Mills, L. S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (2nd edn). Wiley-Blackwell.
5. Nigel Dudley. 2013. Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland.
6. Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.
7. Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun
8. Wildlife Institute of India (2004) Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun
9. Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England.
10. Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

FRM 6.1 Forest Economics and Marketing 2 (1+1)

Objective

- To give exposure to the students on market concepts, marketing of forestry commodities, intermediaries involved, risks in forestry marketing, marketing institutions involved, price dynamics and the role of Government in regulation of markets

Theory

Economics - Definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Forest economics - Definition, characteristics of Forestry sector and its role in economic development. National Income – Definition and concepts: Gross National Product and Gross Domestic Product. Consumption - Utility and its measurement: Cardinal and Ordinal. Theory of consumer behavior – Law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Demand – Law of Demand - Elasticity of demand – Types of elasticity of demand - Importance of elasticity of demand. Engel's law of family expenditure. Consumer surplus. Theory of firm, concept of production, factors of production – Land and its characteristics, labour and division of labour and theories of population. Capital and its characteristics. Enterprises - Factor – Product relationship. Laws of returns – Law of diminishing marginal return – Law of supply – Distribution. Exchange: Marketing – Role of marketing – Marketing functions – Producer surplus – Marketable and Marketed surplus – Marketing channels of forest products – Price spread – Marketing Efficiency – Integration – Market intelligence.

Market equilibrium, Price determination and forecasting under various market structures. Basic guidelines for preparation of project reports – Bank norms and Farm Financial Analysis – Crop Insurance – SWOT analysis – Crisis management. International Trade: Concept of International Trade - Free trade, Autarky and it needs - Absolute and Comparative advantage; present status and prospects of exports / imports - Role of institutions like APEDA, MPEDA, ITTO, UNCTAD and GATT – WTO. Free Trade Agreements – AoA and its implications on Indian agriculture.

Practical

Estimation of consumer's equilibrium – Cardinal and Ordinal Utility Approaches. Plotting and study of demand and supply curves and calculation of elasticities of demand and supply. Study on law of diminishing marginal return. Estimation of Optimal input and Output levels. Estimation of cost of cultivation and cost of production for forest products. Preparation of Bankable projects for forestry products and its value added products. Estimation of farm financial ratios. Computation of marketable and marketed surplus of important commodities, Identification of marketing channel of Agriculture / Horticulture / Forest products – Calculation of Price Spread – Identification of Market Structure – Time series analysis of prices - TCSI. Index number construction and uses. Visit to wood depot/LAMPS/Co-operative marketing society/ Farmers' Markets. Visit to Commercial / Co-operative Bank. Visit to different markets and processing units of Forest products.

Suggested Readings

1. Acharya S.S. and Agarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH Publishers, New Delhi
2. Chadra P. 1984. Projects: Preparation, Appraisal and Implementation, McGraw Hill Inc.
3. Charya SS and Agarwal NL. 2011. Agricultural Marketing in India. Fifth Edition. Oxford and IBH Publishers, New Delhi.
4. Dewett K. K. 2005. Modern Economic Theory. S. Chand and Company, New Delhi.
5. Dewett K. K., Verma. 2004. Elementary Economic Theory, S. Chand, New Delhi.
6. Jhingan M. L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi.
7. Reddy S.S., Raghu Ram P., Neelakanta Sastry T.V. and Bhavani D.I. 2004. Agricultural Economics. Oxford and IBH Publishers, New Delhi.

FRM 6.2 Watershed Planning and Management 2 (1+1)

Objective

- To teach the students on different aspects of hydrology and watershed management and to impart basic knowledge on various measures of soil and water conservation

Theory

Introduction – Hydrology and its importance in forestry. Hydrologic cycle. Precipitation – forms. Rainfall – types. Intensity, duration and frequency. Infiltration, percolation, evaporation, transpiration and evapotranspiration. Runoff - runoff process – factors affecting runoff - prediction and estimation of runoff. Hydrograph – unit hydrograph. Sedimentation and stream gauging. Soil erosion – Principles - types of erosion - geological and accelerated.

Forms of erosion - water erosion - kinds and forms - causes and effects - degree of erosion. Wind erosion – types – saltation, suspension, surface creep. Control of wind erosion - shelter belts and wind breaks. Sand dune stabilization. Land capability classification - recommended land use. Soil and water conservation - historical review – its need. Biological measures – afforestation, contour farming, strip cropping, cropping systems as inter cropping, crop rotation and mixed cropping, mulching and tillage practices. Grassland management. Mechanical measures - Contour bunds, Graded bunds, Bench terracing and Stone wall - Design of structures for soil conservation. Erosion control measures for non-agricultural lands, Soil conservation on Wastelands - contour and staggered trenching. Gully control structures - Temporary and permanent –check dams – types. Spillways – drop and chute spillways, drop inlet. Water Harvesting – definition, methods and techniques - treatment of catchments. Water Harvesting for Trees and Shrubs. Ground water – Aquifer – water harvesting for ground water recharge. Storage structures – Ponds – types. Watershed Management – definitions. Characteristics of watershed - elements and components. Selection of Priority areas - Planning and implementation of watershed programs in forest watersheds. Watershed work plan. Monitoring and evaluation of watershed programs. Remote sensing and GIS in watershed management.

Practical

Computation of mean rainfall – Isohyet and Thiessen polygon methods. Determination of infiltration with double ring infiltrometer. Estimation of runoff. Erosion estimation – Problems on USLE. Design of shelterbelts and windbreaks. Design of contour bunds, stone wall and bench terraces. Design of check dams. Visit to erosion prone and watershed areas. Design of water harvesting systems – roof water harvesting and percolation ponds. Design of micro catchment water harvesting systems for trees. Visit to soil conservation sites and silt monitoring station. Exercises on Demarcation of watershed. Preparation of watershed plan - monitoring and evaluation of watershed programs.

Suggested Readings

1. Das, Ghanshyam. 2009. Hydrology and Soil Conservation Engineering. PHI Publishers, New Delhi.
2. Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
3. Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
4. Oswal, M.C. 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
5. Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
6. Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
7. Suresh, R. 2000. Soil and Water Conservation Engineering. Standard Publishers, New Delhi.

FRM 6.3 Forest Tribology, Ethno-medicine and Extension 3 (2+1)

Objective

- To impart basic knowledge on local indigenous peoples their knowledge on ethno medicines and the extension skills and knowledge with reference to forestry

Theory

Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare. Ethno-medicines of tribals in Southern India. Traditional Botanical Knowledge. Ethno- medicines of the plants from the following families. Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpiniaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae and Thymeliaceae. Introduction-human behaviour and psychology. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Types of education, Formal, informal non-formal education. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programs like RD, OFT, FLD, KVKs – AKIS (Agricultural Information System), ATMA – ICT enable extension services. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Diffusion and adoption process. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group, classification of group.

Practical

Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/Mahila Mandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing). Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards. Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises. Field visit to Different tribal regions to gain ethnobotanical knowledge and the interrelation between plant and people - Survey and identification of plants used by the tribals for medicine, food and other social purposes - Collection and preparation of herbarium specimens of the above plants.

Suggested Readings

1. FAO. 1984. Forestry extension, making it works, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
2. Furer-Haimendorf, C.V. 1985. Tribes of India - the struggle for survival. OUP. New Delhi
3. Hasnain, N. 2007. Tribal India. New Royal Book Company
4. K.A. Jalihal and V. Veerabhadraiah. 2007. Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.
5. L.K. Jha and P. K. Sen Sarma, A.P.H. 2008. A Manual of Forestry Extension Education, Published by VEDAMS, P. 386 p.
6. Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672 p.
7. Sharma, R.N. and Bakshi, S. 1984. Tribes and tribal development. Uppal Publ. House, New Delhi.
8. Sim, D. and Hilmi, H. A.1987. Forestry Extension Methods, FAO Forestry Paper-80, P. 153.
9. Thakur, D. 1986. Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi
10. Vidyarthi, L.P. and Rai, B.K. 1985. The tribal culture of India. Concept Publ. Co., New Delhi.

FRM 6.4 Remote Sensing and GIS 2 (1+1)

Objective

- To inculcate students regarding the concept of Remote sensing and GIS tools in forestry sector

Theory

Definition, scope, history and development of remote sensing; Electromagnetic radiation (EMR) and electromagnetic spectrum; EMR interaction with atmosphere and earth surface; Types of remote sensing; Principles and applications of optical, thermal and microwave remote sensing; Aerial photographs – types, scale, and resolution; Photo interpretation, Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Program. Different concepts of RS. Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery; Forest cover monitoring and Forest fire damage assessment; Microwave remote sensing. Studies of different vegetation indices like NDVI. Wild life assessment. Introduction to GIS - Components of GIS, Hardwares and software's; Differences between GIS and conventional cartography; Spatial and non-spatial data, Integration of attribute data with spatial data. Spatial data - Raster and Vector data. Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection, Topo sheet and Map reading; Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, IRNSS.

Practical

Preparation of base maps, thematic maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping; Digital image processing; Introduction to various GIS and RS software; Exercises in viewing, editing, overlay. Visit to the RS and GIS labs at State level. Using of QGIS Software to prepare different maps.

Suggested Readings

1. Curran, P.J. 1985. Principles of Remote Sensing, Long man Group Ltd., England.
2. Janssen, L.F.2000. Principles of Remote Sensing. ITC. Edl. Text Book Series II. The Netherlands.
3. Rolf A.de by. 2000. Principles of Geographical Information Systems. ITC. Edl. Text Book Series I. The Netherlands.
4. Sabins, F.F.1978. Remote Sensing-Principles and Interpretation. W.H. Freeman and Co. San Francisco.
5. Sharma, M.K.1986. Remote Sensing and Forest Surveys, International Book Distributors, Dehra Dun.
6. Sharma, S. and Dey, S. K. 2021. Entrepreneurship Development and Business Ethics. V.K. Global Pvt. Ltd., New Delhi.

FRM 6.5 Forest Business Management 2 (1+1)

Objective

- To understand the concept of forest business management and steps to start and manage the forest based business

Theory

Management – Definition – Importance of Management – Evolution of Management thoughts - Management functions – Nature of management functions – Management Roles – Functions at various levels of Management – Management skills. Forest Business Management – Definition, Scope, Importance and Characteristics of Forest Business Management -. Special features of Forest Business – Classification of Enterprises-Micro, Small, Medium and Large. Forms of Business Organisations – Sole Proprietorship – Partnership –Private and Public Limited - Business environment – Micro and Macro environment - Startup and Business incubators. Planning – Concept – Nature – Types of Planning – Importance of Planning - Plans-Types of plans –Steps in planning - Organising – Concept of Organising - Departmentation – Basis of Departmentation – Span of control Co-ordination -– Types and Techniques. Staffing – Concept – Human Resource Planning – Process. Recruitment and Selection - Training – Concepts – Methods – Evaluation. Directing – Concept – Principles – Techniques – Supervision. Controlling – Concept – Types. Operations Management – Meaning and Scope, Supply Chain Management – Drivers and flows– Meaning and Principles, Marketing Management – Market Segmentation and Marketing Mix Financial Management – Meaning, Objectives and Scope.

Practical

Assessment of entrepreneurial traits-Identification of new business opportunities-Exercise on SWOC Analysis of Agribusiness Sector in India -Market survey for understanding customer needs- Starting new business - Visit to firms / discussion with entrepreneurs-Documenting Procedure for Establishing Agribusiness Firms-Government programs and institutions for entrepreneurship development-Financing new agribusiness ventures - Visit to banks / discussion-Exercise on Demand Forecasting for Agricultural Inputs/Products - Preparation of Advertisement and Sales Promotion Measures for Agribusiness - Exercise on Inventory Management – ABC Analysis and EOQ Model-Exercise on discounted measures of Capital Budgeting-Calculation of Break Even Point and its Business Implication-Understanding balance sheet and income statement-Financial Performance Analysis - Ratio Analysis.

Suggested Readings

1. Girish B and S S Inamati. Forest Business Management by Shahapurmath. Satish Serial Publishing House
2. Koontz. H and Weihrich, H, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
3. Charles W L Hill and Steven L McShane, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
4. Massie, J.L, 1995, Essentials of Management, Prentice Hall of India Pvt. Ltd., New Delhi. Prasad, L.M, 2005, Principles and Practices of Management, Sultan Chand and Sons Educational Publishers, New Delhi.
5. Rao, V.S.B, and P.S. Narayana, 2004, Principles and Practices of Management, Konark Publishing Pvt. Ltd. New Delhi.

FRM 6.6 Forest Landscape Restoration (FLR) 2 (2+0)

Objective

- To develop students' in-depth understanding of forest landscape restoration through both traditional and modern technology

Theory

Definition, Scope and Objectives of FLR – Role of FLR in national, regional and global commitments – Land Capability Classification and Forest Cover Classification. Need for forest restoration programs. Principles and Guiding Elements. Diverse Knowledge Systems in Forest Landscape Restoration – Social-Ecological Systems and Forest Landscape Restoration - Integrated Landscape Approaches to Forest Restoration. Landscape Ecology - Scope of landscape ecology - Spatial statistics in landscape ecology - Landscape disturbance - Organisms and landscape pattern - Ecosystems processes on landscapes - Land use planning and conservation - Landscape Ecology's contribution to Forest Landscape Restoration. Different Techniques for Forest Restoration – Broad- Scale Traditional Restoration of Landscape techniques – Reforestation with Timber and other woods, Invasive Species Management, Restoring Historic Groundwater Levels and restoration with carbon efficiency

trees. Integration of Traditional and Western Knowledge in Forest Landscape Restoration. Restoration to conserve and increase biodiversity - Achieve Climate Goals - Achieve the Sustainable Development Goal - Spiritual and Social Renewal. Linking forest conservation and food security through agroecology: Insights for Forest Landscape Restoration. Integration for Forest Landscape Restoration Implementation. Stakeholders and Forest Landscape Restoration - Tenure, Property Rights and Forest Landscape Restoration - Polycentric Governance and FLR: Governance process versus governance outcome, Formal and informal governance and Re-scaling, mapping and contextualizing.

Suggested Readings

1. Erbaugh, J. T., and Oldekop, J. A. (2018). Forest landscape restoration for livelihoods and well- being. Current Opinion in Environmental Sustainability, 32, 76-83.
2. Lamb, D., Stanturf, J., and Madsen, P. (2012). What is forest landscape restoration? Forest landscape restoration: integrating natural and social sciences, 3-23.
3. Maginnis, S., Rietbergen-McCracken, J., and Sarre, A. (Eds). (2012). The forest landscape restoration handbook. Routledge.
4. Mansourian, S., Vallauri, D., Dudley, N., Dudley, N., Mansourian, S., and Vallauri, D. (2005). Forest landscape restoration in context. Forest restoration in landscapes: Beyond planting trees, 3-7.
5. Schultz, C. A., Jedd, T., and Beam, R. D. (2012). The Collaborative Forest Landscape Restoration Program: a history and overview of the first projects. Journal of Forestry, 110(7), 381-391.
6. Stanturf, J. A., and Mansourian, S. (2020). Forest landscape restoration: state of play. Royal Society open science, 7(12), 201218.
7. Chaturvedi, R., Duraisami, M., Jayahari, K. M., Kanchana, C. B., Singh, R., Segarin, S., and Rajagopal, P. (2018). Restoration opportunities atlas of India. Washington, DC: World Resources Institute. Retrieved November, 10, 2019.
8. Singh, R., Shelar, K., Chaturvedi, R., Duraisami, M., andGautam, R. S. (2020). Restoring Landscapes in India for Climate and Communities.
9. ITTO. (2020). Guidelines for forest landscape restoration in the tropics. ITTO Policy Development Series No. 24.

FPU 6.1 Forest Biomass Energy and Biofuels 2 (1+1)

Objectives

1. To expose the graduating scholars on the existing challenges in energy sector
2. To create skill and expertise on the need for forest-based bioenergy and biofuel towards creating self-reliance in raw material besides combating the climate change risks and uncertainties

Theory

Energy status in India – demand for electricity –energy generation from various sources- Coal demand and supply-demand for liquid fuels –Petrol and diesel - Need for alternate energy resources – forest biomass and biofuel as an alternate- Government initiatives and policies - National Policy on Biofuels (2018) - National Policy on Biofuels (2018) Amendment, 2022.

Indian scenario – biomass availability - types of biomasses – Agricultural residues - Short Gestation non-edible oil rich crops - Algal feedstock - Non- Edible Oilseeds (TBOs) - Used Cooking Oil (UCO) - Animal tallow – Acid oils - Current challenges and constraints. Forest-based biomass and biofuels. Introduction - scope and potential of dendro energy in India – Dendro biomass: composition, sources, benefits - biomass properties of dendro energy species. Potential dendro energy species – cultivation technology - plantation models – High density energy plantation (HDEP). Harvesting of biomass – hrvesting methods – plantation residues - value addition technology - biomass briquettes, pellets and biocoal. TBOs for biofuels - Introduction and scope - International Scenario - Indian Scenario – Current availability and potential of TBOs-Properties of TBOs - Major TBOs in India – Jatropha curcas, Pongamia pinnata - Azadirachta indica - Calophyllum inophyllum - Madhuca latifolia, Simorouba glauca - Other TBOs – Plantation technologies for major TBOs– Value chain on TBOs – marketing potential of TBOs. Forest biomass - Biomass based power production methods – Pyrolysis - Gasification – Combustion - TBO based biofuels - oil extraction methods - transesterification for biodiesel production -SAF Production process through TBO - Hydroprocessing of Esters and Fatty Acids (HEFA) process – quality characteristics of biodiesel and SAF.

