Modified ICAR Common PG Forestry Course Curriculum and Syllabi as per ICAR BSMA (2009)

[with modification as per V Deans' Committee Recommendations]

College of Forestry
Navsari Agricultural University
Navsari-396 450, Gujarat

2017-18

NEW AND RESTRUCTURED POST-GRADUATE CURRICULA & SYLLABI

Modified as per V Deans' Committee Recommendations from AY 2017-18

Forestry

at

Navsari Agricultural University

Navsari

Education Division
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NEW AND RESTRUCTURED POST-GRADUATE CURRICULA & SYLLABI
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PREAMBLE

Today's Forestry is different than it used to be a hundred years ago. We had enough wood and wood products in the past to meet the needs of the society. Now we look to our forests not only for products and services but also for a safer environment. The forests are looked from livelihood security to a business venture, from rich biodiversity to carbon reserves. Forests is a commodity which is to be managed scientifically to enhance its production and productivity and for protection of environment as well as to sustain our agriculture. We need a trained man-power in various categories of forestry jobs.

To produce world class forestry professionals with very high degree competence and skill, forestry education needs to be reoriented so as to meet the challenges of high forest productivity and global markets. Forestry education needs to be tuned to meet the requirements of various sub sectors such as wasteland afforestation, watershed conservation, forestry economics & planning, forest biotechnology, agroforestry, forest business management and forest industries.

State Agricultural Universities provide unique facilities in Forestry education because of existing infrastructure and linkage between agriculture, animal husbandry and forestry. In order to make the degree programme more relevant and to provide quality education, the IV Dean's Committee of ICAR changed totally the B. Sc. Forestry programme. The Indian Council of Forestry Research & Education (ICFRE), the apex body for Forestry Research & Education endorsed this.

The BSMA Committee on Forestry constituted by National Core Group (ICAR) to review M.Sc. & Ph. D. programme in Forestry had difficult task before it to develop and tune the curriculum in accordance with the total change of B. Sc. Forestry curriculum. In order to bring excellence in teaching at M. Sc. & Ph.D. levels and making the degrees more professional and salable, the core courses have been offered in those fields where opportunities are very high for employability and for development of entrepreneurship. Also due consideration has been given to develop and enhance research capabilities in various upcoming sectors of Forestry.

The degree in Forestry would be Master in Forestry (M. Sc. Forestry) and Doctorate in Forestry (Ph. D. Forestry). At M. Sc. Level, the specialization will be mentioned in the degree (e.g. M. Sc. Forestry in Plantation Technology) whereas at Ph.D. level no specialization will be mentioned in the degree. At present PG degree in Forestry are being awarded with different nomenclatures in various Universities and no common courses are given to students for the same degree at M. Sc. Or Ph. D. level. Under new system, a student getting same degree in any SAU/ Central AU will study compulsory corecourses before taking specializations. This will bring uniformity in curricula in all the Universities offering PG Programmes.

The Forestry Education dates back to 18th century when it was started by some Institutes in Europe. In Asia many developing countries offer courses in Agriculture & Forestry together at one place in the Universities.

In India, Forestry Education was introduced at the University level by starting M. Sc. Forestry in 1976 at Solan. The B. Sc. Forestry degree programme started at Ranchi in 1979. In 1985 many Agricultural Universities started B. Sc. Forestry programme with the directive of MOEF and ICAR. Today, 26 State/Central Agricultural Universities offer degree programme in Forestry. Of which one University of Forestry, some have Forestry or Horti. & Forestry Colleges and many have one department of Forestry, generally in Agricultural Colleges. In order to bring uniformity in the system of imparting forestry

education at University level, ICAR (IV Deans Committee) in 2006 recommended, that each University which offers B. Sc. Programme should have five departments namely Silviculture & Agroforestry, Forest Biology & Tree Improvement, Forest Product & Utilization, Natural Resource Management and Basic Science & Humanities under Forestry Colleges. The Indian Council of Forestry Research & Education endorsed this nomenclature for UG and PG. In 2006, the ICFRE constituted a committee for M. Sc. Curriculum under the Chairmanship of DDG, Education. It drew its members from ICFRE and State Agricultural Universities. The Council recommended the M. Sc. curricular for adoption in SAUs. In 2007, ICAR constituted National Core Group (NCG) with themandate of: (i) Defining names and curricula of Masters and Ph. D. disciplines foruniformity; and (ii) Revision of syllabi for courses of Masters and Ph.D. degree disciplines.

BSMA Committees were constituted by NCG including one in Forestry for preparing the curricula and syllabi. The Universities offering M. Sc. & Ph.D. are as follows:

Sl.	Name of University	Degree Awarded
1.	FRI University	M.Sc. (Forestry), M.Sc. (Wood Science & Technology) and M.Sc. (Environment Management) & Ph.D.
2.	KAU, Tissur, Kerala	M. Sc. (Forestry)
3.	AAI-DU, Allahabad, UP	M. Sc. (Forestry)
4.	NAU, Navsari, Gujarat	M. Sc. (Forestry)
5.	UBKV, Cooch Behar, WB	M. Sc. (Forestry)
6.	BAU, Ranchi, Jharkhand	M. Sc. (Forestry)
7.	UAS Dharward, Karnataka	M. Sc. (Forestry)
8.	TNAU, Coimbatore, TN	M. Sc. (Forestry) & Ph.D. Forestry
9.	CCS HAU, HIssar, Haryana	M. Sc. (Forestry) & Ph.D. Forestry
10.	PAU, Ludhiana (Punjab)	M. Sc. (Forestry)
11.	GGU, Bilaspur, Chattisgarh	M.Sc. (Forestry, Wildlife and Environment)
12.	IGAU, Raipur, Chattishgarh	Ph. D. Agroforestry
13.	HNBGU, Srinagar (UK)	M. Sc. (Forestry and Environmental Sciences)
14.	SKUAST Srinagar (J&K)	M. Sc. (Forestry and Environmental Sciences)
15.	Dr. YSPUHF, Solan, H.P.	M. Sc. (Forest Product), M.Sc. (Silviculture) and M.Sc.(Tree Improvement) & Ph.D. Forestry/Agroforestry

Till date, at Ph. D. level there was no model course curricula and syllabi prepared by ICFRE or ICAR. The BSMA Committee organized 6 meetings and also contacted institutions and other stakeholders from industries, State Forest Departments to develop curricula. New courses on important global issues like climate change, Biodiversity conservation, information technology, GIS have been included in the syllabi.

We hope this degree nomenclature, course curricula and syllabi which have been changed totally will be able to meet the needs of Human Resource development in Forestry at the higher education level so as to produce world class professionals, researchers and teachers.

ACKNOWLEDGEMENTS

This is for the first time the National Core Group and BSMA Committee on Forestry (ICAR) prepared a model course curricula. The ICFRE has endorsed the programme. This was difficult task for both the Councils ICAR and ICFRE to arrive at a common understanding on the system of education in Forestry which remained orphan till now. The Committee is thankful to Dr. Mangala Rai, Director General, ICAR for taking this initiative and to Dr. Jagdish Kishwan, Director General, ICFRE for supporting it. The Committee is equally grateful to Dr. S. P. Tiwari, DDG (Edu.), ICAR, Shri A. K. Wahal, DDG (Edu.), ICFRE and Dr. J. C. Katyal, Chairman NCG & VC, HAU with whose constant persuasion, guidance and direction it was possible to bring out the document in this shape. Sh. A. K. Wahal's help for fine tuning the document is specially appreciated bythe Committee. The Committee is also thankful to Dr. R. K. Mittal, ADG (EQR) for providing administrative support.

The BSMA Committee is thankful to Sh. Sudhir Pande, Former DG and special secretary MOEF, Govt. of India and other co-opted members to the meetings for their active participation and suggestions. The BSMA Committee is also thankful to Dr. M. S. Malik, Dr. M. H. Siddiqui, Dr. S. G. Abbas, Dr. S. K. Singh, Dr. S. Chattopadhaya, Dr. M.Mahto, Sh. Jai Kumar & Sri Manoj Kumar from Birsa Agricultural University, Ranchi for help.