Practical

Dendro energy resources – study of different tree species – short, medium and long duration- QPM Production technology for energy species- Wood and biomass quality characterization – physical and chemical properties - Wood and biomass quality characterization – thermo chemical properties - Study of energy plantation models – block, agroforestry, farmforestry, linear, multi functional, etc - Primary conversion technology for biomass – biomass – converted woods – chips – various sizes and grades – visit to an industry - Study of dendro energy generation technology – pyrolysis, gasification – visit to a gasification unit - Visit to thermal power plants/ biomass combustion plant – study of energy generation through combustion and co-firing process - Study of biofuel crops - TBOs – *Jatropha curcas, Pongamia pinnata* - *Azadirachta indica* - *Calophyllum inophyllum* - *Madhuca latifolia*, *Simorouba glauca* - Nursery production technology for TBOs - Plantation production technology for TBOs - block, agroforestry, farmforestry, linear, multi functional, etc - Study of seed collection, storage and processing of TBOs- Oil quality characterization of various TBOs – laboratory analysis - Visit to oil processing centre – study of oil production and by-products - Study of biodiesel production technology – transesterification and by-products - Study of SAF – properties.

Suggested Readings

1. Adams P, Bridgwater T, Langton L A, Ross A and Watson I. 2018. Biomass Conversion Technologies. Greenhouse Gas Balances of Bioenergy Systems. p134 (ISBN: 9780081010365).
2. Bajpai P. 2020. Biomass to Energy Conversion Technologies -The Road to Commercialization. Elsevier. P 204. (ISBN: 978-0-12-818400-4).
3. Hakem K R, Jawaid M and Rashid U. 2014. Biomass and Bioenergy - Processing and properties. Springer. P343. (ISBN : 978-3-319-07641-6).

4. Pande M and Bhaskarwar A N. 2012. Biomass conversion to Energy - The Interface of Biotechnology, Chemistry and Materials Science. Springer. p.468. (ISBN: 978-3-642-28418-2).
5. Parthiban K.T. and R. Seenivasan. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publisher. Jodhpur. p.629 (ISBN: 978-93-86102-60-7).
6. Parthiban, K. T., Kumar, N. Krishna; Palanikumaran, B.; Kanna, S. Umesh. Dendro biomass resources for solid and liquid fuel generation - Opportunities and challenges. Authors Madras Agricultural Journal, 2020, p30.
7. Paramathma M, Parthiban, K.T. and Neelakantan, K.S. Strategies for improvement and utilization of Tree Borne oil seeds. 2004. Forest College and Research Institute, TNAU, Mettupalayam. p.218.
8. Radhakrishna. P. 2003. Tree Borne oil seeds as a source of energy for decentralised planning. Renewable energy science series XII. Government of India. Ministry of non-conventional energy sources, Regional office, Chennai.
9. Venkata R P and Srinivas S N .1996. Biomass Energy Systems. Tata Energy Research Institute. p345 -87(ISBN: 81-85419-25-6).

SAF 6.1 Trees Outside Forests 2 (2+0)

Objectives

1. To expose students to the growing importance of trees outside forests
2. To make student understand the need of augmenting tree cover towards meeting the domestic and industrial wood requirement
3. To expose students to the existing technologies, models, policies and other government schemes

Theory

Trees Outside Forests (TOF) – introduction –classification-based on Land use – Trees with Settlements- Trees with Agricultural Lands–Trees along Manmade or Natural Features– based on Geometrical Formation - Isolated and scattered trees - Zonal Trees - Methodology of Assessment by FSI - Stratified random sampling design - Multistage stratified sampling design – Status of TOF in India - State wise TOF status and opportunities – demand and supply pattern of wood and non- wood requirements - Government policies to promote TOF – National Forest Policy (1988), National Agroforestry Policy (2014). TOF- Regeneration, restoration and rehabilitation opportunities and methods– Quality Planting Material (QPM)- Principles and criteria - design and development - General Quality Standards for Nurseries and Plants Produced - Hi-tech Nursery - Design and Development – Components and characteristics - Choice of species – utility based – general plantation techniques for prioritized species –Market and industrial linkages – timber and NTFPs –economically important tree species – various models for TOF –Agroforestry – Farm forestry - Linear plantations- windbreaks-shelterbelts -boundary plantations- riverbank plantations - trees on pasture lands- green cities- urban green space – micro forests– Impacts of TOF – contribution to Forest cover - Restoration of degraded lands – ecosystem services – Provisional – Regulating – Cultural – Supporting. Timber products – Global status- National status- Saw

logs and veneer logs- Pulpwood - Ply and panel- Industrial round wood - Non-timber products- Global status and National status- Gums- Resins- Latex – Dammar – Tannins - Fibres- Floss - Market size -Demand and supply - Processing technology- Value addition- Government regulations- Trade channels-Organizations involved -TOF based TBE opportunities – Production – processing – marketing – value addition-based business enterprises – creation of startups – MSMEs – Business incubation. TOF certification - schemes – scope and opportunities – International certification agencies - certification Institution and organization - FSC certification - PEFC certification - Sustainable Forestry initiative (SFI) – Indian Forest and Wood Certification Council (IFWCC) - NCCF - Quality Planting Material – Government Initiatives- Carbon sequestration potential- UNFCC - Kyoto protocol- COP - carbon credit – International and national status - TOF based carbon trading opportunities -Types of carbon markets – Methodology - Benefits to farmers – Circular economy from TOF based products- Significance of TOF in achieving SDGs and NDCs.

TOF related Schemes and Programs - National Bamboo Mission –Submission on Agroforestry- Green highways missions - Mission for integrated development of horticulture -Nagar Van Yojana (NVY) -National Mission for a Green India (GIM) - USAID funded project on TOFI – objectives, activities and partner institution - participating states – innovative platform – tree out growers schemes-NITI Aayog: Greening and Restoration of Wastelands with Agroforestry (G.R.O.W)- National Mission on Oilseeds and Oil Palm (NMOOP): Mini Mission - III (TBOs).

Suggested Readings

1. Parthiban, K.T. and A. Keerthika. 2020. A textbook of Agroforestry: Principles, Practices and Applications. AgroBios (India), Jodhpur. P. 256 (ISBN: 978-81-973776-8-9).
2. Parthiban, K.T. and R. Seenivasan. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publisher. Jodhpur. P.629 (ISBN: 978-93-86102-60-7).
3. Parthiban, K.T., R. Jude Sudhagar, C. Cinthia Fernandaz and K.K. Suresh. 2018. Agroforestry strategies for climate change (Mitigation and adaptation). Jaya Publishing House, New Delhi. P. 395 (ISBN:978-93-86110-53-4).
4. Atyi E and Simmula, M. 2002. Forest certification: pending challenges for tropical timber. Background paper prepared for the ITTO International workshop on comparability and equivalence of forest certification schemes. Kuala Lumpur. April 3-4, 2002.
5. Indian Forest and Wood Certification Scheme – Guidelines. Program for Recognition and Accreditation of Sustainable Management Practices for Agroforestry and Natural Forestry Resources. Ministry of Environment, Forest and Climate Change Government of India. P.76
6. NITI Aayog. Technical Report on Greening and Restoration of Wastelands with Agroforestry. (G.R.O.W). 2024.p.96. (ISBN No. 978-81-956821-3-3)
7. Pandey, D. 2008. Trees Outside the Forest (TOF) resources in India. The International forestry review, vol. 10, no. 2, pp. 125–33. JSTOR, http://www.jstor.org/stable/43740329. Accessed 17 Apr. 2024.
8. Hegde, N.G. 1991. Agroforestry in India: Scope and Strategies. Agroforestry in Asia

and Pacific. RAPA publication:1991/5 Regional Office for Asia and the Pacific. FAO. Bangkok. 47-63 pp.

9. ICFRE (Indian Council of Forestry Research and Education). 2023. Forestry Statistics India 2023. Directorate of Statistics. New Forest. Dehradun. 200 pp.
10. Rudolph S and Aydos E. 2021. Carbon Markets Around the Globe. Sustainability and Political Feasibility. Elgar online. (ISBN: 978-18-391090-8-9).
11. Duraisami M, Singh R and Chalia S. 2022. Roadmap for Scaling Trees outside Forests in India: Learning from select States on Policy Incentives, Enabling Conditions, and Barriers. Working Paper. Mumbai: World Resources India. Available online at https://www.wri.org/research/ roadmap-scaling-trees-outside-forests-india.
12. Parthiban K.T, Subbalakshmi V, Jawahar Vishnu M.V and Dabbas M. 2024. A textbook on Trees outside Forests. Scientific publisher. Jodhpur (In Press).

Semester VII (Elective Courses)

The student will choose one Elective group among the four major disciplines with a total of 20 credits

S. No.	Course category	Credit Hours
1.	Plantation Forestry	20
2.	Multi-Functional Agroforestry	20
3.	High Yielding Short Rotation Forestry	20
4.	Forest Product Development and Utilization	20
5.	Forest Resource Management and Utilization	20
	Total	**20**

Semester VIII

S. No.	Course Title	Credit Hours
1.	Internship/ Project / Students READY Program	20 (0+20)
	Total	**20 (0+20)**

Training attachment in wood-based industry/ forest departments/ Police/ Special Task Force (STF)/ incubation centres/ KVKs or research Institutes/ NGO/ agribusiness entrepreneur, etc. (May be conducted in split manner in more than one industry/ institution/ organization). Ideally it is recommended to have Internship with Forest Department (Administrative Skill) for 5 weeks, Internship with wood-based industries (Technical Skill) for 2 weeks, Internship with Police/ Special Task Force (STF) for Jungle survival for 1 week and Internship with incubation centres/KVKs for 2 weeks. Either project (R and D based, field study based) or entrepreneurship based (incubation/ experiential learning).

ELECTIVE COURSES

Courses under each major discipline

A) EC 7.1 Plantation forestry 20

1. EC 7.1.1 - Commercial tree seedling production (1+2)
2. EC 7.1.2 - Commercial plantation development and management (2+1)
3. EC 7.1.3 - Forest growth modelling (1+1)
4. EC 7.1.4 - Marketing and certification of wood products (1+1)
5. EC 7.1.5 - Restoration of degraded lands (2+1)
6. EC 7.1.6 - Dendro-biomass and energy plantation (2+1)
7. EC 7.1.7 - Plantation and climate change mitigation (2+0)
8. EC 7.1.8 - Plant Biochemistry (1+1)
9. EC 7.1.9 - Research Methodology (1+1)
10. EC 7.1.10 - Statistical Packages for Data Analysis (0+1)
11. EC 7.1.11 - Internship with forest plantations-based institutions/plantation companies (0+2).

EC 7.1.1 Commercial Tree Seedling Production 3 (1+2)

Objective

- To impart knowledge on seed collection, tree seedling production through the natural as well as artificial regeneration techniques

Theory

Introduction and scope for nursery technology. Nursery establishment-site selection – planning, and layout of nursery area. Types of nursery, types of nursery beds, preparation of beds, fumigation. Pre- sowing treatments. Methods of seed sowing and mulching, seed size and position of sowing, seedling growth and development, pricking, watering methods, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Containerised nursery technique – advantages, disadvantages – root deformations- container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages, conditions/practices affecting early survival and early growth. Methods for field handling and planting bare-root stock. Containerised nursery Technique-Type and size of containers. Merits and demerits of containerized nursery. Root trainer techniques Preparation of ingredient mixture. Nursery practices that influence seedling uniformity, diameter/height and size of root system. Stump preparation. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept. Temporary and permanent nursery development- preparation of proposal, layout, economic Considerations-Implementation-Emerging trends in forest tree propagation and nursery technology, VMG: Vegetative multiplication garden.

Practical

Raising of stocks, practicing grafting, budding and layering techniques in tree species-anatomical studies of graft and bud joints – studies on cell differentiation and union-studies on treatment effect and pre curing of scion, growth regulator effect on asexual methods – raising nurseries, practicing seed propagation, taking observations, visit of commercial nurseries. Preparation of production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium, and large sized seeds. Mother bed and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers Study of vegetative techniques-cutting, grafting etc. Visit to tissue culture laboratory and other nurseries Temporary and permanent nursery development preparation of proposal, layout, economic considerations.

Suggested Readings

1. Bewely, J.D. and Black, M. 1985. Seed physiology of development and germination.
2. Bose, T.K., Mitra, S.K. and Sadhu, M.K. 1986 Propagation of tropical and sub-tropical. Crops. Naya Prakash, Calcutta
3. Duryea, M.L. and Landis, T. D. (eds.) 1984. Forest Nursery Manual: Production of Bare root Seedlings. Dr. W. Junk Publishers, The Hague/Boston/Lancaster for Forest Research Laboratory, Oregon State University, Corvallis, 386 p.
4. Evans, J. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Claredon Press.
5. Liegel, L.H. and Venator, R. 1987. A Technical Guide for Forest Nursery Management in the Carribean and Latin America. Gen. Tech. Rep. SO-67, New Orleans, LA: U.S. Department of Agriculture.
6. May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. 1985. Southern Pine Nursery Handbook, USDA Forest Service, Southern Region, Cooperative Forestry Mehta, A.R and Bhatt, P.N. 1990. Hand book of plant tissue and all cultures. Academic book centre, Ahmedabad
7. Napier and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal UK Forestry Research Prakash, R. 1990. Propagation Practices of Important Indian Trees. International Book Distributors, Dehra Dun. Project, Kathmandu Oxford. 472p.

EC 7.1.1 Commercial Tree Seedling Production 3 (1+2)

Objective

- To acquaint students with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations

Theory

Role of plantation forestry in meeting the wood demand - Plantation forestry in India and abroad. Production technology for quality planting stock - preliminary site preparation for establishing plantation - Enrichment of site - Planting program - time of planting - planting pattern - spacing - planting methods. Precision silviculture - concept - advantages of precision

silviculture. Tree management - canopy, root and stem engineering. Fertigation system - drip irrigation management for short and long rotation tree species. Fertilizer management for plantation productivity. Assessment and yield prediction in plantation. Nutrient and irrigation management in plantation, INM, mulching, weed management - Mechanization of plantation operation - Protection and after care of plantation - Pruning and thinning of plantation for quality wood production - Rotation in plantation - Failure of plantations. Management of coppice stand. Industrial Plantation – Importance - Demand and supply scenario in India - Wood based industries - NTFP Plantations - Choice of species and plantation technology - Silvicultural packages for Eucalyptus, Casuarina, Acacias, Silver Oak, Ailanthus, Bamboo, *Melia dubia*, Gmelina, Teak, Sandal and Red sanders. Post- harvest silvicultural techniques. Tools and Implements used in logging operation. Reduced impact logging (RIL), Concept - scope and objectives – impediments to adoption - difference between reduced impact logging and conventional logging. Economics of commercial plantation.

Practical

Plantation planning - Preparation of plantation calendar- Arrangement and preparation of improved planting stock - Planting geometry and calculation of planting stock - Site preparation and planting - Studies on wood-based industries - Plantation geometry - Canopy architecture and management, root pruning and root management, stem management and inter-callery augmentation. Plantation techniques for difficult sites - saline, alkaline soils, rocky area and waterlogged areas and other inhospitable sites. Modern plantation techniques for Eucalyptus, Casuarina, Teak, Acacias and Bamboo plantations - Production technology for energy plantations and NTFP Plantations - Economics of commercial plantation.

Suggested Readings

1. Dwivedi, A.P.1992. Principles and Practices of Indian Silviculture, Surya Publications.420p.
2. Julius, E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
3. Khanna, L.S. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
4. Lamprecht. 1986. Silviculture in the Tropics. Verlag Paul Parey, Hamburg und Berlin.

EC 7.1.3 Forest Growth Modelling 2 (1+1)

Objective

- To impart knowledge on forest growth model for predicting the future of the forest by incorporating the silvicultural treatments

Theory

Model development and validation - Important uses - Indices of competition - Two-sided competition (Distance-independent vs. Distance-dependent) - One-sided competition (Distance- independent vs. Distance-dependent) – Limitations - Low predictive power (Distance-independent vs. distance-dependent) - Influence of sampling design. Whole-stand models - Yield tables and equations - Compatible growth and yield equations - Systems of equations - State-space models - Transition matrix models. Size-class models - Stand table

projection - Matrix models – Diameter (Class models and Cohort models) - Single-tree distance-dependent models - Tree-list distance- independent models. Stand-level mortality – Individual tree-level mortality - Mechanistic models of mortality -Development and application of mortality equations. Genetic improvements (Stand- level and Tree-level) - Early stand treatments (Stand-level and Tree -level) –Thinning (Stand-level and Tree-level) – Fertilization (Stand-level and Tree-level)- Combined thinning and fertilization (Stand-level and Tree-level) – Harvesting (Stand-level and Tree-level).Types of hybrid models - Statistical growth equations with physiologically derived covariate -Statistical growth equations with physiologically derived external modifier - Allometric models -Comparison to statistical models.

Practical

Collection of biometric data for growth model preparation – Sampling design analysis. Whole- stand models - Yield tables and equations. Mortality model and mechanism of model. Modelling silvicultural treatments are Genetic improvements - Early stand treatments – Thinning – Fertilization - Combined thinning and fertilization – Harvesting models. Benefits and uses of working out the growth models.

EC 7.1.4 Marketing and Certification of Wood Products 2 (1+1)

Objective

- To impart knowledge on marketing of the wood products and certification of the forest plantations and wood

Theory

Market, definition, types of markets for timber produce, Economic features of specialized markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in timber, composite wood, pulp wood, match wood. Demand forecasts. Price determination in timber produce. Domestic and International demand and trade in timber products. Market integration and market inefficiencies in timber and measures to check inefficiencies. Role of cooperative societies and NGO's in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. WTO - background, structure, functions and decision-making process. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO). Forest Certification- Definition of forest certification- Origin of certification- process and methods – Advantages and Disadvantages. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Organizations involved in certification. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Program for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests

and forest products of India. Tracing illegal logging. Identification of species and region of origin. Case studies in forest certification.

Practical

Questionnaire preparation for primary data collection; Visit to various wood based (Timber, composite wood, pulp wood, match wood) and non-wood-based industries to study its role in marketing; identification of marketing channel and estimation of price spread for major timber and non-timber forest products; Estimation of marketing efficiency; Analysis of price and quantity data of timber a produce for examining trend, seasonal, cyclical and secular variations. Valuation of timber (Existence value, use and option values, intrinsic value etc).