EXECUTIVE SUMMARY

The Broad Subject Matter Area (BSMA) Committee on Forestry (ICAR) took a gigantic task of preparing PG course curricula and syllabi as there was no uniform course programme in the Agricultural Universities for M. Sc. Forestry. The help was also taken from ICFRE, Dehradun in developing the curricula. The Master level syllabi were prepared in light of B. Sc. Hons (Forestry) syllabus recommended by IV Dean Committee in 2006, which finds new subjects at UG level. A deficiency compulsory course package was also developed by the committee for the students from Agricultural and Horticulture streams seeking to peruse their studies in Forestry at Master level. This package of 18 credits was carefully identified to bring at par the students of B. Sc. Ag. / Horti. to B. Sc. Forestry when they take up M. Sc. Forestry programme, so that professional approach andquality of the degree programme is maintained and at the same time providing opportunities to the Universities to sustain their PG programmes where B. Sc. Forestry degrees are not awarded at present. These courses in the package will include: Principle and Practices of Silviculture, Forest Mensuration, Principles of Tree Improvement, Wild Life Management, Wood Products and Utilization and Forest Management, Policy & Legislation.

In order to provide uniformity in curricula throughout the country, to maintain professionalism in the degree and enhance the opportunities for employability, the degree nomenclature would be M. Sc. Forestry.

The students will be given a set of ten courses which will be compulsory for undertaking the PG programme at Master level. The courses are called Core courses of Forestry. These courses will be different from the courses of his specialization and will represent the major courses as in agricultural sciences. These courses have been developed after identifying the needs of present Forestry scenario and demand of professionals, having the understanding of special fields and subjects in forestry sector, including govt., corporate and private sectors. The package under core courses has been prepared keeping in view the production, management, conservation of forests and plantations. The improvement in the present wood stock, conservation of our biodiversity, wood processing, participation of people in forestry has been incorporated. At the same time every student of forestry will also be taught about Forest Policy and Laws before they study the specialization. The courses are:

i. Silviculture
ii. Forest Biometry
iii. Forest Management
iv. Forest Products – Chemistry And Industries
v. Forest Ecology And Biodiversity Conservation
vi. Forest Resource Management And Economics
vii. Forest Protection
viii. Forest Policy And Laws And International Conventions
ix. Tree Improvement
x. Forests and People

The importance of the use of computer applications in Forestry as well as information technology and GIS has been recognized by the committee. The M. Sc.Forestry students will also study three courses with 5 credits as supporting courses for the degree programme. The compulsory courses are:

i. Computer Application and Information Technology
ii. Remote Sensing and Geographic Information System
iii. General Statistical Methods and Research Methodology

In Forestry Science like Agricultural sciences, there is a need of strengthening various fields not only for developing top quality researchers and faculty resources but also for meeting the demand of professionals in these areas and for increasing employability and entrepreneurship. The faculty resource is also not uniform in various Universities offering PG programmes in Forestry. To have professionals of every field in the country in Forestry sector as well as keeping in view the present constraints of faculty in particular fields of specialization at the Universities, a basket of ten specializations at M. Sc. level have been identified and the course curricula & syllabi developed. Each Institution/University will have the liberty of selecting one or more specializations for the M. Sc. Forestry programme depending upon the type of faculty and their specialization available as well as the needs of the particular regions or State for professionals in a specific area, employability in govt., corporate and private sector for the field of specialization and the potential of entrepreneurship available.

i. Wood Science and Technology

- Species identification, chemical properties to determine life span of timber, mechanical properties for wear & tear forces, wood seasoning and preservation for increasing durability, knowledge of natural and artificial defects in timber and nature of raw material for pulp & paper as well as manufacturing processes of composite and improved wood; and value addition through improved sawing techniques etc. would require professionals in Wood Science and Technology.
- Research in wood qualities, seasoning techniques, pulp and paper quality, composite woods, improving physical and chemical traits etc., demands experts in the field.
- The specialization will after employability in non-timber forest based industry like plywood, match, sports goods, musical instruments, railway sleeper making, aircraft and ship making, wood preservation, cutch & katha making, composite & improved wood etc.
- Provide entrepreneurship in establishment of saw mills, wood based industries, structural and decorative purpose based industries and quality wood products industry.
- The courses on wood identification, wood chemistry seasoning and preservation, pulp & paper technology & wood modification have been included to meet these requirements.

ii. Medicinal and Aromatic Plants

- Medicinal and Aromatic plants trade has increased tremendously in recent times at national and international level demanding professionals in research and business to address the production chain and market.
- Knowledge of use of medicinal plants in Unani, Sidha, Homeopathy and allopathy necessary.
- Scientific and profitable cultivation, grading, storage, mass production of quality planting material, *in-situ* & *ex-situ* conservation, improvement and development in varieties and species to meet specific needs of stakeholders, plant protection, post harvest techniques, biotechnology and phytochemical analysis of active principles would required specialized personnels.

- The employability opportunities of experts are in production of quality planting material, consultancies to govt., public and private sectors dealing in MAPs, research and teaching institutes, pharmaceutical sectors etc.
- Entrepreneurship possibilities are quality seed and seedlings production, cultivation, post harvest technology, value addition, marketing and establishment of pharmaceutical industries.
- The courses have been designed to meet these requirements by including production & breeding techniques, chemistry & processing improvement role of MAPs in health care system, pharmacognogy, biotechnological approaches & Agro-techniques.

iii. Plantation Technology

- Raising & managing the forest plantations scientifically in order to accomplish the target of bringing the one-third area of the country under green cover wouldrequire expertise in plantation technology.
- A strong research base needs to be developed with the objective of achieving high survival rates in forest plantations, developing planting stock with high productivity and production potential suitable for various site conditions, good quality timber, non-wood products, processing technologies, value addition and marketing research accompanied by sustained production, environmental amelioration, etc., demand highly skilled world class researches in the field.
- Plantation technology specialization will attract high rate of employability, asexperts would be required by various line departments, national and international plantation projects and watershed projects and in integrated farming programmes with govt., corporate and private sectors.
- Entrepreneurship opportunities with this specialization will be increased in all plantation related programmes & projects in private sector following production to end-user chain e.g. pulp & paper plantation, match industry, wood based industries, energy sector, rayon and packaging industries.

iv. Watershed Management

- The specialization in watershed Management with forestry degree will provide a strong base of professionals in forestry based watershed programmes and projects.
- Land and water management in a watershed moves around forestry component specially in sloppy lands and hills.
- Research in watersheds involves beside land, water and plant resources, livestock, communities and interaction between various components. To meet the needs of communities through forestry/ agroforestry in the watershed and to improve the quality of the systems and services, the personnal with forestry background would be needed in the research programmes for better quality of life.
- Employability potential of these specialists will be high in the rural, agriculture, forestry, social welfare, horticultural departments, and in Block / District level developmental programmes in govt. sector, national & international watershed projects involving forestry, environmental, etc.
- The students will study the courses on projects formulation, planning in watersheds, GIS, survey, mapping and structural engineering, resource conservation, production systems, bio-diversity, people participation and impact analysis etc. to enable them to address such programmes effectively

v. Eco Tourism

- Tourism is a business industry and by making it environmental friendly, eco- tourism has come up recently as a big enterprise with nature tourism.
- The different ecosystems of the country have become major resources for ecotourism which consist of Biosphere reserves, mangrove zones, coral reefs, Hot & cold deserts, mountain & forests, Wetland etc.
- The professionals would be required in the field of science based nature tours, fossil expeditions, national parks & sanctuaries, nature reserves, zoos, village wildlife conservation, bird watching etc.
- Opportunities for jobs would be in these areas at governmental, public and private sectors. Even entrepreneurs would be in great demands in future in the field of ecotourism.
- The programme has been designed by introducing the subjects like ecosystem of world, ecotourism landscaping, ecotourism in protected areas, economics, design & management of ecotourism.

vi. Agroforestry

- Practicing forestry out side traditional forests along with other farm operations and in association with agricultural, horticultural crops, fisheries & livestock to enhance total production and factor productivity for domestic or commercial purpose would require personnel with the deep knowledge of various production components and their interface.
- Research for developing agroforestry site-specific models under different production systems in various eco-systems will need specialists in the field.
- Professionals with exposure of agroforestry technologies, products and then processing, marketing, value addition technologies will be needed in various community development projects aiming at enhancing the livelihood, food and nutritional security along with economic security and employment of the people.
- For making specialization more saleable with employability potential, the courses on soil and water management, crop/animal production management, fruit plants, forest trees and shrubs, rangeland & pasture management along with economics of these agroforestry systems have been included in the programme.

vii. Forest Genetic Resources

- India is home of biodiversity hot spots and several endemic flora and fauna.
- The productivity of forests is very low as compared to world average and forest cover is 0.06 ha/person as compared to world average of 0.64 ha/person.
- To produce teachers, researchers in the field would be very essential to improve the existing stock in terms of yield, quality, disease resistance and desired traits and conserve endangered flora and provide quality planting material.
- The specialization with courses on forest genetic diversity & conservation and forest breeding has been introduced.

viii. Forest Biotechnology

- Large scale plantations and afforestation, with high productivity of different species and for different ecosystems and problematic areas, would be required to achieve 33 percent forest cover in the country as per National Forest Policy. This demands mass production of quality planting materials including seed with the desired characteristics.