Suggested Readings

1. Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
2. Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
3. Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.
4. Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.
5. Muraleedharan, P. K., Subramanian, K. K., and Pillai, P. P. 1998. Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p.
6. Tewari, D. N. 1995. Marketing and trade of forest produce; International Book Distributors (Book Sellers and Publishers), Dehradun, India. 140p.

EC 7.1.5 Restoration of Degraded Lands 3 (2+1)

Objective

- To impart practical understanding about rejuvenation of forest with tree vegetation and to develop skills on tacking different problem soils with suitable vegetation

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/ wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation / reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas- explanation, impact on pant growth and Biodrainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programs on degraded

lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development program

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (Eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation program.

Suggested Readings

1. Hegde NG 1987. Handbook of Wasteland Development. BAIF, Pune 102p.
2. ICAR 1977. Desertification and its Control. ICAR, New Delhi 358p. National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix.
3. Imeson A 2012. Desertification, Land Degradation and Sustainability, John Wiley and Sons.
4. Kumar Anil and Pandey R N 1989.Wastelands Management in India. Ashish Publishing House, New Delhi.
5. Luna R K 1989 Plantation Forestry in India, International book distributors, Dehra Dun. Forestry; Ministry of Agriculture and Irrigation, Govt. of India, New Delhi 457p.

EC 7.1.6 Dendro- biomass and Energy Plantation 3 (2+1)

Objective

- To develop skill and expertise among the students regarding the Forest Energy Resources

Theory

Forests and Dendro-energy – Definition and Scope Role of Forests – Forest Energy Potential – Status of Forest Biomass – Applications of forest biomass energy resources – Advantages and Disadvantages of Forest Biomass energy resources. Introduction – Biomass Production – Photosynthetic and energy production– Biomass Composition – (Cellulose, Hemicellulose, Lignin, Starch, Proteins, Mineral Elements, Other components (Organic and inorganic) – Biomass Energy Content – Properties of Forest Biomass – Physical – Thermodynamic and other properties. Energy Trees – Short rotation species – Eucalyptus, Casuarina, Subabul, Prosopis and Bamboos – Medium rotation species – All Acacias – Long rotation species – Energy characteristics of the species – Tree borne oilseeds as a source of biofuel – Dendro energy production technology – Site selection – Choice of species – Plantation establishment– Maintenance of plantation– Protection – Harvesting of biomass – Harvesting Methods – Plantation residues – Types – Utilization and value addition through briquetting — Yield potential of different dendro energy species. Dendro energy models – Farm Forestry – Agroforestry – Captive Plantations – High Density Short Rotation Model (HDSR) – High Density Energy Plantation (HDEP) – Clonal Plantations – Monoclonal and Polyclonal Model – Sporadic model – Linear model – Paired row model– Establishment and management – Economics – Handling of Biomass – Drying biomass material –Drying

techniques – Biomass storage and Transportation – Sustainable Production of woody biomass for energy generation. Introduction– Species selection – Energy species amenable for farm forestry – Types of farm forestry models. CDM approach– CDM benefits through Energy Plantations – Carbon sequestration potential of energy trees. Contract energy farming – Scope and methods – Dendro biomass power plants in India – Scope and potential.

Practical

Study on natural and artificial methods for tree biomass production. Identifying suitable tree species (Short rotation, medium rotation and long rotation species) for energy generation. Estimation of calorific value for Short rotation, medium rotation and long rotation species. Study on energy characteristics of the species. Dendro energy production technology – Site selection – Plantation establishment – Plantation management – Harvesting operation. Biomass estimation in trees by using both destructive and non-destructive methods. Plantation residues for dendro-energy production. Dendro energy models. High Density Short Rotation Model (HDSR) and High Density Energy Plantation (HDEP).

Suggested Readings

1. Divya, M.P., K.T. Parthiban, K. Vanangamudi, K. Srinivasan and M. Govinda Rao. 2008. A text Book on Social Forestry and Agroforestry. Sathish Serial Publishing House, Delhi. ISBN: 81- 89304-48-8. P.315.
2. Luna, R.K. 1989. Plantation Forestry in India. International Book Distributors. Pp. 320 – 338.
3. Khanna, L.S. 1999. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi. ISBN: 81-58-933-01-4. P.473.
4. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajedran P. and Durairasu, P. Industrial Agroforestry Perspectives and Prospectives. Scientific Publishers. Jodhpur. P. 396
5. Parthiban, K.T., Subbulakshmi, V., Umesh Kanna, S., Sekar, I., Rajendran, P., Durairasu, P. and Suresh, G. 2013. Dendro Power Generation - Principles and Applications. FCRI, Publications. P.275.
6. Parthiban, K.T, Paramathma, M. and Neelakantan, K.S. 2006, Clonal forestry, FC&RI publication (ISBN no.81-902081-2-8). P. 209.

EC 7.1.7 Plantation and Climate Change Mitigation 2 (2+0)

Objective

- To understand the scenario of climate change and international treaties on climate change, adaptive silviculture for climate change mitigation, silviculture for conservation of ecosystems

Theory

Global climate change - factors involved greenhouse gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change. Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation,

UNFCCC, IPCC, CoP, LULUCF, REDD++ and CDM. National action plan for climate change - Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plan on Climate Change. Silviculture and sustainability- criteria and indicators for sustainable plantation forestry in India. CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change. Analog forestry for site productivity and carbon value. Disturbance- natural and anthropogenic, short- and long- term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans. Invasive – major invasive species in forests – area affected and methodology for mapping. Eradication methods-management. Restoration of invasive affected areas – types - methods approaches, strategies and opportunities. Silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting. Silviculture Climate resilience - definition - resilient forestry - concept - practices and models - resilient forestry practices for different land use systems - Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Silviculture of old growth stands and sacred grooves- their ecological significance and biodiversity values. Silviculture activities for conserving forest resources. Expanding forest and tree cover area - TOF sector in India. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests.

Suggested Readings

1. Adam Markham (Editor). 2010. Potential Impacts of Climate Change on Tropical Forest Ecosystems. Amazon publishers.
2. Anderson, P, and Palik, B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
3. Bravo, F., LeMay, V., Jandl R. and Gadow, von K. (Eds). 2008. Managing Forest Ecosystems: The Challenge of Climate Change. Springer publication. Pp 324
4. Claussen, Eileen, Cochran, Vicki, Davis, Arroyo and Debra, P. and Pew. 2001. Climate Change: Science, Strategies, and Solutions. Brill Academic Pub. Pp 393
5. Streck, Charlotte, O'Sullivan, Robert, Richard Tarasofsky, G. and Janson-Smith, Toby. 2011. Climate Change and Forests: Emerging Policy and Market Opportunities. Brookings Institution Press.

EC 7.1.8 Plant Biochemistry 2 (1+1)

Objective

- To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols,

glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid- base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver- Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO2 fixation, regulation of photosynthesis. Metabolism of carbohydrates - glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites-Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0- 7167-8724-5.
2. Buchanan, Bob B. Gruissem, Wilhelm and L. Jones, Russell. Biochemistry and Molecular Biology of Plants.
3. Jeremy M., Berg, Lubert Stryer, Tymoczko, John and Gregory Gatto. Biochemistry.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer, David T. An Introduction to Practical Biochemistry.
6. Rao, Beedu Sashidhar, Deshpande, Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam, S and Manickam, A. 2009. Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B., Krishnaveni, S. and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet, Donald and Voet, Judith. Biochemistry.
10. Wilson, K. and Walker, J.M. 2000. Principles and techniques of Practical Biochemistry

EC 7.1.9 Research Methodology 2 (1+1)

Objective

- To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey- based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology - Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data – Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

EC 7.1.10 Statistical Packages for Data Analysis 1 (0+1)

Objective

- To learn the art of data collection, processing, analysis and interpretation will be developed to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank

correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G. (1994). Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

B) EC 7.2 Multi-functional agroforestry 20

1. EC 7.2.1 - Agroforestry system (2+1)
2. EC 7.2.2 - Interactions in Agroforestry Systems (1+1)
3. EC 7.2.3 - Agroforestry and Climate Change Mitigation (2+0)
4. EC 7.2.4 - Industrial agroforestry (2+1)
5. EC 7.2.5 - Ecotourism (2+1)
6. EC 7.2.6 - Dendro-biomass and energy plantation (2+1)
7. EC 7.2.7 - Introduction to Agronomy and Crop Production Technology (2+1)
8. EC 7.1.8 - Plant Biochemistry (1+1)
9. EC 7.1.9 - Research Methodology (1+1)
10. EC 7.1.10 - Statistical Packages for Data Analysis (0+1)
11. EC 7.2.8 - Agroforestry business incubation (1+1)
12. EC 7.1.11 - Internship with agroforestry-based institutions/industries (0+2)

EC 7.2.1 Agroforestry Systems 3 (2+1)

Objectives

1. To impart knowledge on suitable agroforestry practices for different land uses
2. To study their role in ecosystem services
3. To teach recent trends in agroforestry research and development

Theory

Agroforestry - objectives, importance, potential and limitations for implementation. Agroforestry systems - simultaneous and sequential agroforestry systems, Basis for classification of agroforestry systems and principles - Structural, functional, ecological and socio-economic basis of classification - Indigenous vs exotic tree species in agroforestry, intraspecific variations- Tree crown architecture and tree root architecture – silvicultural options to minimize negative interactions- Ideotype concept for selection of multipurpose trees and nitrogen fixing trees. Land use – Land capability classification- Survey and analysis of land use system Description of agroforestry systems viz. agri-silviculture, silvipasture, agro-silvipasture, horti-silvipasture -Description of other systems – silvi-mediculture, silvi-pisciculture, silvi-apiculture, urban agroforestry systems and aqua forestry- Wind break and

shelter belt agroforestry systems – Agroforestry practices for wetlands – Agroforestry practices for garden land - Agroforestry practices for semi-arid and arid lands – Agroforestry practices for coastal and hilly areas - Bio saline agroforestry. Ecosystem services – Provisional services – food, fuel, fodder, fibre, timber and non-timber resources, Regulating services - Agroforestry for soil enrichment-biodiversity conservation - improved air and water quality - Cultural services – Religious, aesthetic, recreation - Supporting services – education, soil and environmental conservation, carbon sequestration, climate change mitigation. Nutrient cycling and nutrient pumping in agroforestry systems -Soil productivity and management in agroforestry - Plant management in Agroforestry – manipulation of trees, population densities and mixture of trees and herbaceous crops – ecosystem structure and function- interactions relevant to agroforestry. Formulation of Agroforestry projects - preparation of bankable projects, economic analysis of various agroforestry systems - Budget and other constraints - Financial and socio-economic analysis of agroforestry projects - Role of time in decision making- social and private discount rate - Role of risk and uncertainty in decision making- Participatory Rural Appraisal (PRA) -Rapid Rural Appraisal (RRA) tools for Agroforestry problem diagnosis.

Practical

Studies on global agroforestry systems - Designing agroforestry practices for wet lands - garden lands - dry lands -coastal and hilly areas - multitier systems - light intensity and shade effect under agroforestry systems-quantifying tree-crop interaction by LER method allelopathic studies- case studies on role of agroforestry in carbon sequestration, biodiversity conservation and air and water quality-Agroforestry D &D exercise - Preparation of bankable projects - financial and economic appraisal - Profitability analysis of various agroforestry systems.

Suggested Readings

1. Divya, M.P., Parthiban, K.T., Srinivasan, K., Vanangamudi, K. and M. Govinda Rao. 2008. A Textbook on Social Forestry and Agroforestry. Satish Publishers, Delhi, 315p.
2. Janaki, R. R., Alavalapati and Mercer, D. Evan (Eds). 2005.Valuing Agroforestry Systems, Methods and Applications. Advances in Agroforestry, Vol. 2, Kluwer Academic Publishers.314p.
3. Jose, S. 2009. Agroforestry for Ecosystem Services and Environmental Benefits. Springer Science, The Netherlands. 266p.
4. Nair, P.K.R.1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, 499.
5. Kumar, B.M and Nair, P.K.R. 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry, Vol-8, Springer Science, The Netherlands p307.
6. Ong, C. K. and Huxley, P.K. 1996. Tree Crop Interactions -A Physiological Approach. ICRAF.
7. Parthiban, K.T. Ramah, K., Sivakumar, K and Rao G.R. 2019. Multifunctional Agroforestry Volume – I &II. Jaya Publishing House, New Delhi.
8. Parthiban, K. T. and Keerthika, A. 2021. A Text book of Agroforestry – Principles,

Practices and Applications, Agrobios, Jodhpur.
9. Puri, Sunil and Panwar, Pankaj. 2007. Agroforestry systems and practices. New India Publishing Agency, New Delhi, 641p.
10. Raj, Antony Joesph and Lal, S. B. 2014. Agroforestry- Theory and Practices, Scientific Publishers (India), New Delhi.

EC 7.2.2 Interactions in Agroforestry Systems 2 (1+1)

Objective

- To make students understand the concepts of tree- crop interactions, their quantification and techniques to neutralize the negative interactions

Theory

Agroforestry –general principles of plant productivity – photosynthesis – respiration – plant productivity – manipulation of photosynthesis in Agroforestry – multipurpose tree species - fodder trees – fuel wood trees – fruit trees – industrial wood species – other woody perennials – herbaceous species. Tree-crop interface – factors influencing tree – crop interaction- types of tree –crop interactions based on effect, association and output, position – positive interactions – competition, complementarity in resource sharing – above ground and below ground interaction. Negative interaction – competition, allelopathy – characteristics of tree species and crops – Allelochemicals - source of allelochemicals - process and leaching of allelochemicals - Tree management – manipulation of densities and arrangement of trees – Tree crown and root manipulation - Animal-tree-crop interaction. Method for quantifying interactions, principles of resource capture and utilization of light and water, nutrition and space. Tree-soil-crop interactions- nitrogen fixing trees interactions in agroforestry systems – Use of radioisotopes in tree-crop interaction studies - Root distribution of trees and crops. Management options to neutralize negative interactions – tree husbandry practices for alleviating competition – thinning, pruning, pollarding, lopping, hedging etc. – management of light interception.

Practical

Different methods for quantifying interactions- Studies on allelopathy - Laboratory bioassay with tree /crop parts and rhizosphere soil - different plant mixtures and estimating tree-soil-crop interactions - Working out indices for evaluating agroforestry systems - Measurement and interpretation of light interception in agroforestry system - Interpretation of yield responses to shelter, soil water and drainage measurement - transpiration measurement, quantifying root distribution.

Suggested Readings

1. Avery, M.A. Cannel, M.G.R. and Ong, C.K. 2005. Biophysical Research for Asian Agroforestry. Oxford and IBH Publishing Co. Pvt. Ltd
2. Dagar, J.C. and Tewari, J.C. 2016. Agroforestry Research Developments.
3. Parthiban, K.T. and Keerthika, A. 2021. A Text book of Agroforestry – Principles, Practices and Applications, Agrobios, Jodhpur.
4. Raj, Antony Joesph and Lal, S.B. 2014. Agroforestry- Theory and Practices, Scientific

Publishers (India), New Delhi.

EC 7.2.3 Agroforestry and Climate Change Mitigation 2 (2+0)

Objective

- To develop understanding of students about ecosystem services, environmental benefits and quantification of ecosystem services along with their valuation.

Theory

Global CO_2 emission and patterns of climate variability - Multifunctionality of Agroforestry - Major ecosystem services, environmental benefits and international conventions, charters on climate change (UNFCCC, UNCCD, Agroforestry and Kyoto protocol – genesis, goals, signatories and latest developments - climate change negotiations (CoP), Reduced Emissions from Deforestation and Degradation (REDD) and biodiversity conservation (CBD) – an overview. Agroforestry for carbon conservation, sequestration, substitution – role and potential of various agroforestry systems - Estimates of carbon sequestration potential – measurement – Aspects and criticisms, Factors affecting above and belowground carbon sequestration potential. Agroforestry for soil enrichment – mechanisms – litter and fine root dynamics, rhizo-deposition and other rhizosphere effects, symbiotic and free-living N2 fixation, mycorrhizal associations - Soil and water conservation benefits through agroforestry. Agroforestry for biodiversity conservation - Synergy with climate change mitigation - Landscape connectivity for wildlife, supporting the pollinators of plant species - Agroforestry for improved air and water quality - Non-point source pollution in Indian agro-ecosystems - Riparian buffers for alleviating agricultural non-point source pollution – Pollution reduction measures in forestry. Private profitability vs. social profitability - exclusion or inclusion of social benefits and costs and non-market values, or externalities - Theory of externalities, effect of environmental costs and benefits on the profitability of agroforestry practices - Valuing environmental services - Profitability of timber, pulp wood, ply wood and match wood-based agroforestry systems - Costs and benefits in agroforestry- valuation of inputs and outputs- environmental outputs.

Suggested Readings

1. Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. Agroforestry development: Anenvironmental Economic Perspective. Agroforestry Systems. 61: 299–310.
2. Huxley P. 1999. Tropical Agroforestry. Blackwell.
3. IPCC. 2007. Climate Change 2007. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
4. Jain SK and Singh P. 2000. Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) In Uttar Pradesh (India). Agroforestry Systems. 49: 255–273.
5. Jeffers JNR. 1978. An Introduction to System Analysis with Ecological Application. Edward Arnold.
6. Jose S. 2009. Agroforestry for Ecosystem Services and Environmental Benefits: An Overview. Agroforestry Systems. 76: 1-10.

7. Lyngbaek AE, Muschler RG and Sinclair FL. 2001. Productivity and Profitability for Multistrata.
8. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer, Netherlands.
9. Organic Versus Conventional Coffee Farms in Costa Rica. Agroforest. Syst. 53: 205–213.
10. Schroth G and Sinclair F. 2003. Tree Crops and Soil Fertility: Concepts and Research Methods, CABI, Wallingford, UK.
11. Young A. 1997. Agroforestry for Soil Management. 2nd edn. CABI, Wallingofrd, UK.