- The variety in forest foods, fodder, fuel, energy and timber has become in great demand. Similarly to solve the environmental problems involving micro-organism, for restoration and conservation of plant biodiversity through *ex-situ* and *in-situ* techniques world be needed.
- To produce high quality resistant plants, seed gene banks, tissue culture gene bank, pollen and spore banks etc. need professionalism.
- The specialization will ensure the much needed professionalism in forest biotechnology, required in research organizations, private sectors dealing withforest commodities.

ix. Environment Management

- Environment management has taken front seat today due to global issues tike climate change and pollution and the demand of experts having the knowledge of these subjects has tremendously increased.
- Research based information on many aspects is to be strengthened and need of researchers to address environmental issues will further increase in future.
- The specialization will prepare professionals in the management aspects of environment which will have the potential of employment in govt. / public and private institutions involved in teaching, research and developmental activities related to environment. All developmental projects where natural resources demand Impact Assessment studies require environmental management professionals.
- The students will be offered courses on environmental pollution, global climate change, environmental policy, law, international conventions alongwith other analytical techniques and impact assessment.

x. Forest Business Management

- It will produce high skilled personnel well versed with forest resources, forest industries, value addition and marketing of different resources.
- Business managers will find jobs with industries, banks, companies taking forestry as business enterprise.
- The courses on finance and marketing, farm management, nursery production and plantation forestry, project planning and resource analysis have been included in the programme.

Ph.D. course curriculum in forestry is being developed by ICAR for the first time. Considering the specialization being offered at Masters Level in Forestry and for developing Faculty resources and scientists in Forestry for strong research base as well as for meeting very specialized needs of forestry sector, the following specializations have been identified and course curricula & syllabi developed.

i. Silviculture
ii. Forest Genetic Resources
iii. Wood Science & Technology
iv. Agroforestry
v. Medicinal and Aromatic Plants
vi. Forest Biotechnology
vii. Natural Resource Economics and Policy

The degree nomenclature would be Ph.D. Forestry and course structure is same as in M. Sc. i.e. core courses and supporting courses and specialization courses. At doctorate level advance understanding and knowledge of production system, Forest improvement, forest based wood and non wood products, environment aspects and economic analysis have been considered necessary while developing core compulsory courses. Similarly new courses on climate change, Information Technology in Forestry, Forest Ecological Modeling, Land use planning & Watershed Management have been identified and developed to be taken by students in the supporting category courses.

BSMA Committee on Forestry

(Constituted by ICAR vide Office order No. F. No. 13 (1)/2007- EQR dated January 14, 2008)

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Note: In this endeavour of the ICAR, the Indian Council of Forestry Research and Education, Dehradun (ICFRE) has also significantly contributed in the development of the Course Curricula and Syllabi of the Forestry discipline.

REQUIREMENTS FOR IMPLEMENTATION OF NEW CURRICULUM

Infrastructure: The Universities offering PG programmes in forestry need to be supported for establishing specialized laboratories equipped with state-of-the art equipments. It is expected that if each institution provided at least 4 specializations than 8-10 crores rupees would be required per University for establishing good laboratories.

Faculty Training: Forestry teaching programmes at the University always suffered due to either insufficient faculty or non-availability of subject specialists in many disciplines. ICAR under Indo-US programmes trained teachers in various disciplines by sending them to different US Universities for 1-2 years. Today many of them either has retired from service or serving in disciplines/departments other than in which they were trained.

A new programme needs to be initiated at ICAR level for providing training to the forestry faculty in India or if the need be in foreign Universities. Many subject specialists are not available in the institution. A programme of outsourcing from Indian/foreign Universities with special funding from ICAR would be required for some initial years. Compulsory 1-2 months in another University in 2 years for each faculty at the University under faculty exchange programmes can also be strengthened by ICAR.

Budgetary Requirements: Forestry colleges and faculties in SAUs are still not well developed to meet the new challenge in forestry education required to produce professionals and researchers at par with the International Institutions / foreignuniversities. To meet the today's environmental challenges, bring 1/3 area of the country under green cover and enhance the productivity of our existing forests and raise plantation with very high yield potential, the higher education in forestry at the Universities needs over hauling. The proposed curricula and syllabi is aimed to achieve all these goals, provided a strong financial support is earmarked in forestry sector to the Universities and recommended programmes are sincerely implemented by the Universities.

Besides developing high quality laboratories with state-of-the-art equipments, good library facilities, infrastructure for teaching and faculty, training to the faculty and forest visit facilities, as well as for development forestry museums would require a minimum grant of 20 crores per University.

ORGANIZATION OF COURSE CONTENTS
&
CREDIT REQUIREMENTS

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600-series to Doctoral level. A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's programme.
- Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
- A list of journals pertaining to the discipline is provided at the end which may be useful as study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Eligibility for Admission:

(a) Masters degree programme:

1. B.Sc. Forestry (4 years programme)/B.Sc. (Hons.) Forestry
2. In case B.Sc. Forestry/B.Sc. (Hons.) Forestry candidates are not available, B.Sc. Ag./B.Sc. Hort. may be considered.

(b) Doctoral degree programme:

Master's degree in Forestry

Minimum Credit Requirements

Subject	Master's programme	Doctoral programme
Major (Core)	22	15
Minor (Specialization)	12	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total Credits	**60**	**75**
Compulsory Non Credit Courses	See relevant section	

Major subject: The subject in which the student takes admission
Minor subject: In Forestry, the specialization within a major subject is taken as minor.
Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.

M. Sc. FORESTRY

Course Structure – at a Glance

A. CORE COURSES (MAJOR)

CODE	COURSE TITLE	CREDITS
FOR 501	SILVICULTURE	2+0
FOR 502	FOREST BIOMETRY	1+1
FOR 503	FOREST MANAGEMENT	2+0
FOR 504	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES	2+1
FOR 505	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1
FOR 506	FOREST RESOURCE MANAGEMENT AND ECONOMICS	1+1
FOR 507	FOREST PROTECTION	1+1
FOR 508	FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS	2+0
FOR 509	TREE IMPROVEMENT	1+1
FOR 510	FORESTS AND PEOPLE	1+1

B. SUPPORTING COURSES

FOR 511	COMPUTER APPLICATION AND INFORMATION TECHNOLOGY	0+1
FOR 512	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	1+1
FOR 513	GENERAL STATISTICAL METHODS AND RESEARCH METHODOLOGY	1+1