EC 7.2.4 Industrial Agroforestry 3 (2+1)

Objective

- To develop skill and expertise on Industrial Agroforestry and associated supply and value chain management

Theory

Forests and Agroforestry – Extent of Area - Current status – National and International scenario – Role of Forests in Industrial sector – Industrial raw material – Demand and supply – Indigenous and exotic industrial resources – Policy and legal issues in industrial wood plantations and agroforestry - Major wood-based industries in India – Timber, pulpwood, plywood, panel. match splints, sports and goods, agricultural implements, construction, body building, ship industry, etc. - raw material requirements and procurements – Industrial important NTFPs – Scope and importance - Promotion of industry-based farm and agroforestry – Strategies for promotional activities. Industrial Agroforestry plantations – Status in India – Preferred species – Plantation management and establishment – Precision silvicultural techniques for Timber, pulp and paper, Match, plywood, dendro power– Propagation and plantation techniques – Pest and disease management for major industrial agroforestry tree species. Harvest operation – Mechanization – Yield potential. Value addition – Utilization of plantation and industrial residues – Briquettes and pellets. Supply Chain - Definition – Concept – Supply chain network – Logistic activities – Marketing system – Marketing type and channel – Price patterns of various agroforestry industrial wood products – Contract farming - Definition – Concept and methods of contract farming – Contract tree farming systems in India – Experiences of wood based industries in contract farming – buy back– Corporates in Industrial Agroforestry – International corporate involved in Industrial Agroforestry –Success stories - Corporate social responsibilities – Tree Insurance Scheme (TIS) – Felling regulatory mechanism. Consortium of Industrial Agroforestry – TNAU Model for sustaining industrial agroforestry - Agroforestry business innovations and entrepreneurship development - Agroforestry based business incubation opportunities. Impact of Industrial Agroforestry – Economic and Ecological impacts: Climatic, edaphic and biotic– Carbon sequestration – Carbon storage potential of Industrial Agroforestry and carbon trading mechanism of Industrial Agroforestry – Socio-economic impacts – Rural livelihood improvement and economic return – Environmental impact.

Practical

Study of various wood based industries – Preferred species (State specific) – Timber agroforestry -Pulp and paper based agroforestry– Plywood based agroforestry – Matchwood based agroforestry – Dendro energy agroforestry – NTFPs agroforestry - Plantation management – Harvest and mechanization – Value addition Technology – Contract tree farming – Economics – Bankable project preparation - Visit to wood and non-wood based industries – Exposure to Business opportunities –DPR preparation for industrial agroforestry based business model.

Suggested Readings

1. Balasubramanian, A., Hari Prasath, C.N., Radhakrishnan, S. 2020. Textbook on Plantation Forestry. Jain Publication, New Delhi, p336
2. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajendran, P. and Durairasu, P. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
3. Parthiban, K.T. and Seenivasan, R. 2017. Forestry Technologies- A Complete Value Chain Approach. Scientific Publishers. Jodhpur. p 629.
4. Parthiban, K.T. and Keerthika, A. 2020. Textbook on Agroforestry – Principles, practices and Applications. Agrobios, Jodhpur, p256.

EC 7.2.5 Ecotourism 3 (2+1)

Objective

To develop knowledge, understanding, and appreciation of environmentally responsible travel to relatively undisturbed natural areas that promote biodiversity conservation, has low negative visitor impact, and provide socio-economic benefits to the local stakeholder communities

Theory

Ecotourism – Definition - History of tourism and evolution of ecotourism. Various forms of tourism - Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism. Organised tours and Free Independent Traveller – World Tourism Organization. Concept of ecotourism and flaws in real world. Problems with definition of ecotourism and criticisms. Dimensions of ecotourism and the criteria to qualify for ecotourism. Declaration – Different forms of ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Ecotourism-its potential in developing countries- Poverty and biodiversity, Ecotourism as a rural development strategy in tropical countries use- possibilities of integration – Ecotourism policies at national and local level. Environmental Impacts of ecotourism and its mitigation - Case studies from different parts of the world- Concept of "scale". The checks and controls and institutional mechanisms for controlling the environmental impacts, Mitigation of pollution. Social Impacts of ecotourism and precautionary principles to avoid ill effects Stories from different parts of the world narrating ecotourism development and its influence

on society and their culture – The societal advantages and the negative impacts of ecotourism development – Ways forward to address the negative social impacts Indigenous people and ecotourism. Ecotourism economics and business – Investment of international agencies like World Bank in ecotourism projects Ecotourism economics at macro and micro economic level in developing countries Ecotourism as a green business and role of green consumerism – Business plans- unique selling points for marketing – Potential of internet in marketing ecotourism – Payments for Environmental services and role of ecotourism Multiplier effects, opportunity costs and leakage in ecotourism industry Sharing ecotourism revenues among stakeholders – Training in ecotourism to deliver quality service. Ecotourism as a vehicle for the conservation of common property resources – potentials and pitfalls, Dangers involved in management of common property resources Relations between the government and the private sector. Ecotourism and Protected Areas Changing paradigms in the Protected Area Management Support at international level for ecotourism Integrated Conservation Development Projects (ICDPS) and role of ecotourism Community based ecotourism programs. Planning and management of ecotourism – Ecotourism plans and management of visitors and other resources including human and natural resources – Quality control, codes of conduct etc. Use of GIS and ICT for effectively managing and planning ecotourism – Criteria and indicators for sustainable management and monitoring – Charter for Sustainable Tourism – Sustainability issues in ecotourism management and ecotourism certification. Ecotourism design – Role of socio-economic factors in decision making – Designing ecotourism products using local technologies – Carrying capacity considerations. – Use of GIS in ecotourism. Ecotourism markets and influences of climate change Existing ecotourism markets and ecotourism market segmentation – Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets.

Practical

Preparation of a thematic compendium after extensive and original independent investigation about the chosen Protected Area. Be familiar with Government policy and legislation, the current policies regarding the component land uses of the study site. Stakeholder analysis and social Impacts Assessment. Identify different stakeholders at different levels. Based on this perform a stakeholder analysis and then conduct social surveys to gather the information required for assessing the impacts of current management and to explore the intervention needed in the chosen protected area. Ecological surveys including Environmental Impact Assessment. Assess the ecological impacts of current human use using standard techniques in order to identify the intervention needed in the chosen protected area.

Suggested Readings

1. Bhatt, S. and Liyakhat, S. 2014. Ecotourism Development in India: Communities, Capital and Conservation
2. Lindberg, K., Wood, M. E. and Engeldrum, D. 1998. Ecotourism- A guide for planners and managers (Environment and Development). Foundation Books
3. Page, S. J. and Dowling, R. K. 2002. Ecotourism. Pearson Education Limited, Essex. The Ecotourism Society, Vermont.
4. Weaver, D. 2002. Ecotourism. Milton, Queensland, Australia: John Wiley and Sons

Australia.

EC 7.2.6 Dendro- biomass and Energy Plantation 3 (2+1)

Objective

- To develop skill and expertise among the students regarding the Forest Energy Resources

Theory

Forests and Dendro-energy – Definition and Scope Role of Forests – Forest Energy Potential – Status of Forest Biomass – Applications of forest biomass energy resources – Advantages and Disadvantages of Forest Biomass energy resources. Introduction – Biomass Production – Photosynthetic and energy production– Biomass Composition – (Cellulose, Hemicellulose, Lignin, Starch, Proteins, Mineral Elements, Other components (Organic and inorganic) – Biomass Energy Content – Properties of Forest Biomass – Physical – Thermodynamic and other properties. Energy Trees – Short rotation species – Eucalyptus, Casuarina, Subabul, Prosopis and Bamboos – Medium rotation species – All Acacias – Long rotation species – Energy characteristics of the species – Tree borne oilseeds as a source of biofuel – Dendro energy production technology – Site selection – Choice of species – Plantation establishment– Maintenance of plantation– Protection – Harvesting of biomass – Harvesting Methods – Plantation residues – Types – Utilization and value addition through briquetting — Yield potential of different dendro energy species. Dendro energy models – Farm Forestry – Agroforestry – Captive Plantations – High Density Short Rotation Model (HDSR) – High Density Energy Plantation (HDEP) – Clonal Plantations – Monoclonal and Polyclonal Model – Sporadic model – Linear model – Paired row model– Establishment and management – Economics – Handling of Biomass – Drying biomass material –Drying techniques – Biomass storage and Transportation – Sustainable Production of woody biomass for energy generation. Introduction– Species selection – Energy species amenable for agroforestry – Types of agroforestry models– Silvi agriculture – Silvi pastoral based energy farming– Alley cropping– CDM approach– CDM benefits through Energy Plantations – Carbon sequestration potential of energy trees. – Contract energy farming – Scope and methods – Dendro biomass power plants in India – Scope and potential.

Practical

Study on natural and artificial methods for tree biomass production. Identifying suitable tree species (Short rotation, medium rotation and long rotation species) for energy generation. Estimation of calorific value for Short rotation, medium rotation and long rotation species. Study on energy characteristics of the species. Dendro energy production technology – Site selection – Plantation establishment – Plantation management – Harvesting operation. Biomass estimation in trees by using both destructive and non-destructive methods. Plantation residues for dendro-energy production. Dendro energy models. High Density Short Rotation Model (HDSR) and High-Density Energy Plantation (HDEP).

Suggested Readings

1. Luna, R.K. 1989. Plantation Forestry in India. International Book Distributors. Pp. 320

– 338.
2. Divya M.P., Parthiban, K.T., Vanangamudi, K., Srinivasan, K. and Rao, M. Govinda. 2008. A text Book on Social Forestry and Agroforestry. Sathish Serial Publishing House, Delhi. ISBN: 81-89304-48-8. P.315.
3. Khanna, L.S. 1999. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi. ISBN: 81-58-933-01-4. P.473.
4. Parthiban, K.T., Umarani, R., Umesh Kanna, S., Sekar, I., Rajendran, P. and Durairasu, P. 2014. Industrial Agroforestry: Perspective and Prospective. Scientific Publishers, Jodhpur, India. Pp:396.
5. Parthiban, K.T, Subbulakshmi, V., Umesh Kanna, S., Sekar, I., Rajendran, P., Durairasu, P. and Suresh, G. 2013. Dendro Power Generation - Principles and Applications. FCRI, Publications. P.275.
6. Parthiban, K.T., Paramathma, M. and Neelakantan, K.S. 2006, Clonal forestry, FC&RI publication (ISBN no.81-902081-2-8). P. 209.

EC 7.2.7 Introduction to Agronomy and Crop Production Technology 3 (2+1)

Objective

- To impart the basic and fundamental knowledge of Agronomy

Theory

Agronomy and its scope: Definition, Meaning and scope of Agronomy; Art, science and business of crop production, relation of Agronomy with other disciplines of Agricultural Science, Fields crops and classification, importance, ecology and ecosystem, Seeds and sowing: Definitions of crops, variety and seed. Factors affecting crop stands establishment: good quality seed, proper tillage, time of sowing seed rate, depth and method of sowing: broadcasting, drilling, dibbling, transplanting etc. Tillage and tilth: Definition, objectives, types, advantages and disadvantages of tillage including conservation tillage. Crop density and geometry: plant geometry and planting geometry, its effect on growth, yield Crop nutrition: Definition of essential nutrients, criteria of essentiality, functional elements, classification of essential nutrients, role of macro and micro nutrients. Nutrient absorption, active and passive absorption of nutrients, forms of plant nutrients absorbed by plants, Combined / un-combined forms Manures and fertilizers, nutrient use efficiency: Sources of nutrients: Inorganic (fertilizers), organic (manures) and bio-fertilizers; their classification and characteristics, method of preparation and role of organic manures in crop production Integrated Nutrient Management: Meaning, different approaches and advantages of INM Green manure- role in crop production: Definition, objectives types of green manuring, desirable characteristics, advantages and limitations of green manuring , Water management: Water resources of the world, India and the state; Soil Moisture Constants –gravitational water, capillary water, hygroscopic water, Soil moisture constants, Concept of water availability to plants, soil plant-water relationship, crop water requirement, water use efficiency, Methods of irrigation : Scheduling of irrigation, different approaches of scheduling irrigation Weeds: Definition, Importance and basics of classification of weeds and their control Cropping systems: Factors affecting cropping systems, major cropping patterns and

systems in the country. Sustainable crop production: Definition, importance and practices, natural resources and conservation pollution and pollutants, Allelopathy: Meaning and importance in crop production, Growth and development of crops: Definition, Meaning and factors affecting growth and development.

Practical

A visit to Instructional Crop farm and study on field crops, Identification of crops, seeds, fertilizers, pesticides, Crops and cropping systems in different Agro-climatic zones of the state, Study of some preparatory tillage implements, Study of inter tillage implements, Practice of ploughing / puddling, Study and practice of inter cultivation in field crops, Numerical exercises on calculation of seed, plant population and fertilizer requirement, Study of yield contributing characters and yield estimation of crops, Identification of weeds in different crops, Seed germination and viability test of seed, Practice on time and method of application of manures and fertilizers, Measurement of soil moisture by gravimetric and volumetric method and bulk density,

Suggested readings

1. Donn, William L. 1965. Meteorology. McGraw-Hill Book Co. New York.
2. Rao V S. 1992. Principles of Weed Science. Oxford and IBH Publishing Co. Ltd. New Delhi.
3. Reddy Yellamanda T and Shankar Reddy G H. 1995. Principles of Agronomy. Kalyani Publishers 6. Ludhiana.
4. Reddy S R. 2008. Principle of Crop Production. Kalyani Publisher, Ludhiana.
5. Yawalkar K S and Agarwal J P. 1977. Manures and Fertilizers. Agricultural Horticultural Publishing House, 3. Nagpur. 90.

EC 7.1.8 Plant Biochemistry 2 (1+1)

Objective

- To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid- base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver- Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive

and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO_2 fixation, regulation of photosynthesis. Metabolism of carbohydrates - glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites- Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L (2007) Biochemistry. 7th edn. Wiley Eastern Ltd. ISBN:0- 7167-8724-5.
2. Berg Jeremy M., Stryer Lubert, Tymoczko John and Gatto Gregory. Biochemistry.
3. Buchanan Bob B, Gruissem Wilhelm and Jones, Russell L.. Biochemistry and Molecular Biology of Plants.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer David T. An Introduction to Practical Biochemistry.
6. Rao Beedu Sashidhar and Deshpande Vijay Experimental Biochemistry: A student companion.
7. Sadasivam S and Manickam A (2009), Biochemical Methods, 3rd edn, New Age International.
8. Thayumanavan B, Krishnaveni S and Parvathi K (2004), Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet Donald and Voet Judith. Biochemistry.
10. Wilson K and Walker J M (2000), Principles and techniques of Practical Biochemistry.

EC 7.1.9 Research Methodology 2 (1+1)

Objective

- To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey- based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection,

analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools. Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research – Interview studies in Research methodology - Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data -Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

EC 7.1.10 Statistical Packages for Data Analysis 1 (0+1)

Objective

- The art of data collection, processing, analysis and interpretation will be developed to the translate simple data in to scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Jayaraman, K. and Rugmini, P. 1990. Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.
2. Nigam, A.K. and Gupta, V.K.1979. Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
3. Panse, V. G. and Sukhatme, P.V. 1967. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
4. Petersen Roger G. 1994. Agricultural Field Experiments: Design and Analysis. Marcel

Dekker, New York.

C) EC 7.3 High Yielding Short Rotation (HYSR) Forestry 20

1. EC 7.3.1 - Applied Tree Improvement (2+1)
2. EC 7.3.2 - Reproduction Biology of Tree Crops (2+1)
3. EC 7.3.3 - Biometrical Genetics in Tree Breeding (1+1)
4. EC 7.3.4 - Marker Assisted Breeding in Forestry (2+1)
5. EC 7.3.5 - Tissue Culture Application in Forestry (1+2)
6. EC 7.3.6 - Controlled Breeding in Tree Crops (0+2)
7. EC 7.3.7 - Tree Seed Orchards (2+1)
8. EC 7.3.8 - Forest Genetic Resources (2+0)
9. EC 7.3.9 - Clonal Forestry (1+1)
10. EC 7.1.8 - Plant Biochemistry (1+1)
11. EC 7.1.9 - Research Methodology (1+1)
12. EC 7.1.10 - Statistical Packages for Data Analysis (0+1)
13. EC 7.1.11 - Internship with Tree Breeding and Biotechnology-Based Institutions/Industries (0+2)

EC 7.3.1 Applied Tree Improvement 3 (2+1)

Objectives

1. To impart applications of principles of tree breeding and improvement to the students
2. To breed new varieties with increased productivity to cater needs of user agencies

Theory

General concept of tree breeding, tree improvement and forest genetics – History of tree improvement – Reproduction in forest trees - Mode of Reproduction – Significance – Pollination – Types of pollination – Pollination mechanism - Pollination in cross pollinated and self-pollinated tree species. Pollen dispersion distances, pollinators and their energetics. Pollen handling - Forced flowering for seed orchard manipulation. Variation in trees, importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races – Selective breeding methods. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding for forest trees. Indirect selection for biotic and abiotic stresses. Wood and tree improvement – wood properties and their genetic relationships. Progeny selection and clonal selection – Concepts – scope – limitations. Progeny and clonal testing. Estimating genetic parameters and genetic gain breeding values. Average performance of half sibs and full-sibs. GxE interaction in trees. Seed orchards – type, functions and importance. Exotic forestry and tree breeding - gains and risks - donor and receptor countries - genetic improvement of exotics. Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Natural and artificial hybrids - Indian examples – Teak, sal, shisham, eucalypts, acacias, pines and poplars. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Mutation Breeding and its application in tree improvement.

Biotechnology in tree improvement. Genetically Modified tree species – Varietal registration-procedures-conducting DUS test. Tree DUS testing- development of descriptors for trees. Economics of tree improvement.

Practical

Identification of ecotypes, races, and land-races in natural forest. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Progeny and clone testing. Mating and field designs. Estimating genetic parameters and genetic gain - Visit to species, provenance and progeny trials. Visit to seed orchards. Comparison of parents and their putative hybrids. Macro and micro propagation. Tree Improvement Programs in Timber species and non-Timber species.