D. SPECIALIZATIONS (MINOR)

1. Wood Science and Technology		
WST 521	WOOD IDENTIFICATION	0+2
WST 522	WOOD CHEMISTRY	1+1
WST 523	GENERAL PROPERTIES OF WOOD	1+1
WST 524	WOOD SEASONING & PRESERVATION	2+1
WST 525	PAPER & PULP TECHNOLOGY	2+1
WST 526	WOOD MODIFICATION & COMPOSITE WOOD	2+1
2. Medicinal and Aromatic Plants		
MAP 521	BASICS OF PLANT PRODUCTION AND BREEDING TECHNIQUES	2+1
MAP 522	MEDICINAL CHEMISTRY & PROCESSING OF MAP'S	2+1
MAP 523	BIOTECHNOLOGICAL APPROACHES AND AGRO TECHNIQUES FOR MAP SPECIES.	2+1
MAP 524	IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS	1+1
MAP 525	ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS	2+0
MAP 526	PHARMACOGNOSY OF MAP'S	1+1
MAP 527	STUDY TOUR (Visit to Pharmaceutical and Processing Units)	0+1
3. Plantation Technology		
PT 521	SEED COLLECTION, STORAGE AND TESTING	2+1
PT 522	MODERN NURSERY TECHNOLOGY	1+1
PT 523	NUTRIENT & WEED MANAGEMENT IN NURSERY & PLANTATION	2+1
PT 524	MANAGEMENT OF INSECT-PESTS AND DISEASES	1+1
PT 525	ENERGY PLANTATIONS AND BIO-FUELS	1+1
PT 526	PLANTATION FORESTRY	2+1
4. Watershed Management		
WM 521	WATERSHED CONCEPTS, PROJECT FORMULATION AND PLANNING	2+1
WM 522	APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT	1+1
WM 523	WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS	2+1
WM 524	WATERSHED HYDROLOGY AND RESOURCES CONSERVATION	2+1
WM 525	PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED.	3+1
WM 526	PEOPLE'S PARTICIPATION AND IMPACT ANALYSIS IN WATERSHED	2+1

5. Eco-Tourism		
ET 521	ECOTOURISM- CONCEPTS AND MODERN APPROACHES	2+2
ET 522	ECO SYSTEMS OF THE WORLD	2+0
ET 523	ECOTOURISM IN PROTECTED AREAS	2+1
ET 524	ECOTOURISM LANDSCAPING	2+1
ET 525	ECONOMICS OF ECOTOURISM	2+1
ET 526	DESIGN AND MANAGEMENT OF ECOTOURISM	2+1
6. Agro-Forestry		
AF 521	AGROFORESTRY SYSTEMS	2+1
AF 522	SOIL AND WATER MANAGEMENT IN AGROFORESTRY	1+1
AF 523	CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY	2+1
AF 524	FRUIT PLANTS, TREES & SHRUBS FOR AGROFORESTRY	2+1
AF 525	ECONOMICS OF AGROFORESTRY SYSTEMS	2+1
AF 526	RANGE LAND AND PASTURE MANAGEMENT	2+0
7. Forest Genetic Resources		
FGR 521	BREEDING METHODS IN FOREST TREES	2+1
FGR 522	REPRODUCTIVE BIOLOGY OF FOREST TREES	2+1
FGR 523	TREE SEED ORCHARDS	2+1
FGR 524	QUANTITATIVE GENETICS IN FOREST TREE BREEDING	3+0
FGR 525	FOREST GENETIC DIVERSITY AND CONSERVATION	3+0
8. Forest Biotechnology		
FB 521	BIOTECHNOLOGY APPROACHES IN FORESTRY	2+1
FB 522	PLANT TISSUE CULTURE	2+1
FB 523	MOLECULAR BIOLOGY	2+1
FB 524	PRINCIPLES & TECHNIQUES IN GENETIC ENGINEERING	2+1
FB 525	ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY	2+0
9. Environment Management		
EM 521	INTRODUCTION TO ENVIRONMENTAL SCIENCES	2+0
EM 522	ENVIRONMENTAL POLLUTION	3+0
EM 523	ENVIRONMENTAL ANALYTICAL TECHNIQUES	2+0
EM 524	GLOBAL CLIMATIC CHANGES	2+0
EM 525	ENVIRONMENTAL POLICY LAW AND INTERNATIONAL CONVENTIONS	3+0
EM 526	ENVIRONMENTAL IMPACT ASSESSMENT	3+0
10. Forest Business Management		
FBM 521	FOREST RESOURCE ANALYSIS	3+0
FBM 522	FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES	2+1
FBM 523	FARM MANAGEMENT	3+0
FBM 524	PRODUCTION MANAGEMENT OF NURSERY AND PLANTATION FORESTRY	2+1
FBM 525	PROJECT PLANNING, MONITORING AND EVALUATION	2+1
FBM 526	MANAGERIAL ECONOMICS	3+0

Revised Nomenclature of M.Sc. and Ph.D. Forestry degree programmes as per V Deans' committee recommendation at NAU, Navsari

[Ref: AC/36.19 dated 25-04-2017 on Adoption of PG degree nomenclature as per ICAR V Deans' committee recommendations]

Resolutions: Adoption of V Deans' committee recommendation for M.Sc./Ph.D. degree programme with the nomenclature: M.Sc./Ph.D. (Forestry) with specialization in (i) Silviculture and Agroforestry, (ii) Forest Biology and Tree Improvement, (iii) Natural Resource Management and (iv) Forest Products and Utilization, at Navsari Agricultural University, from the Academic session beginning from 2017-18.

Sr. No.	**M.Sc. (Forestry)**		**Ph.D. (Forestry)**	
	Present Nomenclature as per IV Dean Committee (BSMA 2009)	**Proposed nomenclature as per V Deans' Committee recommendation**	**Present Nomenclature as per IV Dean Committee (BSMA 2009)**	**Proposed nomenclature as per V Deans' Committee recommendation**
1.	a. Forest Genetic resource b. Forest Biotechnology	Forest Biology & Tree Improvement	a. Forest Genetic resource b. Forest Biotechnology	Forest Biology & Tree Improvement
2.	a. Agroforestry b. Plantation Technology	Silviculture & Agroforestry	a. Silviculture b. Agroforestry	Silviculture & Agroforestry
3.	a. Medicinal and Aromatic Plants b. Wood Science and Technology	Forest Products & Utilisation	a. Medicinal and Aromatic Plants b. Wood Science and technology	Forest Products & Utilization
4.	a. Watershed management b. Environmental Management c. Forest Business Management d. Ecotourism	Natural Resource Management	a. Natural Resource Economics	Natural Resource Management

Modified Course curriculum of M.Sc. (Forestry) and Ph.D. (Forestry) in different specialization as per Fifth Deans Committee recommendation by altering the course curriculum of BSMA (2009)

M.Sc. (Forestry) 60 Credits:

Core Courses:

CODE	COURSE TITLE	CREDITS
FOR 501	SILVICULTURE	2+0
FOR 502	FOREST BIOMETRY	1+1
FOR 503	FOREST MANAGEMENT	2+0
FOR 504	FOREST PRODUCTS - CHEMISTRY AND INDUSTRIES	2+1
FOR 505	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1
FOR 506	FOREST RESOURCE MANAGEMENT AND ECONOMICS	1+1
FOR 507	FOREST PROTECTION	1+1
FOR 508	FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS	2+0
FOR 509	TREE IMPROVEMENT	1+1
FOR 510	FORESTS AND PEOPLE	2+0
		17+5= 22
FOR 591	MASTER SEMINAR	1+0
FOR 599	MASTER RESEARCH	20

Supporting courses:

CODE	COURSE TITLE	CREDITS
FOR 511	COMPUTER APPLICATION AND INFORMATION TECHNOLOGY	0+1
FOR 512	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	1+1
FOR 513	GENERAL STATISTICAL METHODS AND RESEARCH METHODOLOGY	1+1
		2+3=5

Specialization courses:

I) SILVICULTURE AND AGROFORESTRY			
New Code	**Existing Code**	**Course Title**	**Credits**
SAF 521	AF 521	AGROFORESTRY SYSTEMS	2+1
SAF 522	AF 522	SOIL AND WATER MANAGEMENT IN AGROFORESTRY	1+1
SAF 523	AF 523	CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY	2+1
SAF 524	AF 524	FRUIT PLANTS, TREES AND SHRUBS FOR AGROFORESTRY	2+1
SAF 525	AF 525	ECONOMICS OF AGROFORESTRY SYSTEMS	2+1
SAF 526	AF 526	RANGELAND AND PASTURE MANAGEMENT	2+0
SAF 527	PT 521	SEED COLLECTION, STORAGE AND TESTING	2+1
SAF 528	PT 522	MODERN NURSERY TECHNOLOGY	1+1
SAF 529	PT 523	NUTRIENT AND WEED MANAGEMENT IN NURSERY AND PLANTATION	2+1
SAF 530	PT 524	MANAGEMENT OF INSECT-PESTS AND	1+1