Suggested Readings

- FAO. 1985. Forest Tree Improvement, FAO. Publication
- Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No. 34
- Khosla PK. 1981. Advances in Forest Genetics. Ambika Publ., New Delhi
- Mandal AK and Gibson GL. (Eds). 1997. Forest Genetics and Tree Breeding. CBS
- Parthiban, K.T, Krishnakumar, N. and Devanand, P.S. 2020. Tree Breeding and Improvement – Theories and Techniques. Scientific Publishers. Jodhpur
- Sandeep Kumar and Matthias Fladung. 2005. Molecular genetics and breeding of forest trees, International book distribution Co. India 436 pages
- Surendran C, Sehgal RN and Paramathma M. 2003. Text Book of Forest Tree Breeding. ICAR Publ.
- White JW. 1976. Introduction to Forest Genetics. Academic Press
- Zobel BJ and Talber J. 1984. Applied Forest Tree Improvement. John Wiley and Sons.

EC 7.3.2 Reproduction Biology of Tree Crops 3 (2+1)

Objective

- To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding and sex expression

Theory

Reproductive Biology – Introduction – Concepts – Importance – Mode of reproduction – types – Tropical trees – Temperate trees – Tree characteristics - growth and development (both vegetative and reproductive) - Floral morphology and types of flowers- floral initiation and breeding systems. Floral Measurement and prediction of Flowering-Juvenility and vernalization - Floral diversity and pollination. Mode of pollination – Cross pollinated and self-pollinated tree species. Mechanisms and significance - Pollination syndromes and their evolution; Plant – Pollinator systems, Diversity of pollination syndromes in selected plant families. Sex expression, monoecy, dioecy and its evolution. Environmental effects on sex expression. Floral attractants and rewards; Biology of floral and extra floral nectaries; Examples of plant insect interactions involving pollination. Floral characteristics of the main pollination syndromes- Mating system dynamics in Forest trees – Factors affecting different mechanisms – Mechanisms promoting high levels of Out-Crossing – self incompatibility –

Factors leading to unusually low levels of out crossing – Factors that prevent or limit self-fertilization. Environmental effects on sex expression - Plant-pollination interactions, Pollinator energetic and nectar production, Pollen travel within and between trees – pollination efficiency, reproductive efficiency, Distance of pollen travel, pollen transport and pollen viability. Fertilization in hard wood trees – Double fertilization – Seed formation in angiosperms - fertilization in soft wood trees – Cone formation in softwood trees. Seed dispersal – Benefits of seed dispersal – types of dispersal – consequences of seed dispersal – Gene flow- Barrier to gene flow – Gene flow between species (Genetic pollution) – Models of gene flow – Gene flow mitigation.

Practical

Sex expression in forest trees – Out crossing mechanisms in forest trees – Measurement of pollen flow in wind – pollinated and insect-pollinated species – Pollen viability – Hanging drop techniques and fertility – Seed dispersal mechanisms – wind – water.

Suggested Readings

1. Dattee, Christian Dumas and Andre Gallais.1992. Reproductive Biology and Plant Breeding. Springer
2. Khosla PK. 1981. Advances in Forest Genetics. Ambika Publ., New Delhi
3. Mandal AK and Gibson GL. (Eds) 1997. Forest Genetics and Tree Breeding
4. Ramawat Kishan Gopal, Mérillon Jean-Michel, and Shivanna K R. 2014. Reproductive Biology of Plants. CRC Press.
5. Shivanna K R and Rangaswamy N S.1992. Pollen Biology a Laboratory Manual. Springer- Verlag. New York
6. Zobel BJ and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley andSons
7. Zobel BJ, Wyk GV and Stahl P. 1987. Growing Exotic Forests. John Wiley and Sons.

EC 7.3.3 Biometrical Genetics in Tree Breeding 2 (1+1)

Objective

- To impart knowledge in the field of biometry as applied to breeding population, provinces and making experiment in forest genetics and tree breeding

Theory

History and principles of quantitative genetics in forest trees and importance of qualitative and quantitative traits in tree breeding; Basic statistical Tools-Mean, mean, mode, standard deviation; Experimental design, principles and components of experimental design; Phenotypic variance, genotypic variance and its partitioning, models of gene action. Nature of Gene Action - Dominance and Epistatic-Qualitative and quantitative traits in tree breeding; Biometrical Techniques used for assessing the variability in germplasm collection various types of variability – Significance; Heterosis, types of heterosis, Factors affecting heterosis, Genetic basis of heterosis; Heritability, Types of heritability – methods of estimation of heritability, genetic gain and genetic advance. Association analysis - Correlation coefficient analysis – Types of correlation – Application in tree improvement; Path analysis Merits, Demerits, Application in Plant Breeding; Combining ability, types of combining ability –

Inbreeding depression and its effects in tree breeding; Mating design in trees and its classification. D^2 statistics – Merits and Demerits; Molecular Diversity Analysis –marker approach – Computation of Data; Adaptation, Types of adaptation, causes of adaptation; Stability analysis of important fast-growing trees; Comparison of stability, combining ability and Heritability analysis.

Practical

Estimation of first and second degree of statistics -mean, median, range, mode, standard deviation and coefficient of variation in tree species-Problems on multiple factor inheritance - Estimation of genotypic and phenotypic variance in Eucalyptus tree species - Analysis of additive and dominance component of variances in red sanders - Estimation of heterosis in Kadamba trees - Estimation of heritability and genetic gain in Casuarina - Analysis of phenotypic and genotypic correlation in Eucalyptus - Estimation of path analysis in sandal trees - Estimation of GCA and SCA in teak tree species - Studies of different mating design in tree species - Estimation of selection methods in tree species of *Melia dubia* - Line × tester analysis in Eucalyptus tree species - Diallel analysis in *Melia dubia* - Stability analysis in teak tree species - D^2 analysis in Kadamba tree species - Studies of different DNA markers in improving tree species

Suggested Readings

- Nadarajan N. and M. Gunasekaran. 2005. Quantitative Genetics and biometrical techniques in plant breeding. Kalyani Publishers.

EC 7.3.4 Marker Assisted Breeding in Forestry 3 (2+1)

Objective

- To provide insight into development of markers in the tree improvement program for identifying the important traits

Theory

Domestication: The Evolution of Crop Plants – Breeding methods- transgenic technology- Molecular markers- Achievement and future prospective in Marker Assisted breeding. Hybridization based markers- Restriction Fragment Length polymorphism (RFLP) techniques and application; PCR based markers –Randomly Amplified Polymorphic DNA marker (RAPD) and its types; Amplified Fragment Length polymorphism (AFLP) principle and their application - Microsatellites marker/ Simple Sequence Repeat maker (SSR) development and application - Development of SCAR and STS marker principle and application. Introduction – SNP marker discovery – methods and tools - whole genome SNP analysis for major gene discovery – Allele mining; Applications of DNA markers in diversity analysis – characterization of plant genetic resources – role of markers in Plant Variety protection. Mapping populations- Linkage Mapping of Molecular Markers and Oligogenes- Mapping of Quantitative Trait Loci - Association Mapping. Marker-Assisted characterization of germplasm and genetic purity- Marker-Assisted Backcrossing- Multitrait Introgression- Innovative Breeding methods for effective use of MAS- Genomic Selection- Phylogenetic Relationships and Genetic Diversity- High-Throughput SNP Genotyping- Bioinformatics

Tools and Databases for Genomics Research-Phenomics.

Practical

Analysis of morphological diversity through statistical package like NTSYS - Extraction, quantification and separation of protein markers using SDS-PAGE. Isolation of plant genomic DNA, quantification and quality assessment by agarose gel - PCR using RAPD primers and separation of RAPD fragment using agarose gel electrophoresis. Amplified Fragment Length Polymorphism marker data generation - PCR amplification of genomic DNA using SSR primers -Separation of SSR markers using urea PAGE denaturing gel and silver staining - Finger printing of germplasm lines and seed varietal purity test using SSR markers -Development of SCAR marker from RAPD marker. Phenotyping the mapping population RILs or F2 using the morphological traits - Genotyping the mapping population RILs or F2 using the SSR markers - Construction of linkage map using map maker software and QTL analysis. SNP markers data generation and analysis using Real time PCR. Whole genome SNP array data analysis using the Microarray platform. SNP data analysis using pLink software. Marker assisted breeding – MABB studies.

Suggested Readings

1. Ahmar, S., Ballesta, P., Ali, M. and Mora-Poblete, F. (2021). Achievements and challenges of genomics-assisted breeding in forest trees: From marker-assisted selection to genome editing. International Journal of Molecular Sciences, 22(19), 10583.
2. Grattapaglia, D. (2008). Perspectives on genome mapping and marker-assisted breeding of eucalypts. Southern Forests: a Journal of Forest Science, 70(2), 69-75.
3. Nilausen, C., Gélinas, N., and Bull, G. (2016). Perceived acceptability of implementing marker- assisted selection in the forests of British Columbia. Forests, 7(11), 286.
4. O'malley, D. M., and McKeand, S. E. (1994). Marker assisted selection for breeding value in forest trees.

EC 7.3.5 Tissue Culture Applications in Forestry 3 (1+2)

Objective

- To provide basic knowledge on the plant tissue culture, techniques, mass propagation, hardening and certification

Theory

Introduction-Concepts and principles. History of Plant tissue culture. Sterilization Techniques- Nutritional requirements for plant tissue culture - Factors affecting plant tissue Culture-Commercial PTC Lab Organization-Micropropagation – applications and limitations. Low cost alternatives in micro propagation. Morphogenesis – direct and indirect, organogenesis and somatic embryogenesis. Callus initiation - establishment and maintenance. Synthetic seeds and applications. Meristem culture and virus elimination - virus indexing methods. Shoot tip culture and in vitro clonal Multiplication-Applications. Embryo culture and embryo rescue-applications. In vitro fertilization techniques. Ovule, ovary and endosperm culture. Anther and microspore culture - production of Haploids-Protoplast isolation, culture and protoplast fusion - applications - Somaclonal variation - applications. In vitro germplasm

conservation. Commercial scale micropropagation – Micropropagation of - Neem, Teak, Bamboo, Paulownia, Eucalyptus, Red sanders, Mahogany, Sandal wood, Melia, Casuarina and Gmelina. Micropropagation of rare and endangered plants. Methods for Hardening-Acclimatization-Physiological changes during hardening. Packaging and transport of tissue cultured plants – Domestic and export. National certification system – Guidelines for Accreditation of Test laboratory for virus diagnosis and genetic fidelity testing of tissue culture raised plants and Tissue Culture Production Facility. Classification of secondary plant metabolites. Extraction and quantification methods for secondary metabolites. Plant Cell cultures for secondary metabolite production–steps. Large scale production through bioreactors.

Practical

Laboratory organization - safety regulations and Sterilization techniques for aseptic manipulation. Nutrient stock and growth regulator stock preparation -Culture media preparation. Micropropagation of Neem, Teak, Bamboo, Paulownia, Eucalyptus, Red sanders, Mahogany, Sandal wood, Melia, Casuarina, Gmelina. Inoculation of explants for callus culture - Clonal propagation through meristem culture - Anther and Microspore culture - Embryo culture - Sub-culturing technique for regeneration. In vitro and ex vitro rooting of tissue culture plantlets - Induction of somatic embryos and synthetic seeds - Establishment of suspensions and viability assay - Determination of cell growth in suspensions - Extraction of secondary metabolites. Phytochemical assay of secondary metabolites - Quantification by HPLC and GC-MS - Testing anti-microbial activity. Induction of hairy roots-medium preparation, strain selection, co-cultivation and maintenance of hairy roots. NCSTCP-Procedures and Quality analysis by Genetic Fidelity test - Virus indexing in TC plants - A demonstration on hardening and field transfer of TC plants - Visit to commercial tissue culture laboratory - Project preparation for establishment of tissue culture lab.

Suggested Readings

1. Bonga, J. M. and Durzan, D. J. (Eds). (1982). Tissue culture in forestry. Springer Science and Business Media.
2. Bonga, J. M. and Durzan, D. J. (Eds). (2012). Cell and Tissue Culture in Forestry: Volume 2 Specific Principles and Methods: Growth and Developments (Vol. 24). Springer Science and Business Media.
3. Hasnain, S. and Cheliak, W. (1986). Tissue culture in forestry: economic and genetic potential. The forestry chronicle, 62(4), 219-225.
4. Savangikar, V. A. (2004, February). Role of low cost options in tissue culture. In Low cost options for tissue culture technology in developing countries. Proceedings of a Technical Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (pp. 11-15).
5. Tanase, C., Volf, I., Vintu, S., Gradinaru, R., and Popa, V. I. (2013). Potential applications of wastes from energy and forestry industry in plant tissue culture. Cell. Chem. Technol, 47(7-8), 553-563.
6. Thorpe, T. A. (1983). Biotechnological applications of tissue culture to forest tree improvement. Biotechnology Advances, 1(2), 263-278.

EC 7.3.6 Controlled Breeding in Tree Crops 2 (0+2)

Objective

- To provide insight into development of hybrids for tree crops and its exploitation for yield improvement through conventional and modern plant breeding approaches

Practical

Pollination and Reproduction in tree crops - Alternation of generation and life cycle - Mode of pollination - Mechanisms enforcing self and cross pollination in tree crops. Methods of survey, exploration and collection of genetic resources of tree crops - Methods of conservation and maintenance of different tree crops. Study of germplasm characterization and evaluation of different tree crops. Study of cataloguing and data storage of genetic resources of tree crops. Study of Cryopreservation techniques of different tree crops – need and utilization. Breeder's kit and its components for tree crops. Pollen morphology - Exine structure of different tree crops. Techniques for pollen collection and storage for different tree crops. Study of pollen viability and sterility for different tree crops. Emasculation and pollination techniques for self-pollinated tree crops. Emasculation and pollination techniques for cross pollinated tree crops. Basic techniques for selfing in tree crops. Basic techniques for crossing in tree crops. Lay out of different yield trials - Observing the experimental plots in tree crops. Assessment of variability parameters (mean, range, PCV, GCV, heritability, genetic advance) in tree crops. Studies on hybrids – Estimation of heterosis in different tree crops. Studies on segregating generations and maintenance of records of different tree crops. Studies on different wild species in tree crops and wide hybridization. Mutagenesis study - physical and chemical mutagens. Polyploidy breeding - Agents for the induction of various ploidy levels. Identification of polyploids in different tree crops. Screening methods – laboratory – field – for specific traits. Screening techniques for biotic stresses in tree crops. Screening techniques for abiotic stresses in tree crops. Floral Biology, Anthesis, Pollination, Selfing and Crossing techniques in Teak. Rosewood, Sandalwood, Eucalypts, Melia dubia, Acacia and Mahogany.

Suggested Readings

1. Mandal, A. K. and Gibson, G. L. (Eds). (1998). Forest genetics and tree breeding. CBS Publishers and Distributors.
2. Schmidt, L. H. (1997). Tree Improvement Glossary Illustrated glossary of terms used in forest tree improvement. Danida Forest Seed Centre (Technical Note No. 46).
3. Singh, B. D. (2016). Plant Breeding: Principles and Methods. Kalyani publishers.
4. Zobel, B. and Talbert, J. (1984). Applied forest tree improvement. John Wiley and Sons.

EC 7.3.7 Tree Seed Orchard 3 (2+1)

Objective

- To develop understanding among students about tree seed orchards

Theory

Importance of genetically improved seed in plantation forestry. Status of seed

production among major plantation species. Short term supply of superior seed. Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones. Seed orchard: need, evolving seed orchards, containerized seed, hybrid and research seed orchards; first, second and advanced generation seed orchards. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortet age and its effect on seed production. Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield. Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

Seed orchard - Visits and study of seed orchard designs - Estimation of overlap in flowering among genotypes - Study of inter and intra-clonal variation in floral, seed characters - Effect of girdling on flowering. Plant growth regulator application for flower induction - Pollen viability/ fertility - Assessment of pollen dispersal. Supplemental mass-pollination - Effects of foliar application of fertilizers on seed set - Estimation of genetic parameters for a few traits - Estimation of parental balance.

Suggested Readings

1. Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No. 34.
2. Fins L, Friedman ST and Brotschol JV. 1992. Handbook of Quantitative Forest Genetics.
3. Khosla PK. 1981. Advances in Forest Genetics.
4. Mandal AK and Gibson GL. (Eds). 1997. Forest Genetics and Tree Breeding. Ambika Publ., New Delhi. CBS.
5. Nanson A. 2004. Genetics of Forest Tree Breeding. Agronomic Press
6. Surendran C, Sehgal RN and Parmathama M. (Eds). 2003. A Text Book of Forest Tree Breeding. ICAR.
7. Wright JW. 1976. Introduction to Forest Genetics. Academic Press.
8. Zobel BJ and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley and Sons.

EC 7.3.8 Forest Genetic Resources 2 (2+0)

Objective

- To impart knowledge on forest genetic diversity, biodiversity assessment, global conservation initiatives and conventions related to conservation of forest genetic diversity

Theory

Genetic diversity and differentiation: definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation. Molecular approaches for assessing genetic diversity; isozymes, biochemical makers and molecular markers: principles, importance and relevance. Biological diversity: concept and levels. Inventory and monitoring biodiversity: sampling strategies for genetic

diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts. Effects of sampling on genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Population size and genetic variability – Genetic variation in natural population: data, models and hypotheses – Inbreeding depression -Changes genetic diversity over time – Effects of logging and other forms of harvesting - Forest Fragmentation and environmental population - Gene flow in forest trees – Methods of estimating gene flow – Conservation methods - Threats to in situ and ex situ Genetic Conservation. Conservation of genetic diversity and invasive species. Global and local initiations for biodiversity conservation. Law and policies. Criteria and indicators for the conservation of genetic diversity. Methods for maintenance of conservation: gene banks, arboreta, botanical gardens, breeding populations as repositories of gene conservation. Rare, threatened biodiversity, endangered and endemise plants (IUCN). Global and local initiations for Biodiversity conservation. Concept of island biogeography. Managing corridors and natural habitat fragments. Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora, tourism impacts and urbanization of rare plants. Implications of rarity. Dunkal draft – need for trade agreement – TRIPS, TRIMS – IPR - WTO – TRIPS and Patenting Issues – The Protection of Plant Varieties and Farmers' Rights Act 2001 - National Biodiversity Act 2002 – Biopiracy – CITES – Cartagena Protocol on Biosafety - Biosafety protocol.

Suggested Readings

1. Bebarta, Kailash Chandra. 2002. Planning for forest resources and bio-diversity management principles, organization and methodology. Concept publishing company, New Delhi, India. ISBN 81-7022-879-4.
2. Groom, M. J., Meffe, G. K. and Carroll, C. R. 2006. Principles of conservation biology. Sinauer Associates Inc. USA.
3. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press. P. 1140.
4. Mandal, A. K. and Gibson, G. L. (Ed.). 1997, Forest Genetics and Tree Breeding. CBS.
5. Kotwal, P.C. and Banerjee, Sujoy. 2004. Biodiversity conservation-in managed forests and protected areas. Agrobios (India). 81-7754-119-6.
6. Parthiban K.T., Krishnakumar, N. and P.S Devanand. 2020. Tree Breeding - Theories and Techniques. Scientific Publishers, P 391.

EC 7.3.9 Clonal Forestry 2 (1+1)

Objective

- To learn the state-of-the-art clonal technology and its application in operational plantation development program

Theory

Clonal Forestry – definition – History of clonal forestry- Basic concepts in clonal forestry – Strategies for clonal forestry for higher productive potential – advantages of clonal forestry constraints – Selection of Plus Trees – Propagation methods- auto and hetero

propagation methods – rooting of cutting, grafting, layering, budding- micro-clonal propagation methods. Potting media – components of potting media - physical and chemical characteristics of potting media – peat, vermiculite, perlite, styrofoam, soil, sand - Plant growth substances – Auxins – cytokinins – gibberellins – ethylene – preparation of powder and liquid formulations –Applications in clonal multiplication. Juvenility and maturation, rejuvenation and maintenance, regulation of phase changes, markers of phase changes. Breeding strategies using vegetative propagation- selection and breeding for extreme genotypes. Physiological research for higher productivity of clonal forest. Field design, testing and evaluation of clones. Genetic gains from breeding with clonal option. Clonal conservation approaches- management of populations for genetic diversity and gain - Designs of clonal evaluation – Amplified clonal test. Hi-tech Nursery – Components and Characters. Mini clonal technology – Clonal mother garden – Care and Management of mother garden – Multiplication technology for commercially important species - Clonal plantation establishment- management strategies – Problem and constraints in clonal forestry – Development of QPM through clonal plants - Role of industries in clonal production.

Practical

Clonal forestry – Hi-tech nursery – Components and characters – Biological components – Clonal genetic resources – Commercially important species – Mother Garden establishment – Care and management – Irrigation – Fertilization. Physical components - Propagation Chambers – Mist chamber – Green house – Cost of establishment – Technology component – Mini clonal technology – Design and Development – Potting media – Hardware's – Growth regulators – Root trainer technology. Visit to industries and other nurseries involved in clonal production – Economics of clonal production.

Suggested Readings

1. Ahuja and Libby. 1986. Clonal Forestry. Martinus Nijhoff Publishers, Dordrecht.
2. Hartman, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 1997. Plant Propagation – Principles and Practices. Prentice- Hall of India Pvt. Ltd., New Delhi. P 770.
3. Parthiban K.T. 2024. Hi-tech Nursery – Components and Characters. Technical Bulletin, TNAU Publication
4. Parthiban K.T., Paramathma, M., and Neelakantan, K.S. 2004. Clonal Forestry. TNAU Publications, Coimbatore. Pp: 209. REPORT OF THE ICAR SIXTH DEANS' COMMITTEE

EC 7.1.8 Plant Biochemistry 2 (1+1)

Objective

- To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols,

glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid- base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver- Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO2 fixation, regulation of photosynthesis. Metabolism of carbohydrates - glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites-Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0- 7167-8724-5.
2. Buchanan, Bob B. Gruissem, Wilhelm and L. Jones, Russell. Biochemistry and Molecular Biology of Plants.
3. Jeremy M., Berg, Lubert Stryer, Tymoczko, John and Gregory Gatto. Biochemistry.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer, David T. An Introduction to Practical Biochemistry.
6. Rao, Beedu Sashidhar, Deshpande, Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam, S and Manickam, A. 2009. Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B., Krishnaveni, S. and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet, Donald and Voet, Judith. Biochemistry.
10. Wilson, K. and Walker, J.M. 2000. Principles and techniques of Practical Biochemistry

EC 7.1.9 Research Methodology 2 (1+1)

Objective

- To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey- based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology - Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data – Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

EC 7.1.10 Statistical Packages for Data Analysis 1 (0+1)

Objective

- To learn the art of data collection, processing, analysis and interpretation will be developed to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank

correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G. (1994). Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

D) EC 7.4 Wood and NWFPs product development and utilization 20

1. EC 7.4.1 - Wood Identification (0+2)
2. EC 7.4.2 - Wood Physics and Chemistry (2+1)
3. EC 7.4.3 - Forest Products Laboratory Techniques (0+2)
4. EC 7.4.4 - Wood Seasoning and Preservation (1+2)
5. EC 7.4.5 - Wood Working and Carpentry (0+2)
6. EC 7.4.6 - Composite Wood Technology (2+1)
7. EC 7.4.7 - Non-Wood Forest Products and Value Addition Technology (2+1)
8. EC 7.4.8 - Ethnobotany, Medicinal and Aromatic plants (2+1)
9. EC 7.4.9 - Certification of Forest Products (2+0)
10. EC 7.1.8 - Plant Biochemistry (1+1)
11. EC 7.1.9 - Research Methodology (1+1)
12. EC 7.1.10 - Statistical Packages for Data Analysis (0+1)
13. EC 7.1.11 - Internship with tree breeding and biotechnology-based institutions/industries (0+2)

EC 7.4.1 Wood Identification 2 (0+2)

Objectives

1. To equips students with knowledge of macro and micro-structure of softwoods and hardwoods and their relation with properties of wood
2. To exposes students to use of anatomical features of wood in timber identification and classification

Practical

Planes of wood and physical characteristics of important woods. Identification of different types of cells and tissues. Anatomical studies of soft and hard woods. Hand lens features and identification of wood - soft wood and hardwood, sapwood and heartwood specimens. Maceration, staining, slide preparation and measurement of dimensions of woody tissues. Anatomical studies of reaction wood. Ultrastructures and their interpretation. Measurement of fibril angle and tissue proportions. Microscopic features of Bamboo, Palmyrah, Cane and Coconut. Classification of timber using dichotomous keys. Modern

timber identification techniques. Microscopic features, slide inspection of twenty-five species characteristics. Morphological observations on import timber species of common occurrence for architectural patterns of habit, and buttress.

Suggested Readings

1. Meier, E. 2015. Wood identifying and using hundreds of woods worldwide. Wood database.
2. Porter, T. 2004. Wood identification and use. Guild of Master Craftsman, UK.
3. Purkayastha, S K. 1982. Indian woods: Their identification properties and uses. Controller of Publication
4. Ratura and Juneja, K.D.S.1971. A Handbook for field identification of fifty important timbers of India. Manager of Publications.

EC 7.4.2 Wood Physics and Chemistry 3 (2+1)

Objectives

1. To impart knowledge about the physical and chemical properties of wood, cell wall constituents and wood extractions
2. To study the industrial utilization of wood extractives

Theory

Density and specific gravity. Variation in density of early and late wood constituents. Effect of growth rings on density. Pith to peripheral density variations. Different modes of presentation in relation to moisture content-wood water relationship and moisture estimation in wood. Physical properties of wood as influenced by moisture content. Specific gravity of wood substance. Anisotropy in Wood. Dimensional changes on heating green wood. Effect of dry and wet heat and heating in presence or absence of air on strength and dimensional stability. Thermal expansion, specific heat, thermal insulation value, ignition of wood and fuel value. Thermal conductivity and diffusivity. Change of temperature in wood under heating. Effect of moisture on thermal properties. Thermal properties of wood composites. DC and AC characteristics of wood-electrical conductivity, effect of moisture content and temperature. Activation energy associated with electrical conduction. Voltage breakdown strength. Dielectric properties of wood under alternating current and electro. Dielectric strength - dielectric constant and loss. Power factor - magnetic field conditions, effect of specific gravity, moisture content, temperature and extractives. Principles of induction and dielectric heating. Piezo-electric properties of wood and its applications. Sound transmission and acoustics in buildings. Speed of sound- wave resistance - coefficient of sound absorption - Response of defects to stress waves in timber-acousto-ultrasonics based non-destructive evaluation techniques. Wood chemistry-introduction-present status-scope of wood chemical Industry-Chemical composition of cell wall. Carbohydrate polymers - holo cellulose, cellulose, hemi-cellulose and other minor polysaccharides. Lignin and extractives. Chemistry of bark, extractives, hemi celluloses, cellulose, lignin and inorganics. Distribution of chemical components in the cell wall. Components of cell. Volatile oils and extractives. Chemical relativities of cellulose, hemicellulose and lignin. Cellulose derivatives and their applications. Lignin based products. Hydrolysis and fermentation of ligno cellulosic materials. Pyrolysis

and gasification of wood. Bioactive components from wood. Eco- friendly dyes from bark and wood. Isolation of extractives from wood and bark. Separation of secondary metabolites. Industrial utilization of wood and bark extractives such as natural rubber, resin and turpentine from pines, tannins, pharmacologically active metabolites and future directions for their utilization.

Practical

Properties of wood, electrical, acoustic. Sonic and ultra-sonic properties. Determination of strength properties, specific gravity, F.S.P. from shrinkage and sorption. Determination of thermal conductivity, dielectric constant, permeability of wood to air. Extraction of cellulose, hemicellulose, lignin, extractives and ash content of wood. Determination of calorific value of different wood species and ligno cellulosic wastes. Making charcoal and briquettes. Wood chemical isolation through chromatography. Isolation of pure chemical constituents using thin layer and column chromatography. Estimation of turpentine and resin. Isolation of polysaccharides and characterization of mono sugars. Estimation of oil from sandal wood. Extraction of dyes from different wood species. Visit to natural dye industry and study its properties.

Suggested Readings

1. Franz, F.P, Kollmann, Kuwnzi, E and Stamm, A.J. 1975. Principle of wood science and technology. Wood based material. Vol. II Springer-Verlag, Berlin, Heidelberg.
2. Meyland, B.A and Butterfield, B.G (Eds). 1972. Three-dimensional structure of wood: a scanning electron microscope study. Syracuse University Press.
3. Roger, R.M (Ed). 2013. Handbook of wood chemistry and wood composition. 2nd Ed. CRC Press.
4. Rowell, R.M. 1984. The chemistry of solid wood (advances in chemistry series). American Chemical Society.

EC 7.4.3 Forest Products Laboratory Techniques 2 (0+2)

Objectives

1. To acquaint the students to commonly used techniques in laboratory
2. To expose the students to the practical aspects of laboratory techniques employed in forest products

Practical

Introduction to laboratory techniques - Applicability of laboratory techniques in Forest Products Lab - Practicing of machine vision techniques - Morphometric and anatomical changes during wood Seasoning and Preservation - Wood and non-wood product sampling, drying and storage. Estimation of extraneous components of wood. Analysis of volatile compounds. Estimation of chemical composition of wood samples (Hardwoods, softwood and other lingo cellulosic material) and ash. Separation of components by column, paper, and thin layer chromatography. HPLC techniques. Determination of strength properties of paper and wood composites.

Suggested Readings

1. Furr A K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Meyland BA and Butterfield BG. 1972. Three-Dimensional Structure of Wood: A Scanning Electron Microscope Study. Syracuse University Press.

EC 7.4.4 Wood Seasoning and Preservation 3 (1+2)

Objective

- To understand the importance of wood seasoning and preservation for utilizing secondary timber for multipurpose use.

Theory

Wood water relationship, absorption behaviour and wood drying, Refractory and non-refractory behaviour of wood, Wood seasoning, types- air, kiln and special seasoning methods like steaming, chemical, high temperature drying, vacuum drying and water conditioning. Defects of timber - natural, seasoning defects, defects due to external agencies, machining defects. Effect of defects on utilization. Detection and diagnosis of discoloration and decay in wood: decaying agencies - fungi, insects and borer. Durability of timbers. Mechanism of wood preservation – kinds of wood preservatives - Advantages and safety concern of wood preservatives, fire retardants. Graveyard test and anti-fungal activity of wood. Bio-preservation. Methods of application of wood preservatives – Non pressure methods – Brushing – Steeping – Hot and cold bath process – Diffusion process – Momentary dip process – Sap displacement method – Boucherie method – Pressure method – Full cell process – Empty cell process.

Practical

Determination of moisture content and swelling coefficients of different woods. Visit to timber depot/saw mill to study the stacking methods and various defects in wood. Visit to Wood seasoning unit to study the various types of seasoning methods and Safety aspects. Exercise on fixing seasoning schedule for timbers under steam heated kiln and FRI solar heated kiln seasoning method. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters. Visit to wood testing laboratories. Laboratory methods for testing efficacy of wood preservative against fungi and termite. Study on the environmental health and safety aspects of wood preservatives. Exercise on non-pressure methods of application of preservatives for plantation timber - End coating - Sap Displacement Method and Boucherie process. Exercise on Full cell process techniques. Study of seasoning and preservative treatments for fast growing tree species. Study of seasoning and preservative treatments for lesser known tree species. Conducting Grave yard test to evaluate natural durability of plantation and imported timber.

Suggested Readings

1. FAO. 2007. Wood preservation manual. International Book Distributor
2. Hunt GM. 1967. Wood Preservation. 3rd edn. McGraw-Hill Book Company.
3. Purushotham A, Pande JN and Jadhav. 1959. Wood Preservation in India. Manager of

Publications.

EC 7.4.5 Wood Working and Carpentry 2 (0+2)

Objective

- To make students to understand and learn about the wood working and carpentry skills

Practical

Identify timber/ wood and apply measuring, marking and testing instrument and holding and supporting hand tools following safety precautions. Work on various saws and portable power saw machines for Ripping, cross cutting, Oblique sawing and curve cutting. Analyze the surface finish with exact sizing by planning operation - Identify and apply various shaving tools or portable power planning machine. Identify and apply various paring tools and analyze and choose the positioning and employ holding device for chiselling. Identify and classify various types of joints, analyze and prepare correct joint at correct position, related with strength and appearance. Make small wooden job as per drawing with schedule sizes of timber or alternatives of timber. Analyze and identify various carving tools and convert a wooden block/ piece into a decorative article. Demonstrate preservation of wooden item through surface finishing with various processes such as painting, polishing, varnishing etc. Demonstrate ripping, cross cutting, pedestal grinding, Tenon and mortise machine. Demonstrate different operations on Sanding machine. Prepare various roof truss, door and windows frame and shutters. Check, identify, analyze and repair the wooden job.

Suggested Readings

1. Bates, D. (2013). Carpentry and Joinery Book 1. Routledge.
2. Brett, P. (2012). Carpentry and Joinery Book Two: Practical Activities. Oxford University Press-Children.
3. Goring, L. (2018). Manual of First and Second Fixing Carpentry. Routledge.
4. Wheeler, C. G. (2018). Wood-Working for Beginners. BoD–Books on Demand.

EC 7.4.6 Composite Wood Technology 3 (2+1)

Objective

- To impart knowledge regarding the processing technology for wood composites and modified woods

Theory

Introduction to wood modification, its need and scope, chemical modification of wood (Acetylation, reaction with isocyanates, acetates, ethers, epoxides, etc.). Wood impregnation and compregnation, heat stabilization, compressed wood, wood densification. Wood plastic composites- polymer used-manufacturing process. Scope and importance-veneer production process-rotary cutting and slicing-types of veneer and their uses-advantages of veneered panels in wood products- veneer jointing – finger joints -veneer grading-storage and handling of veneer. Production, properties, performance and application of Glue Laminated Timber (GLT), Structural Composite Lumber (LVL, PSL, LSL). Production, properties, performance

and application of plywood, Particle board, Sandwich board, Core board, Flake board, Fibre board (LDF, MDF, HDF) and Nano Composites. Wood adhesives - types, characteristics and their applications. Scope and merits of laminated wood-choice of species and dimensional stability consideration, multispecies laminates- types of Laminates-Matte-finish laminate, textured laminate, gloss-finish laminate, metallic laminate, PVC-finish laminate, acrylic-finish laminate and exterior laminate. Laminated wood from bamboo and bamboo laminates. Acoustic panels from laminated wood densified laminate panels. Bamboo composite wood-based Industries. Bamboo Mat based Products-Bamboo Mat Board (BMB), Bamboo Mat Veneer Composites [(BMVC) and Bamboo Mat Corrugated Sheet (BMCS), Bamboo mat tray. Bamboo strip-based products - Bamboo flooring tiles and high density transport flooring.

Practical

Preparation of veneer and testing the quality. Visit to plywood industry, particle board and hard board industry. Plywood preparation and Accelerated ageing test on plywood. Preparation of particle board and hard board and conducting accelerated ageing test, glue shear strength and internal bond strength test. Assessment of wood quality in plantation grown timber for the production of plywood and particle board. Visit to Wood Plastic Composite manufacturing unit, wood plasticization unit and studying the plasticity of wood. Determination of linear and volumetric shrinkage of composite wood. Study of different grades of composite wood, nano composite preparation and commercial utilization. Assessment of different grades of plywood. Evaluation of penetrability of preservatives in composite wood. Study on wood modification technology. Study on Bamboo Mat Based Products- BMB, BMVC and BMCS. Study on Bamboo Strip Based Products - Bamboo flooring tiles and high density transport flooring. Visit to Laminated bamboo furniture industry.

Suggested Readings

1. Antole A. Klyosov, 2007. Wood Plastic Composites. Wiley-Interscience, 1st edn.
2. Ansell Martin P, 2015. Wood Composites. Wood head publishing.
3. Jin Kuk Kim, 2011. Recent Advances in the Processing of wood-plastic composites. Springer publications.
4. Papadopoulos Antonios N, 2020. Advances in Wood Composites.
5. Roger M and Rowell, 2005. Handbook of Wood Chemistry and Wood Composites. Published by Taylor and Francis.