		DISEASES	
SAF 531	PT 525	ENERGY PLANTATIONS AND BIO-FUELS	1+1
SAF 532	PT 526	PLANTATION FORESTRY	2+1
		12 credits will be offered as per the research problem	

II) FOREST BIOLOGY & TREE IMPROVEMENT			
New Code	**Existing Code**	**Course Title**	**Credits**
FBT 521	FGR 521	BREEDING METHODS IN FOREST TREES	2+1
FBT 522	FGR 522	REPRODUCTIVE BIOLOGY OF FOREST TREES	2+1
FBT 523	FGR 523	TREE SEED ORCHARDS	2+1
FBT 524	FGR 524	QUANTITATIVE GENETICS IN FOREST TREE BREEDING	3+0
FBT 525	FGR 525	FOREST GENETIC DIVERSITY AND CONSERVATION	3+0
FBT 526	FB 521	BIOTECHNOLOGY APPROACHES IN FORESTRY	2+1
FBT 527	FB 522	PLANT TISSUE CULTURE	2+1
FBT 528	FB 523	MOLECULAR BIOLOGY	2+1
FBT 529	FB 524	PRINCIPLES AND TECHNIQUES OF GENETIC ENGINEERING	2+1
FBT 530	FB 525	ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY	2+0
		12 credits will be offered as per the research problem	

III) FOREST PRODUCTS AND UTILIZATION			
New Code	**Existing Code**	**Course Title**	**Credits**
FPU 521	WST 521	WOOD IDENTIFICATION	0+2
FPU 522	WST 522	WOOD CHEMISTRY	1+1
FPU 523	WST 523	GENERAL PROPERTIES OF WOOD	1+1
FPU 524	WST 524	WOOD SEASONING AND PRESERVATION	2+1
FPU 525	WST 525	PAPER & PULP TECHNOLOGY	2+1
FPU 526	WST 526	WOOD MODIFICATION AND COMPOSITE WOOD	2+1
FPU 527	MAP 521	BASICS OF PLANT PRODUCTION AND BREEDING TECHNIQUES	2+1
FPU 528	MAP 522	MEDICINAL CHEMISTRY AND PROCESSING OF MAPS	2+1
FPU 529	MAP 523	BIOTECHNOLOGICAL APPROACHES AND AGROTECHNIQUES FOR MAP SPECIES	2+1
FPU 530	MAP 524	IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS	1+1
FPU 531	MAP 525	ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS	2+0
FPU 532	MAP 526	STUDY TOUR	0+1
FPU 533	MAP 527	PHARMACOGNOSY OF MAPS	1+1
		12 credits will be offered as per the research problem	

IV) NATURAL RESOURCE MANAGEMENT			
New Code	**Existing Code**	**Course Title**	**Credits**
NRM 521	WM 521	WATERSHED CONCEPTS, PROJECT FORMULATION AND PLANNING	2+1
NRM 522	WM 522	APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT	1+1
NRM 523	WM 524	WATERSHED HYDROLOGY AND RESOURCES CONSERVATION	2+1
NRM 524	WM 525	PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED	3+1
NRM 525	WM 526	PEOPLE'S PARTICIPATION AND IMPACT ANALYSIS IN WATERSHED MANAGEMENT	2+1
NRM 526	EM 521	INTRODUCTION TO ENVIRONMENTAL SCIENCES	2+0
NRM 527	EM 523	ENVIRONMENTAL ANALYTICAL TECHNIQUES	2+1
NRM 528	EM 526	ENVIRONMENTAL IMPACT ASSESSMENT	2+1
NRM 529	FBM 521	FOREST RESOURCE ANALYSIS	3+0
NRM 530	FBM 524	PRODUCTION MANAGEMENT OF NURSERY AND PLANTATION FORESTRY	2+1
NRM 531	FBM 525	PROJECT PLANNING, MONITORING AND EVALUATION	2+1
NRM 532	FBM 523	FARM MANAGEMENT	3+0
		12 credits will be offered as per the research problem	

1 Non Credit six compulsory courses PGS – 501, 502, 503, 504, 505 and 506

V) WILDLIFE SCIENCES (Offered during 2019-20 & 2020-21)			
New Code	**Existing Code**	**Course Title**	**Credits**
ET 521	ET 521	ECOTOURISM- CONCEPTS AND MODERN APPROACHES	2+2
ET 522	ET 522	ECO SYSTEMS OF THE WORLD	2+0
ET 523	ET 523	ECOTOURISM IN PROTECTED AREAS	2+1
ET 525	ET 525	ECONOMICS OF ECOTOURISM	2+1
		12 credits will be offered as per the research problem	

M. Sc. FORESTRY
Course Contents

A. CORE COURSES (MAJOR)

FOR 501 SILVICULTURE 2+0

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics-forest succession, productivity and vegetation forms and natural regeneration of tree species.

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

FOR 502 FOREST BIOMETRY 1+1

Objective

To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT I

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands,. Preparation of volume & its application, yield and stand tables.

UNIT II

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT III

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.

Ram Parkash 1983. *Forest Surveying*. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 503 FOREST MANAGEMENT 2+0

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density & forest valuation.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies.

UNIT III

Forest valuation and appraisal in regulated forests.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

FOR 504 FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES 2+1

Objective

The course will equip the students regarding wood based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannis and various type of non timber products. Practical will make them aware regarding extracting method of different products of wood.

Theory

UNIT I

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products.

UNIT II

Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes.

UNIT III

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood – water and organic solvent soluble.

UNIT IV

Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents – Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood, Visit to nearby forest based industries.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR.

Anonymous. 2007. *Year Book of Forest Products*. FAO.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

FOR 505 FOREST ECOLOGY AND BIODIVERSITY CONSERVATION 2+1

Objective

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

Theory

UNIT I

Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

UNIT II

Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservations laws and acts. Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies.

UNIT III

Documentation and evaluation of forests genetical resources (FGR), *in situ* and *ex situ* conservation of gene resources. Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

Practical

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis, Measurement of biomass and productivity, Quantification of litter production and decomposition, Visit to nationalparks, wldlife sanctuaries, botanical gardens and arboreta.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India.

Dhyani SN. 1994. *Wildlife Management*. Rawat Publ.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures*. Pointer Publ.
Kimmins JP. 1976. *Forest Ecology*. MacMillan.
Nautiyal S & KoulAK. 1999. *Forest Biodiversity and its Conservation Practices in India*. Oriental Enterprise.
Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*. Man and Biosphere Series. The Parthenon Publ. Group.

FOR 506 FOREST RESOURCE MANAGEMENT AND ECONOMICS 1+1

Objective

To develop understanding of students about forest resource management and economics management decisions, natural and environmental resource accounting.

Theory

UNIT I

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory.

UNIT II

Inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decisions. Externalities and property rights.

UNIT III

Natural and environmental resource accounting –methods and implications. Application of operations research tools in evaluating forest management alternatives in public and private forest planning.

Practical

Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forest products. Exercises on financial and economic appraisal of forestry projects. Exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluatingforest management alternatives.

Suggested Readings

FAO 1986. *Guidelines to Practical Project Appraisal*. Natraj Publ.
Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxford & IBH.
Nautiyal JC. 1988. *Forest Economics – Principles and Applications*. Natraj Publications, Dehradun.
Sharma LC. 1980. *Forest Economics, Planning and Management*. International Book Distributors, Dehradun.

FOR 507 FOREST PROTECTION 1+1

Objective

To provide knowledge to students about forest protection through diseases & pest management.

Theory

UNIT I

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT II

Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots – factors affecting heart rots, damage caused, compartmentalization of decay in trees andmanagement of heart rots. Role of mycorrhiza in tree health.

UNIT III

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT IV

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

Practical

Collection, identification and preservation of important insect pests and disease specimens of forest plants. Detection of insect infestation and seed borne mycoflora. Assessment of losses due to diseases, insect pests etc. Habitat management of vertebrate pests. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycrorrhizal root infection.

Suggested Readings

Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.
Jha LK & Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.
Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall.
Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.

FOR 508 FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS 2+0

Objective

To develop understanding of students about forest policy and laws and international conventions

Theory

UNIT I

Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988;

UNIT II

General principles of criminal law; Indian Penel Code, criminal procedure code; Indian evidence act applied to forestry matters.