EC 7.4.7 Non-Wood Forest Products and Value Addition Technology 3 (2+1)

Objective

- To make students understand and learn about the different non wood Forest Products and their scientific extraction, processing and disposal

Theory

Non-Wood Forest Products - Present status, demand and supply, classification, distribution and marketing. Role of tribal co-operative societies in NWFPs. Recent trends in NWFP. Quality assessment of important products and their methods for storage. Important

non-wood forest products industries. Gums – Occurrence, origin, functions, kinds, properties, tapping methods, factors affecting gum formation, scientific management, collection, processing and storage -value addition - industrial application- uses. Resins –occurrence, origin, kinds, properties, tapping methods, processing and storage, uses, industrial application and value addition. Lac -different species, distribution, improved method of cultivation, scientific management, collection, processing and storage, value addition and uses. Shellac - cleaning and grading, properties, value addition and their uses. Tannins - Definition, species - nature and kinds, occurrence, function, collection, extraction, processing, value addition and uses. Dyes - definition, species, types, extraction, processing value addition and uses. Cutch and Katha - species, extraction methods, processing value addition and uses. Essential oils - species, types, extraction process, value addition and commercial applications -Tree Borne Oil seeds (TBOs) tree species, collection, extraction methods and uses. Drugs species – extraction process – industrial applications. Animal products – honey and wax -collection, processing, storage. Silk – silk farming – silk types, mulberry –types, distribution, improved method of cultivation, collection and storage, value addition and uses. Mineral products - other miscellaneous products.

Practical

Visit to nearby forests to study important NTFP yielding plants. Visit to non-wood forest products-based industries. Visit to agave extraction unit and study the fiber extraction process. Visit to Sericulture unit to study Silk production technology. Visit to Essential oil extraction unit and study the different extraction methods. Study of tans and visit to tannin industry. Study of dyes and visit to dye extraction unit and their sources. Visit to biodiesel production and study the trans-estrification process. Visit to Herbal Gardens and herbaria to study medicinal plants. Quality assessment of important NWFP and their methods for storage. Study of plants yielding drugs, spices, wild edible plants, poisons and bio-pesticides and their collection from nearby forests. Visit to a tribal village involved in collection, processing and sale of NTFPs. Utilization of various NWFP and their scientific management for processing, value addition and disposal.

Suggested Readings

1. Linskens H F and Jackson J F. 1991. Essential oils and waxes (Ed.). Springer-Verlag Berlin Heidelberg.
2. Mathe A. 2015. Medicinal and aromatic plants of the world-scientific, production, commercial and utilization aspects. Springer, Netherlands.
3. Panda H. 2005. Hand book on specialty gums, adhesive, oils, rosin and derivatives, resins, oleoresins, katha, chemicals with others natural products. Asia Pacific business press. Inc.
4. Panshin A J, Harrer E S and Bethel J S. Forest products, their sources, production and utilization.
5. Shackleton S, Shackleton C and Shanley P. (Ed.) 2011.Non-timber forest products in the global context. Springer-Verlag Berlin Heidelberg.

EC 7.4.8 Ethnobotany, Medicinal and Aromatic plants 3 (2+1)

Theory

Definition and scope of ethno-botany. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic – people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc Methods and tools in Ethnobotanical studies. Ethnobotany of tribals in Southern India. Traditional Botanical Knowledge- concepts.

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, Champaka, Sandal, Cinnamum spp., *Bursera delpechiana* - botany, climate and soil requirements, planting cultural and manorial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and Karnataka - history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like atropa, cinchona, rauvolfia, opium, sandal, acorus, cannabis, digitalis, *Strychnos nux-vomica, Aconitum,* Neem, *Dioscorea, Costus, Solanum* etc. Cultivation practices of medicinal plants like *Adhathoda zylanica, Sida cordifolia, Sterospermum colais, Plumbago zylanica, Tinospora cordifolia, Kaemferia glanga, Indigofera tinctoria, Morinda citricifolia* and *Phyllanthus neeruri*. Conservation packages for the medicinal plants collected in wild.

Practical

Ethnobotanical studies of the important plants from the following families: Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Field visit to different tribal regions to gain ethno-botanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Suggested Readings

1. Atul, C.K. and Kapur, B.K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.
2. Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.
3. Cunningham, A. 2014. Applied Ethnobotany: People, Wild Plant Use and Conservation. Taylor and Francis.
4. EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction

5. Ethnobotany. Principles and applications. (1997). C. M. Cotton. John Wiley and Sons Ltd. 424p.
6. Gunther, E. (1975). The essential oils. Robert, K Krieger Pub. Co., New York.
7. Jain, S.K. 2010. Manual of Ethnobotany (2nd edn). Scientific Publishers, India, 242p.
8. Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672p.

EC 7.4.9 Certification of Forest Products 2 (2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Program for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Suggested readings

1. Bass, S. 1996. Introducing forest certification. A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest Institute, Discussion Paper 1. 30p. Details available at: http://www.giz.de/Themen/de/dokumente/en- d28-inenpenennt-certification-verification-forest-manage.pdf.
2. Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
3. Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
4. Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

EC 7.1.8 Plant Biochemistry 2 (1+1)

Objective

- To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols,

glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid- base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver- Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO2 fixation, regulation of photosynthesis. Metabolism of carbohydrates - glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites-Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0- 7167-8724-5.
2. Buchanan, Bob B. Gruissem, Wilhelm and L. Jones, Russell. Biochemistry and Molecular Biology of Plants.
3. Jeremy M., Berg, Lubert Stryer, Tymoczko, John and Gregory Gatto. Biochemistry.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer, David T. An Introduction to Practical Biochemistry.
6. Rao, Beedu Sashidhar, Deshpande, Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam, S and Manickam, A. 2009. Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B., Krishnaveni, S. and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet, Donald and Voet, Judith. Biochemistry.
10. Wilson, K. and Walker, J.M. 2000. Principles and techniques of Practical Biochemistry

EC 7.1.9 Research Methodology 2 (1+1)

Objective

- To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey- based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology - Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data – Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

EC 7.1.10 Statistical Packages for Data Analysis 1 (0+1)

Objective

- To learn the art of data collection, processing, analysis and interpretation will be developed to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank

correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G. (1994). Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

EC 7.5 Forest Resource Management and Utilization 20

1) EC 7.5.1 - RS and GIS Application for Forest Resource Management (2+1)
2) EC 7.5.2 - Ecosystem Services and Valuation of Forest Resources (2+1)
3) EC 7.5.3 - Entrepreneurship in value chain improvement of Forest Resources (2+1)
4) EC 7.5.4 - Joint Forest Planning and Management (1+1)
5) EC 7.5.5 - Climate Change Mitigation (2+1)
6) EC 7.5.6 - Ecotourism (2+1)
7) EC 7.5.7 - Restoration of Degraded Lands (2+1)
8) EC 7.5.8 - Urban Ecology and Environment (2+1)
9) EC 7.1.8 - Plant Biochemistry (1+1)
10) EC 7.1.9 - Research Methodology (1+1)
11) EC 7.1.10 - Statistical Packages for Data Analysis (0+1)
12) EC 7.1.11 - Internship with Forest Business Unit/RS-GIS Company or Organization (0+2)

EC 7.5.1 RS and GIS Application for Forest Resource Management (2+1)

Theory

Remote sensing types, Digital data formats, Image processing techniques, Electromagnetic spectrum and its interaction with atmosphere and surface, Creation of False Color Composites (FCC). Geometric and Radiometric Errors of images, Geometric and Radiometric corrections: contrast enhancement, Linear contrast stretch, Histogram equalization, Filtering, Image fusion technique, Vegetation Indices, Supervised and Unsupervised Classification. GIS and its components, Raster and vector data models, Visual image interpretation, database management system (DBMS), Essential map elements, Coordinate System and Projection, Attribute data and thematic mapping. Geographical Positioning System (GPS), GPS accuracy, Segments of GPS.

Practical

Introduction to GIS Software, Satellite data handling, Geo-referencing. Creation of False Color Composite. Image processing techniques: Contrast enhancement, Linear contrast

stretch, Histogram equalization, Filtering, Image fusion technique, Vegetation Indices. Projection of digital data. On screen digitization with QGIS. Spatial and attribute data in maps in DBMS. Handling GPS receiver.

Suggested reading

1. Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London
2. Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA: ESRI
3. Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351
4. Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press
5. Lillesand, T.M. and Kiefer, W. R. (1994). Remote sensing and Image Interpretation, Fourth edition. John Wiley and Sons, Inc., USA
6. Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS and LUP, Nagpur.

EC 7.5.2 Ecosystem Services and Valuation of Forest Resources 3 (2+1)

Theory

Ecosystem Services (ES) basics, importance, history of ES and natural capital, Classification of ES-provisioning, regulating, supporting and cultural services and their status and changes, drivers of change of ecosystem services, international conventions and charters on ES-Inter-Governmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Millennium Ecosystem Services (MEA) assessment - an overview. Linkages among biodiversity, ecosystem services and human wellbeing. Quantification of ecosystem services-direct and indirect approaches. Ecological Economics: Valuation of ES, need for valuation. Use values and Non-Use values direct value, indirect value, optional value, bequest value, existence value. Valuation Methods-Market price-based approach such as stumpage value method, productivity and cost-based approaches such as replacement cost method and surrogate market and stated preference approaches such as stumpage value method, Hedonic Pricing Method, Contingent Valuation Method, Travel Cost Method, etc., Case studies in India and abroad. Challenges in valuation of ES. Governance and policy issues in ecosystem services, Payment for ecosystem services (PES), mechanisms of benefit sharing, eco-certification, Certification process in agro-forestry based carbon projects and carbon finance. Geographic Indications, Forest Stewardship Council, Landscape labelling. National and International initiatives in PES and recent policy and programs.

Practical

Valuation methods - direct and indirect methods, Valuation of standing timber, Case studies of PES in India and Abroad, Case studies on certification and geographical indications.

Suggested Readings

1. Alavalapati JRR and D Evan Mercer. 2004 Valuing Agro-forestry Systems: Methods and Applications. Kluwer Academic Publishers.
2. Huxley P. 1999. Tropical Agro-forestry. Blackwell.

3. Jain SK and Singh P. 2000. Economic Analysis of Industrial Agro-forestry: Poplar (*Populus deltoides*) in Uttar Pradesh (India). Agro-forestry Systems.
4. Jeffers JNR. 1978. An Introduction to System Analysis with Ecological Application. Edward Arnold.
5. Jose S. 2009. Agro-forestry for Ecosystem Services and Environmental Benefits: An Overview. Agro-forestry Systems.
6. Nair PKR. 1993. An Introduction to Agro-forestry. Kluwer, Netherlands.
7. Paulo ELD and Nunes. 2014. Handbook on the Economics of Ecosystem and Biodiversity. E-book.
8. Sander J, Nicolas D and Hans K. 2014. Ecosystem Services: Global Issues and Local Practices. First Edition. Elsevier Publications.
9. Schroth G and Sinclair F. 2003. Tree Crops and Soil Fertility: Concepts and Research Methods, CABI, Wallingford, UK.
10. Young A. 1997. Agro-forestry for Soil Management. Second edition. CABI, Wallingford, UK.

EC 7.5.3 Entrepreneurship in value chain improvement of Forest Resources 3 (2+1)

Theory

Forest resources as Agri-business option for rural development, SWOT analysis of forest resource entreprise, Demand and supply forecasts in forest resources, Price determination and price discovery in forest resources, Collection, processing and value addition of forest resources, Value chain analysis (VCA) of forest resources, market dynamics and trade mechanism in forest resources, Cost benefit considerations in forest resources production, Economics and marketing of forest resources, Cooperative societies, industries, NGOs and Government organizations in strengthening forest based livelihood.

Practical

Field based value chain study of any important forest resource. Case study on entrepreneurship of any cooperative, NGO, society, industry.

Suggested Readings

1. Charles W, Hill L and Steven L McShane, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
2. Girish B and S S Inamati. Forest Business Management by Shahapurmath. Satish Serial Publishing House
3. Koontz H and Weihrich H, 2007, Principles of Management, Tata McGraw Hill, New Delhi.
4. Massie J L, 1995, Essentials of Management, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Prasad L M, 2005, Principles and Practices of Management, Sultan Chand and Sons Educational Publishers, New Delhi.
6. Rao V S B, and Narayana P S, 2004, Principles and Practices of Management, Konark Publishing Pvt. Ltd. New Delhi.

EC 7.5.4 Joint Forest Planning and Management 2 (1+1)

Theory

Concept of JFM. Definition. Meaning what is your idea of JFM, CFM? Learn Definition of JFM in state and national JFM guidelines (latest versions): what is common to all? -what is different? -if different, why? -what is specific to your own state?

Concept-why from the conventional management of forests did JFM evolve? -what was the status of: protection, harvest and provision of benefits in: 1. conventional forest management 2. Social forestry.

JFM Key Principles What is management of resources? -what are the resources available to be managed in the forests? -why the resources are to be managed? -what is the difference of carrying capacity of forests with canopy? -visualize canopy wise availability of resources. (Between 0.1 and 0.4, more than 0.7) 1.2 what is joint management of resources.

Legal position-what are the criteria to identify target areas? Area coverage? Community? -what will be the time span to be earmarked for JFM? -Why? - Figure out stages of JFM program period. -what is the functional role of FD and local people? - What is the legal frame that endorses the above identified factors? 1 hour

Scope and limitations-what will be the measures to fill gaps? -what will be possible limitations? Community Forestry: Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry. Forests and man: Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural Environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community Forest development, social economical and environmental aspects, Community Forest development through NGOs, civil societies, citizen groups. Social Forestry for fodder production, fuel wood, production, leaf manure, timber production.

NTFPs Joint Forest management: concept, legislation, rules, importance Joint Forest management: concept, legislation, rules, importance. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMS, FDCS. VFCS, CBOS. NGOS and co-operative societies Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies.

Practical

Joint Forest management: concept, legislation, rules, importance Joint Forest management: concept, legislation, rules, importance. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation- problems and prospects, Micro plan Preparation. JFMS, FDCS. VFCS, CBOS. NGOS and co-operative societies Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules,

importance. Case studies of JFM implementation- problems and prospects, Microplan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co- operative societies. Community forest development, social economical and environmental aspects, Community Forest development through NGOs, civil societies, citizen groups. Social Forestry for fodder production, fuel wood, production, leaf manure, timber production, PRA exercises. Visit to village to study the community forestry components- Community reserve, organizational set up and administrative procedures in a social forestry (SF) Range, Microplan Preparation-Field visit to a JFM operational area and conduct PRA surveys. Afforestation techniques and social forestry.

Suggested reading

1. Balakathiresan, S. (1986). Essentials of forest management, Nataraj Publishers, Dehradun.
2. Bullock, R. C. L. and Hanna, K.S. (2012). Community Forestry Local Values, Conflict and Forest Governance. Cambridge University Press.
3. FAO (1984). Forestry extension, making it work, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
4. Jha, L.K., Sen P. K. and Sarma, A.P.H. (2008). A Manual of Forestry Extension Education, Published by VEDA MS, P. 386 p.
5. Jalihal, K.A. and Veerabhadraiah, V. (2007), Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.
6. Gunter, J. (Ed.). (1973). The Community Forestry Guidebook (http://www.forrex.org/ sites/ default/ files/ forrex_series/FS15.pdf).
7. Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R and Belcher, B. (2007). Communities, Forests and Governance: Policy and Institutional Innovations from Nepal. Adroit Publishers, New Delhi, India.
8. Roy, S.B. and Chatterjee, M. (1994). Joint Forest Management. Inter India Publications Tiwari, K.M. (1983). Social forestry for rural development. International Book Distributors. Vyas, G. P.D. (2006). Community Forestry. Agrobios, India.
9. Sim, H. and Hilmi A. (1987), Forestry Extension Methods, FAO Forestry Paper-80, P. 153.

EC 7.5.5 Climate Change Mitigation 3 (2+1)

Objective

- To understand the scenario of climate change and international treaties on climate change, for climate change mitigation and conservation of ecosystems

Theory

Global climate change - factors involved greenhouse gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change. Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP, LULUCF, REDD++ and CDM. National action plan for climate

change - Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plan on Climate Change. Silviculture and sustainability- criteria and indicators for sustainable plantation forestry in India. CIFOR guidelines. Analog forestry for site productivity and carbon value. Disturbance- natural and anthropogenic, short- and long- term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans. Invasive – major invasive species in forests – area affected and methodology for mapping. Eradication methods- management. Restoration of invasive affected areas – types - methods approaches, strategies and opportunities. Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Expanding forest and tree cover area – TOF sector in India. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests.

Suggested Readings

1. Anderson, P. and Palik, B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
2. Bravo, F., LeMay, V., Jandl, R., and Gadow, von K. (Eds). 2008. Managing Forest Ecosystems: The Challenge of Climate Change. Springer publication. Pp 324.
3. Claussen, Eileen, Cochran, Vicki, Arroyo, Davis, Debra, P. and Pew. 2001. Climate Change: Science, Strategies, and Solutions. Brill Academic Pub. Pp 393.
4. Markham, Adam (Ed.). 2010. Potential Impacts of Climate Change on Tropical Forest Ecosystems. Amazon publishers.
5. Streck, Charlotte, O'Sullivan, Robert, Tarasofsky, Richard, G., Janson-Smith, Toby. 2011. Climate Change and Forests: Emerging Policy and Market Opportunities. Brookings Institution Press.

EC 7.5.6 Ecotourism 3 (2+1)

Objective

- To develop knowledge, understanding, and appreciation of environmentally responsible travel to relatively undisturbed natural areas that promotes biodiversity conservation, has low negative visitor impact, and provides for socio-economic benefits to the local stakeholder communities

Theory

Ecotourism – Definition - History of tourism and evolution of ecotourism. Various forms of tourism - Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism. Organised tours and Free Independent Traveller – World Tourism Organization. Concept of ecotourism and flaws in real world. Problems with definition of ecotourism and criticisms. Dimensions of ecotourism and the criteria to qualify for ecotourism. Declaration – Different forms of ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism.