UNIT III

Forest laws; Indian Forest Act –1927, general provision and detailed study; Forest Conservation Act 1980, Wildlife Protect Act 1972 Important Forest Rules and Guidelines.

UNIT IV

Important case studies and landmark judgments.

Suggested Readings

Indian Forest Acts (with short notes)1975. Allahabad Law Agency.

Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy.* Ashish Publ. House.

National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi.

National Forest Policy 1988. Ministry of Environment and Forests, New Delhi.

Negi SS. 1985. *Forest Law*. Natraj Publ.

Saharia VB. 1989. *Wildlife Law in India*. Natraj Publ.

FOR 509 TREE IMPROVEMENT 1+1

Objective

To acquaint the students about general principles of tree breeding with examples of important trees.

Theory

UNIT I

General concept of forest tree breeding, tree improvement and forest genetics.

UNIT II

Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms.

UNIT III

Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

UNIT IV

Seed, seed formation, dispersal, storage, stratification and seed dormancy.

UNIT V

Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breedingmethods and progress in selective breeding in forest trees. Indirect selectionfor biotic and abiotic stresses.

UNIT VI

Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT VII

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, acacias, pines and poplars.

UNIT VIII

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-weinberg law, null hypothesis, Wohlund's Principle.

UNIT IX

Biotechnology in tree improvement. Mutation breeding.

UNIT X

Economics of tree breeding.

Practical

Floral biology, modes of reproduction and modes of pollination in forest trees. Estimating pollen viability. Controlled pollination and pollenhandling. Manipulation of flowering through hormones. Identification of ecotypes, races, and land-races in natural forest. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids. Induction of polyploidy through colchicine treatment.

Suggested Readings

Mandal AK & Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

White JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talber J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

FOR 510 FORESTS AND PEOPLE 2+0

Objective

It will help students to understand socio-economic, cultural and ecological relationship between forests and people. It will acquaint students with the role of people in forest management through analysis of need dependence and traditional interactions between forests and society.

Theory

UNIT I

Forests and its importance, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to eco-philosopy.

UNIT II

Afforestation programmes and forest conflicts, wildlife and humanconflicts, important forest movements like Chipka Movement, Gender dimension of forest management, tribal economy and forests. Pastoralists and their dependence on forests. Forests and economic security of tribals.

UNIT III

Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and local development, land use change and forestry.

UNIT IV

Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals and non-triabals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management.

Suggested readings

Annamalai R. 1999. *Participatory Learning Action and Microplanning for JFM*. Dean SFRC, Coimbatore.

FAO. 1978. *Forestry for Local Community Development*. FAO Publ.

Shah SA. 1988. *Forestry for People*. ICAR.

Tiwari KM. 1988. *Social Forestry and Rural Development*. International Book Distr.

Vyas GPD. 1999. *Community Forestry*. Agrobios.

B. SUPPORTING COURSES

FOR 511 COMPUTER APPLICATION AND INFORMATION TECHNOLOGY 0+1

Objective

To develop understanding about Computer based modeling, data base management and networking.

Practical

Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management programme. Use of electronic spread sheet and graphics. Use of SPSS statistical application packages. Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management programme. Use of electronic spread sheet and graphics. Use of SPSS statistical application packages. Features of Information Technology: Introduction to Information Technology – Basis of computer networking - LAN, WAN – BUS-Tokening- star-internet, intranet – Basics of E-mail – Exposure to web browsing(structure of URL), Types of web sites – internet service provider – using internet news – scope of IT in forestry

Suggested Readings

Balaguruswamy E. 1998. *Programming with ANSI C*. Tata McGraw Hill.

Gottfried B. 1999. *Programming with C*. Schaum Outline Series. Tata McGraw Hill.

IASRI 1999. *Introduction to MS Office 97 and SPSS*. IASRI Publ.

Malvino AP & Brown JA. 1999. *Digital Computer Electronics*. Tata McGraw Hill.

Mano MM. 1999. *Digital Logic and Computer Design*. Prentice Hall of India.

Tanenbaum AS. 2003. *Computer Networks*. Prentice Hall of India.

FOR 512 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM 1+1

Objective

To acquaint with the use of imageries, GIS and simulation in forest survey and management.

Theory

UNIT I

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo- referenced forest resources data and information.

UNIT II

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management; satellite systems; satellite imageries – techniques, uses and limitation;

UNIT III

Future prospects of remote sensing in India; softwares used in remotesensing ; GIS versus remote sensing; GIS Software used in forestry and environments; Analysis of data; Application of GIS in forestry.

Practical

Uses of various photogrammetry instruments, recognition and identification of objects on photography, compilation of maps and their interpretation, Hands on practice on remote sensing and GIS, software.

Suggested Readings

Burrough PA. 1990. *Principles of GIS for Land Resources Assessment*. Oxford & IBH.

Lillsand TM. 1989. *Remote Sensing and Image Interpretation*. John Wiley.

Narayanan LRA. 1999. *Remote Sensing and its Application*. Universities Press (India) /Orient Longman.

Sharma NK. 1986. *Remote Sensing and Forest Survey*. International Book Distr.

FOR 513 GENERAL STATISTICAL METHODS & RESEARCH METHODOLOGY 1+1

Objective

To provide exposure about methods of statistical analysis, designs and sampling techniques.

Theory

UNIT I

Introductory: Statistics scales of measurement, concept of graphical, exploratory and inferential data analysis, important variables of forestry sector

UNIT II

Probability and probability distributions: Review of probability theory, concept of random variable and expectation, probability distributions (Binomial, Poisson, Normal, Weibull)

UNIT III

Correlation and regression: Simple, Rank, Partial, Multiple, Infraclass correlations, Furnivall Index and coefficient of determination. Linear and

nonlinear regressions, parabolic, exponential, power and logarithmic functions

UNIT IV

Estimation and Testing of Hypotheses, Concept of point and interval estimation, estimators and estimates, properties of good estimators – unbiasedness and minimum variance, tests of significance – t, F, z, and $\chi 2$, testing significance of correlation and regression coefficients, analysis of variance (ANOVA) – one way and two way classification with single and more than one cell frequency.

UNIT V

Design of Experiments. Principles of experimental designs, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Row- Column (alpha) designs, Split Plot and Strip Plot Designs.

UNIT VI

Sampling – Theory and applications Why sample? Simple Random Sampling (with and without replacement), Stratified Random Sampling, Double sampling, Multistage sampling, Cluster sampling

UNIT VII

Multivariate statistical techniques Multivariate Analysis of Variance, Principal Component Analysis, Factor Analysis, Cluster Analysis.

Practical

Fitting of probability distributions, Computation of correlations and regressions, Tests of significance – t, F, z and $\chi 2$, Exposure to statistical packages SPSS and GENSTAT for ANOVA, multivariate analysis Laying out of designs in the field (i) Fan design, (ii) Latin Square, (iii) Randomized block design, (iv) Split plot design, (v) Row-Column designs and (vi) Scattered block. Data analysis of the above designs.

Suggested Readings

Dear KBG, Mead R & Relay J. 1987. *Statistical Tools for Agro-Forestry Research – Bivariate Analysis for Intercropping Experiments*. ICRAF, Nairobi.

Matin J. 1976. *Principles of Database Management*. Prentice Hall.

Pase UG & Sukhatme MU. 1978. *Statistical Methods for Agricultural Workers*. ICAR.

Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding.* ICAR.

C. SPECIALIZATIONS (MINOR)

1. SILVICULTURE AND AGROFORESTRY

SAF 521 AGROFORESTRY SYSTEMS 2+1

Objective

To impart knowledge on the concept of agroforestry land use including diagnosis & design methodologies

Theory

UNIT I

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.

UNIT II

Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Productin potential of different silvi-pasture system.

UNIT III

Concepts of community forestry and social forestry, linear strip plantations.

UNIT IV

Diagnosis and Design – Trends in Agroforestry systems research and development.

Practical

Survey and analysis of land use systems in the adjoining areas. Design and plan of suitable models for improvement.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 522 SOIL AND WATER MANAGEMENT IN AGROFORESTRY 1+1

Objective

To impart knowledge on soil and water management in agroforestry including biogeochemical cycling of nutrients.

Theory

UNIT I

Soil and water management –objectives and scope in relation to agro-forestry systems. Soil and water conservation , land classification and carrying capacity. Irrigation potential and methods. Optimization of waters use in agroforestry systems and dry land farming .

UNIT II

Soil water relations, moisture regimes and management techniques. Problem soils and their management, soil organisms and nitrogen fixation.

UNIT III

Biogeochemical cycling of nutrients including organic matter decomposition. Nutrients budgeting and soil productivity under different agroforestry systems.

Practical

Calculation of water storage and fluxes in the soil. Determination of "in- situ infiltration rate of soils. Measurement and estimation of run-off . Mineral nutrient analysis of soil and plants. Study of biogeochemical cyclesin agro-forestry systems.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 523 CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY 2+1

Objective

To impart knowledge on interactions between tree and live stock including their management, principles of crops and fodder production in agroforestry

Theory

UNIT I

Choice of inter-crops for different tree species, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions

UNIT II

Role of tree architecture and its management on system's productivity. Production potentials of fodder based agroforestry system in different agro climatic conditions. Crop combination, crop combination interactions in crop mixtures. Importance of cattle –sheep and goat vis-à-vis agro-forestry systems. Feed and fodder resources in agro-forestry systems and live stock management.

UNIT III

Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with agro-forestry forages and tree leaves. Forage and tree leaves preservation.

UNIT IV

Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing.

UNIT V

Integrated Agroforestry Farming System

. **Practical**

Measurement of crop growth rates. Study of tree crop association and management methods. Quantitative evaluation of tree-crop, livestock. Analysis of forages and feeds for mineral and incrementing constituents. Digestibility of some agro-forestry forages. Preparation of leaf meal and forage conservation. Familiarity with common veterinary instruments, AI equipments and common feeds and fodders & Field visits.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI

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SAF 524 FRUIT PLANTS, TREES AND SHRUBS FOR AGROFORESTRY 2+1

Objective

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for agorforestry.

Theory

UNIT I

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques.

UNIT II

Fruits crop and their need and relevance in Agroforestry fruits tree suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertility management, yield and quality improvement. UNIT III

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

Practical

Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of tree, shrubs and fruit trees for enhancing production in Agroforestry system.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 525 ECONOMICS OF AGROFORESTRY SYSTEMS 2+1

Objective

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems

Theory

UNIT I

Basic principles of economics applied to agro-forestry. Optimization techniques- Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making.

UNIT II

Financial and socio-economic analysis of agro-forestry projects.

UNIT III

Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

Practical

Exercises on agro-forestry production relationships. Preparation of enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestry products.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 526 RANGELAND AND PASTURE MANAGEMENT 2+0

Objective

To develop understanding of students about watershed management and Range Land Management.

Theory

UNIT I

Concept of watershed management. Ideo-types of watershed development plans and activities for the watershed. Criterion for watershed size determination.

UNIT II

Principles and practices of range land management. Improvement of range productivity by vegetation manipulation through control of undesirable vegetation, burning, fertilization, soil and water conservation and protection. Range improvement and livestock management.

UNIT III

Feeding habits and grazing behavior of range livestock. Optimal livestock and range utilization, fodder from trees/shrubs and their nutritive values, propagation techniques, Micro climatic studies, root behavior, crown architecture including methods for minimizing unfavorable interactions.

UNIT IV

Production potential of different silvi-pasture systems.

UNIT V

Characteristics of a watershed and their role in watershed management. Quantification of the benefits and effectiveness of the package of practices adopted for management of watershed, Dynamics vis-à-vis plant growth and post harvest processing for evaluation of chemical constituents.

UNIT VI

Biological and engineering approach in the management of degraded and denuded habitats as an integrated and multiple approach. SPP Testing. Provenance trials. Seed certification and storage. Elite trees selection.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 527 SEED COLLECTION, STORAGE AND TESTING 2+1

Objective

To impart knowledge and develop understand about seed development in tropical, sub-tropical and temperate region, testing & certification.

Theory

UNIT I

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems- limiting actors in tree propagation and afforestation.

UNIT II

Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/ fruit.

UNIT III

Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, stage methods and seed testing techniques.

UNIT IV

Seed certification.

UNIT V

Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

Practical

Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Tests of viability viz., cutting, hydrogen peroxide, excised tetrozolium, embryo, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, Recording, calculation and use of results of seed treatment.

Suggested Readings

Khullar P 2003. *Forest Seed*. ICFRE Publication, Dehradun.

Lars Schmidt. 2000. *Guide to Handling of Tropical and Subtropical Forest Seeds*. Danida Forest Seed Center, Denmark.

Singh V. 2003. *Forestry Seed and Nursery Management*. Bishen Singh & Mahendra Pal Singh, Dehradun.

Willan RL. 1985. *A Guide to Forest Seed Handling*. FAO.

SAF 528 MODERN NURSERY TECHNOLOGY 1+1

Objective

To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use.

Theory

UNIT I

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery.

UNIT II

Bare root nursery- nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out-planting.

UNIT III

Containerized nursery - Type and size of container including root trainers, selection of growing medium.

UNIT IV

Types of green house and mist chamber for propagation. vegetative propagation - importance, selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering. Factors affecting rooting of cuttings.

UNIT V

Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.

Practical

Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Use of vegetative propagation methods such as budding, grafting and layering. Precaution required in vegetative propagation, use of plant bio-regulators for rooting Maintenance of nursery records. Identification of nursery insects and diseased and their control measures. Visit to nurseries.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.

Dwivedi AP. 1993. *Forestry in India.* Suya Publ.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

SAF 529 NUTRIENT AND WEED MANAGEMENT IN NURSERY AND PLANTATION 2+1

Objective

To disseminate knowledge about managing nurseries and plantations under optimal conditions.

Theory

UNIT I

History of nutrient management in forest nurseries and plantation. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ Interactions. Concept of nutrient availability.

UNIT II

Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors.

UNIT III

Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers.

UNIT IV

Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable waste and their recycling.

UNIT V

Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weed side classification, properties and their application.

Practical

Principles and methods of soil and plant analysis. Preparation of nutrient solutions. Practical application of fertilizers. Study of fertilizer response and diagnosis of deficiency symptoms. Fertilizer testing and pot experiments. Nursery inoculation techniques of bio-fertilizers. Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods.

Suggested Readings

Allen V & Barker 2007. *Handbook of Plant Nutrition*. Pilbeam London.

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Singh O & Negi M. 1993. *Bibliography on Biomass and Nutrient Cycling of Forest Species*. FRI Dehradun.

SAF 530 MANAGEMENT OF INSECT-PESTS AND DISEASES 1+1

Objective

To impart knowledge about maintaining plantations and forests under disease free conditions.

Theory

UNIT I

Principles and methods of integrated pests management – physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques.

UNIT II

Diseases of forest nurseries and plantations. Abiotic agents of tree diseases and their relationship with hosts. Methods of disease control – exclusion, cultural, biological and chemical.

UNIT III

Rodents, Birds, squirrels, herbivores. Forest plant quarantine.

Practical

Collection and identification of insects and non-insects. Inspection and collection of damaged material showing insect damage. Identification and use of plant protection equipments. Preparation of different concentrations of pesticides and Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation

Suggested Readings

Evane JW. 1989. *Insect Pest and their Control*. Samir Book Center, Delhi.
Phillip DM. 1982. *Diseases of Forest and Ornamental Trees*. MacMilan.
Speight MR. 2000. *Insect Pest in Tropical Forestry*. RoseWilley Publ..

SAF 531 ENERGY PLANTATIONS AND BIO-FUELS 1+1

Objective

To develop understanding about the scope and advantages of using and raising bio-energy plantations.

Theory

UNIT I

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy.

UNIT II

Assessment of bio-energy programmes in India. Power generation from energy plantation, producer gas. High Density Energy Plantations (HDEP). Land and biomass availability for sustainable bio energy. Impact of energy efficiency in power sector.

UNIT III

Need for research and development on environment friendly and socio economical relevant technologies. Energy from plants-problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation.

UNIT IV

Recent energy technologies in the product of bio-fuels.

Practical

Identification of important fuel woods and petro-crops. Study on different bio fuels used in India. Determination of calorific value, moisture and ash

content in biomass Study of energy consumption pattern in rural and urban areas through survey. Visit to nearby Bio-energy units.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.