Ecotourism-its potential in developing countries- Poverty and biodiversity, Ecotourism as a rural development strategy in tropical countries Ecotourism as a land use- possibilities of integration – Ecotourism policies at national and local level. Environmental Impacts of ecotourism and its mitigation - Case studies from different parts of the world- Concept of "scale". The checks and controls and institutional mechanisms for controlling the environmental impacts, Mitigation of pollution. Social Impacts of ecotourism and precautionary principles to avoid ill effects Stories from different parts of the world narrating ecotourism development and its influence on society and their culture – The societal advantages and the negative impacts of ecotourism development – Ways forward to address the negative social impacts Indigenous people and ecotourism. Ecotourism economics and business – Investment of international agencies like World Bank in ecotourism projects Ecotourism economics at macro and micro economic level in developing countries Ecotourism as a green business and role of green consumerism – Business plans- unique selling points for marketing – Potential of internet in marketing ecotourism – Payments for Environmental services and role of ecotourism Multiplier effects, opportunity costs and leakage in ecotourism industry Sharing ecotourism revenues among stakeholders – Training in ecotourism to deliver quality service. Ecotourism as a vehicle for the conservation of common property resources – potentials and pitfalls, Dangers involved in management of common property resources Relations between the government and the private sector. Ecotourism and Protected Areas Changing paradigms in the Protected Area Management Support at international level for ecotourism Integrated Conservation Development Projects (ICDPS) and role of ecotourism Community based ecotourism programs. Planning and management of ecotourism – Ecotourism plans and management of visitors and other resources including human and natural resources – Quality control, codes of conduct etc. Use of GIS and ICT for effectively managing and planning ecotourism – Criteria and indicators for sustainable management and monitoring – Charter for Sustainable Tourism – Sustainability issues in ecotourism management and ecotourism certification. Ecotourism design – Role of socio-economic factors in decision making – Designing ecotourism products using local technologies – Carrying capacity considerations. – Use of GIS in ecotourism. Ecotourism markets and influences of climate change Existing ecotourism markets and ecotourism market segmentation – Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets.

Practical

Preparation of a thematic compendium after extensive and original independent investigation about the chosen Protected Area. Be familiar with Government policy and legislation, the current policies regarding the component land uses of the study site. Stakeholder analysis and social Impacts Assessment. Identify different stakeholders at different levels. Based on this perform a stakeholder analysis and then conduct social surveys to gather the information required for assessing the impacts of current management and to explore the intervention needed in the chosen protected area. Ecological surveys including Environmental Impact Assessment. Assess the ecological impacts of current human use using standard techniques in order to identify the intervention needed in the chosen protected area.

Suggested Readings

1. Bhatt, S. and Liyakhat, S. 2014. Ecotourism Development in India: Communities, Capital and Conservation
2. Lindberg, K., Wood, M. E. and Engeldrum, D. 1998. Ecotourism- A guide for planners and managers (Environment and Development). Foundation Books.
3. Page, S. J. and Dowling, R. K. 2002. Ecotourism. Pearson Education Limited, Essex. The Ecotourism Society, Vermont.
4. Weaver, D. 2002. Ecotourism. Milton, Queensland, Australia: John Wiley and Sons Australia.

EC 7.5.7 Restoration of Degraded Lands 3 (2+1)

Objective

- To impart practical understanding about rejuvenation of forest with tree vegetation and to develop skills on tacking different problem soils with suitable vegetation

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/ wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation /reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas explanation, impact on pant growth and Bio-drainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programs on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development program.

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (Eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation program.

Suggested Readings

1. Hegde, N.G. 1987. Handbook of Wasteland Development. BAIF, Pune 102p.
2. ICAR. 1977. Desertification and its Control. ICAR, New Delhi 358p. National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix.
3. Imeson, A. 2012. Desertification, Land Degradation and Sustainability, John Wiley and Sons.

4. Kumar, Anil and Pandey, R. N. 1989.Wastelands Management in India. Ashish Publishing House, New Delhi.
5. Luna, R. K. 1989. Plantation Forestry in India, International book distributors, Dehra Dun. Forestry; Ministry of Agriculture and Irrigation, Govt. of India, New Delhi 457p.

EC 7.5.8 Urban Ecology and Environment 3 (2+1)

Objectives

1. To understand urban ecology, biodiversity conservation and management for sustainable development
2. To evaluate environmental and social impacts to deal with global challenges of climate change in cites

Theory

Concepts of urban ecology: Theories of urban ecology and linkages with sustainable urbanism, Concepts of Eco cities, smart cities, compact cities etc., Challenges and opportunities of urban, rural and peri-urban growth. Green Spaces, bio-diversity conservation and conflicts: Urban greens: challenges and choices for management, Human nature interactions and urban forest management, introduction to functional diversity and traits, Bio-diversity conservation conflicts, Spatial dimensions of urban ecology. Urban Environment: Introduction to urban morphology, Industrial ecology and symbiosis, Management of air quality and noise, Urban solid waste management, Urban water ecological challenges. Impact Analysis and Ecological Footprint Analysis: Environmental Impact Analysis 10 2, Social Impact Analysis and Strategic Environmental Assessment, Urban metabolism and Ecological Footprint Analysis. Ecological risk assessment framework (Definition, Problem formulation, Risk analysis, Risk characterization, Risk management), Climate change, mitigation and adaptation, Climate modifications and managing climate change challenges in cities, Adaptation and mitigation measures to make cities resilient, Ecosystem services and nature-based solution to address urban resilience.

Practical

Vegetation analysis and characterization of green spaces in nearby urban areas. Identifying challenges in soil waste management in nearby urban areas. Urban Risk assessment and mitigation in urban areas.

Suggested Readings

1. Adler, F. R. and Tanner, C. J. 2013. Urban Ecosystems. Cambridge University Press.
2. Cities and Bio-diversity Outlook. 2013. Action and Policy: A Global Assessment of the Links between Urbanization, Biodiversity, and Ecosystem Services, by Secretariat of the Convention on Biological Diversity.
3. Dale, R. 2004. Evaluating Development Program and Project, Second Edition, Sage Publication.
4. Keitaro Ito. 2021. Urban biodiversity and ecological design for sustainable cities. Springer.
5. Mostafavi, M. and Doherty, G. 2010. Ecological urbanism, published by Baden:

Harvard University Graduate School of Design.
6. Morrison-Saunders, A. and Arts, J. (Eds) 2004. Assessing Impact: Handbook of EIA and SEA Follow-up, Earthscan James andJames, London.
7. Parris, K. M. 2016. Ecology of urban environments. Chichester, West Sussex; Hoboken, Nj: John Wiley and Sons Ltd.
8. Singhal, S. and Kapur, A. 2002. Industrial Estate Planning and Management in India – an Integrated Approach towards Industrial Ecology. Journal of Environmental Management, Elsevier Science Ltd., 66, 2002.
9. Sivaramakrishnan, K. and Rademacher, A. 2013. Ecologies of Urbanism in India Metropolitan Civility and Sustainability. Hong Kong China: Hong Kong University Press, Baltimore.
10. United Nations Human Settlements Program (UN-HABITAT). 2011. Global report on human settlements - Cities and Climate Change: Policy Directions
11. World Bank. 2009. Strategic Environmental Assessment in East and Southeast Asia, A Progressive and Comparison Country Systems and Cases, Washington D.C.
12. WWF India. 2011. Impact of urbanization on bio-diversity: Case Studies From India.

EC 7.1.8 Plant Biochemistry 2 (1+1)

Objective

- To understand the basic scenario of biochemical action that happens in the plant system

Theory

Introduction to biomolecules. Chemistry of carbohydrates: Monosaccharides, classification, Configurations and conformations (Anomerism, epimersim, mutarotation, inversion); Disaccharides and polysaccharides (structural and storage); Glycosaminoglycans and glycoproteins. Chemistry of lipids: Lipid classification- Fatty acids, triacylglycerols, glycerophospholipids and sphingolipids. Amino acids of proteins – General properties, peptide bonds, classification and characteristics, acid- base properties; Optical activity. Primary, secondary, tertiary and quaternary structure of proteins; fibrous and globular proteins; protein stability and denaturation. Chemistry of nucleic acids: Bases, sugars, Nucleosides and nucleotides. Chemical structure and properties of DNA and RNA. Chemical catalysts vs. biological catalysts; substrate specificity-stereo, geometric specificities; Enzymes – nomenclature, classification, enzyme kinetics- rates of reactions; Lock and Key hypothesis and induced fit models; Enzyme assay, transition state theory, Michaelis Menten equation, Lineweaver- Burk plot, enzyme inhibition-reversible (Competitive, uncompetitive and mixed) and irreversible, allosteric enzymes, Effect of pH and temperature on enzyme activity; Isozymes, coenzymes. Photosynthesis – light reactions, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3, C4 and CAM plants, CO2 fixation, regulation of photosynthesis. Metabolism of carbohydrates - glycolysis, TCA cycle, electron transport chain. Lipid metabolism – beta oxidation and fatty acid biosynthesis. Secondary metabolites-Classification and functions of phenolics, terpenoids and alkaloids.

Practical

Qualitative analysis of carbohydrates. Estimation of sugar by Dubois method. Determination of reducing sugars by DNS method. Determination of total carbohydrate by anthrone method. Protein estimation by Bradford method. Absorbance curve of two dyes. Qualitative analysis of amino acids. Titration of amino acids. Purification of acid phosphatase from mustard seedlings. Qualitative analysis of oils and fats. Estimation of saponification value of oils. Estimation of iodine number of oils/fats. Chromatography of photosynthetic pigments. Lipid analysis by thin layer chromatography. Total protein estimation by Lowry's method. Kinetics of alkaline phosphatase.

Suggested Readings

1. Berg J M, Tymoczko J L and Stryer L. 2007. Biochemistry, 7th edn. Wiley Eastern Ltd. ISBN:0- 7167-8724-5.
2. Buchanan, Bob B. Gruissem, Wilhelm and L. Jones, Russell. Biochemistry and Molecular Biology of Plants.
3. Jeremy M., Berg, Lubert Stryer, Tymoczko, John and Gregory Gatto. Biochemistry.
4. Lehninger. Principles of Biochemistry –David L. Nelson and Michael M. Cox
5. Plummer, David T. An Introduction to Practical Biochemistry.
6. Rao, Beedu Sashidhar, Deshpande, Vijay. Experimental Biochemistry: A student companion.
7. Sadasivam, S and Manickam, A. 2009. Biochemical Methods, 3rdEdn, New Age International.
8. Thayumanavan, B., Krishnaveni, S. and Parvathi, K. 2004. Biochemistry for Agricultural Sciences, Galgotia Publications Pvt Ltd., New Delhi. ISBN :81-7515-459-4.
9. Voet, Donald and Voet, Judith. Biochemistry.
10. Wilson, K. and Walker, J.M. 2000. Principles and techniques of Practical Biochemistry

EC 7.1.9 Research Methodology 2 (1+1)

Objective

- To inculcate the art of research and expose the students through various methodologies of data collection, processing, tabulation and interpretation

Theory

Role of research methodology - Induction and deduction, Sources of information - Review of literature, Identification of problem - Formulation of objectives and hypothesis - Scope of survey- based research - Types of surveys- identification of research problem - Analysis of research problem, customer identification, categorization- Data collection, analysis and compilation of survey report - Types of data, concepts of population - Analysis of data, graphical and diagrammatic presentation - Measures of central tendencies-mean, median, mode- problems- Reliability and validity of measuring tools.- Reporting: Significance of report writing, steps in report writing- Processing Information in Research Methodology - Importance of Experiments in research - Interview studies in Research methodology -

Solutions of research methodology.

Practical

Research problem identification, objective and Hypothesis Formulation - Research design, Collection of data, Analysis of Data for the identified Problem- Hypothesis testing, interpretation and report writing for the identified problem- Application of Scales for measurement – Nominal and ordinal- Application of Scales for measurement –Interval and Ratio- Application of Scales for measurement – Likert and other scales-Identification of Primary and Secondary Data – Correlation - Simple and partial correlation - Correlation - Multiple correlation analysis - Regression – Simple and Multiple regression analysis- Dummy variable analysis - Construction of Index Numbers - Factor analysis - Cluster analysis.

EC 7.1.10 Statistical Packages for Data Analysis 1 (0+1)

Objective

- To learn the art of data collection, processing, analysis and interpretation will be developed to translate simple data into scientific data

Practical

SYSTAT package – data entry and creation of a data file – importing an excel file, SPSS file, database file, BMDP file and SAS file in Systat for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SYSTAT- SAS package – data entry and creation of data files in SAS – opening a file – importing an excel file, Systat file, database file and SPSS file in SAS for analysis- Data manipulation – transformation – ranking, sorting, appending, merging and transposing of data in SAS- Data analysis using SYSTAT and SAS packages- Descriptive statistics- Cross tabulation – one way, two way and multi-way tables- Chi square test- Student's t test – comparing a single mean- Comparison of two means – independent t test- Comparison of two means – paired t test- One way ANOVA- Two way ANOVA- Correlation analysis- Spearman's rank correlation and Kendall's tau- Jaccard and tetra correlation coefficients- Complete regression analysis.

Suggested Readings

1. Nigam A.K. and Gupta, V.K. (1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
2. Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
3. Petersen Roger G. (1994). Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.
4. Jayaraman, K. and Rugmini, P. (1990). Statistical techniques in forestry - Research and forestry. Kerala Forest Research Institute, Peechi, Thrissur.

SKILL ENHANCEMENT COURSE

Skill Enhancement Course (Indicative SEC Courses I)

- SEC 1.1 - Commercial Seedling Production
- SEC 1.2 - Forest Machine Learning Technology
- SEC 1.3 - Commercial Forestry
- SEC 1.4 - Landscape Management and Restoration
- SEC 1.5 - Wildlife Photography
- SEC 1.6 - Ecotourism
- SEC 1.7 - Para-taxonomy
- SEC 1.8 - Ornithology
- SEC 1.9 - Herpetology
- SEC 1.10 - Design and Development of Wood Products

Skill Enhancement Course (Indicative SEC Courses II)

- SEC 2.1 - Clonal Seedling Production
- SEC 2.2 - Commercial tree seed production
- SEC 2.3 - Forest Based Industrial Training
- SEC 2.4 - Urban Forestry Designing and Planning
- SEC 2.5 - Wood Working and Carpentry
- SEC 2.6 - Wood Seasoning and Preservation Technology
- SEC 2.7 - Zoo Management
- SEC 2.8 - Wild and Commercial Beekeeping
- SEC 2.9 - Mining Afforestation
- SEC 2.10 - Advanced Wood Working
- SEC 2.11 - Lac and Tassar Cultivation

Skill Enhancement Course (Indicative SEC Courses III)

- SEC 3.1 - Timber Conversion
- SEC 3.2 - Value addition of NTFPs
- SEC 3.3 - Briquetting Technology
- SEC 3.4 - Forest Fire Management
- SEC 3.5 - Activated Carbon Technology
- SEC 3.6 - Wood carving through CNC Technology
- SEC 3.7 - Burlapping Technology
- SEC 3.8 - Micro Forest
- SEC 3.9 - Import and Export of forest Products
- SEC 3.10 - e-Timber Market
- SEC 3.11 - Community Forest
- SEC 3.12 - Human Animal Ecosystem Interface
- SEC 3.13 - AR/VR Module Creation in Forestry
- SEC 3.14 - Forest Resource Assessment
- SEC 3.15 - Multifunctional Agroforestry
- SEC 3.16 - Biofuels Technology through forestry

Skill Enhancement Course (Indicative SEC Courses IV)

- SEC 4.1 - Wildlife Forensic Sciences
- SEC 4.2 - Dendroenergy Generation
- SEC 4.3 - Big Data Management
- SEC 4.4 - Artificial Intelligence in Forestry Operation
- SEC 4.5 - Specialty Seedling Production
- SEC 4.6 - Woodlot Establishment and Management
- SEC 4.7 - Tools for Consulting Forester's
- SEC 4.8 - Application of Drone in Forestry
- SEC 4.9 - Forest Certification
- SEC 4.10 - Arboriculture
- SEC 4.11 - Forest Project Designing and Analysis
- SEC 4.12 - Wood Mechanics
- SEC 4.13 - Mulberry and Non-mulberry based Silk Production
- SEC 4.14 - Internet of Things (IoT) in Forestry
- SEC 4.15 - Marketing and Economics of NTFPs
- SEC 4.16 - Carbon financing projects

ONLINE COURSES

The students will have to take a minimum of 10 credits of online courses (as per UGC guidelines for online courses) as a partial requirement as for the B. Sc. (Forestry) program.

The online courses can be from any field in forestry 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 program. 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.

List of Suggestive Courses on SWAYAM/MOOC

Course Title	Duration	Credits
Forests and their Management	12 weeks	1
Wildlife Ecology	12 weeks	1
Introduction to Biology: Ecology	4 weeks	1
Introduction to Biology: Ecology, Evolution, and Biodiversity	17 weeks	1
Introduction to Biology: Biodiversity	5 weeks	1
Ecology: Ecosystem Dynamics and Conservation	5 weeks	1
Fire Ecology	8 weeks	1
Ecology and Society	12 weeks	1

Environmental Studies	12 weeks	1
Environmental Studies: A Global Perspective	6 weeks	1
Toolbox for Environmental Management	5 weeks	1
Environmental Protection and Sustainability	8 weeks	1
Ecosystem and Natural Resources	12 weeks	1
NGO'S and Sustainable Development	15 weeks	1
Nanotechnology Applications in respective fields	8 weeks	1
Personality Development and Communication Skills	8 weeks	1
Personality Development	8 weeks	1
Yoga Practices 1	12 weeks	1
Yoga Practices 2	12 weeks	1
Ethics: Theories and Applications	12 weeks	1

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Navsari - 396 450 (Gujarat)