Kumar V. 1999. *Nursery and Plantation Practice in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

SAF 532 PLANTATION FORESTRY 2+1

Objective

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

Theory

UNIT I

Role of plantation forestry in meeting the wood demand – Plantation forestry in India and abroad, Purpose of plantation, Factors determining scale and rate of plantation, Land suitability and choice of plantation species

UNIT II

Production technology for quality planting stock, preliminary site preparation for establishing plantation, Planting programme, time of planting, planting pattern, spacing, plating method.

UNIT III

Nutritional dynamics and irrigation of plantation, Mechanization in plantation, Protection and after care of plantation, Pruning and thinning of plantation for quality wood production, Rotation in plantation, Failure of plantations, Impact of interaction and integration of plantation forestry, Protective Afforestation, afforestation of inhospitable sites, Ecological factors and long term productivity, Sustainable yield from plantation.

UNIT IV

Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias,Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc.

UNIT V

Wasteland plantation

UNIT VI

Industrial Plantation

Practical

Analysis of plantation problems in Asia and India – Preparation of plantation calendar –Preliminary arrangement for a plantation programme –Planting geometry and calculation of planting stock – Study of different cultural operations and site preparation for plantation – Studies on wood based industries – Problems and prospects – Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and Bamboo plantations – Production technology for energy plantations – INM in plantations – Irrigation and plantations – Economics of pulpwood, timber and energy plantations.

Suggested Readings.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

2. FOREST BIOLOGY AND TREE IMPROVEMENT

FBT 521 BREEDING METHODS IN FOREST TREES 2+1

Objective

To acquaint the students about the concepts of sub- selection, population structure for breeding and production, genetic testing and making designs.

Theory

UNIT I

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes.

UNIT II

Long-term and short-term breeding populations. Selective breeding methods- mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, subjective evaluation. Selection for different traits.

UNIT III

Genetic testing programmes – mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating.

UNIT IV

Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection.

UNIT V

Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance.

UNIT VI

Tree improvement case histories. Calculating gene and genotype frequencies. Flow chart for different breeding methods.

Practical

Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating. Selection for biotic and biotic stresses.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 522 REPRODUCTIVE BIOLOGY OF FOREST TREES 2+1

Objective

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

Theory

UNIT I

Importance and application of reproductive biology in tree breeding.

UNIT II

Modes of reproduction: sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecy and its evolution.

UNIT III

Out-crossing mechanism in forest trees.

UNIT IV

Environmental effects on sex expression. Floral biology. Initiation and development. Modes of pollination; Self and out-crossing.

UNIT V

Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

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 and fertility. Seed dispersal mechanism.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 523 TREE SEED ORCHARDS 2+1

Objective

To develop understanding of students about tree seed orchards.

Theory

UNIT I

Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply ofsuperior seed.

UNIT II

Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones.

UNIT III

Seed orchard: need, evolving seed orchards, containerized seed, hybrid and

research seed orchards; first, second and advanced generation seed. 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.

UNIT IV

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.UNIT V

Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

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 parametersfor a few traits. Estimation of parental balance.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley& Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 524 QUANTITATIVE GENETICS IN FOREST TREE BREEDING 3+0

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

UNIT I

Historical aspects of quantitative genetics; multiple-factor-hypothesis. Population structure, mating systems.

UNIT II

Hardy-Weinberg equilibrium: properties and implications of equilibrium , influence of mutation, migration and selection. Random mating consequences in small populations. Random drift, inbreeding coefficient, rate of inbreeding.

UNIT III

In breeding in pedigreed population, inbreeding coefficient under regular systems of inbreeding. Statistical parameters used in studying polygenic

traits.

UNIT IV

Testing and estimating: population mean and components of phenotypic value, breeding value, dominance, interaction and environment deviation. Models of gene action, significance of different genetic components, G x E component of variance.

UNIT V

Estimation of genetic components of variance through resemblance of relatives. Fisher's fundamental theorem on natural selection and its implications. Heritability-its estimation and significance.

UNIT VI

Selection theory for a quantitative character. Prediction of selection response: patterns, asymmetry, and causes. Selection criteria and use of information from relatives. Correlation among characters, correlation response and indirect selection.

UNIT VII

Effect of inbreeding on mean and variance. Heterosis and causes for heterosis in F1 and later generations. Combining ability effects, variances and selection for combining ability. Threshold characters.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book ofForest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 525 FOREST GENETIC DIVERSITY AND CONSERVATION 3+0

Objective

To provide the students knowledge about the genetic diversity in forest tree species, their distribution, assess and analysis laws and methodologies of *in-situ* and *ex-situ* conservation.

Theory

UNIT I

Biological diversity-concept, levels ecosystem. Genetic diversity and differentiation-definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation.

UNIT II

Molecular approaches for assessing genetic diversity. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts.

UNIT III

Effects of sampling on genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Global and local initiations for bio chemistry conservation.

UNIT IV

Laws and policies. Methods for maintenance of conservation: Gene banks, arboreta, gardens, breeding populations as repositories of geneconservation. Rare, endangered and endemise plants (IUCN).

UNIT V

Techniques for survey and assessment of endangered plants. Rarity patterns and endemism. Concept of island biogeography. Managing corridors and natural habitat fragments.

UNIT VI

Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora tourism impacts and urbanization of rare plants. Implications of rarity.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 526 BIOTECHNOLOGICAL APPROACHES IN FORESTRY 2+1

Objective

To imbibe an understanding of scope, potential and techniques in forest biotechnology and to prepare them for experimentation in the discipline.

Theory

UNIT I

Historical development of biotechnology; scope of biotechnology in forestry; different methods of biotechnology related to forestry

UNIT II

Plant tissue culture and response pattern; application of plant tissue culture in tree improvement.

UNIT III

In vitro selection and micro propagation in forestry for conservation; gene regulation, genetic engineering techniques; basis of operation in DNA manipulation;

UNIT IV

Transgenic plants; molecular markers and its application in forestry; modification of plant species to practically desired products; bio-degradation of forestry wastes through genetically engineered microbes.

Practical

Micro propagation technique, Preparation of MS media, collection of explants, acquaintance of different instruments use in biotechnology, visit to the laboratories.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 527 PLANT TISSUE CULTURE 2+1

Objective

To develop faculties of students to explore and analyze the propagation techniques *in vitro* and to provide knowledge in the field with principles, techniques and progress achieved in the discipline.

Theory

UNIT I

Tissue culture-principles as applied to forest tree species, history, development, fields of application, progress and prospects with special reference to tree crops. Culture conditions. Stages of micro propagation.

UNIT II

In vitro propagation via enhanced release of auxiliary buds. Somatic organogenesis and somatic embryo genesis, leaf diseases, embryoid and synthetic seed production.

UNIT III

Problems and Progress in *in vitro* propagation of tree crops. *In vitro* pollination and fertilization for distant hybridization. Somaclonal variation – factors influencing – exploitation for crop improvement.

UNIT IV

Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration; Protoplast fusion for somatic hybridization and its application.

UNIT V

Techniques for direct gene transfer to protoplasts.

UNIT VI

Need of in vitro conservation. Short and medium term conservation. Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, prefreezing treatments – use of cryo-protectants, dry freezing, incubation.

UNIT VII

Alteration/modifications in cell components during cryo-preservation. Recalcitrant species. Thawing and reculture. Survival of freeze preserved cells/tissues.

UNIT VIII

Clonal fidelity and karyotype stability of cryopreserved cultures and regenerates. Use of biochemical and molecular markers for testing the stability, Protocol development.

Practical

Preparation and storage of stock solutions, preparation of culture media. Collection, handling and pre-treatment of explants. Micro-propagation of tree species via different routes. *Ex vitro* establishment of plantlets. Production of somatic embryos. *In vitro* pollination and fertilization. Protoplast isolation and culture. Haploid culture. Components and preparation of culture medium. Collection, handling and surface sterilization of explants. Inoculation and incubation. Preparation of in vitro cultures for short, medium and long term preservation. Practicing different protocols for conservation. Thawing and reculture. Assessing the stabilityof regenerates. RFLP, RAPD and other techniques. Manipulation of culture media and conditions for prolonging the culture period. Essential featuresof tissue culture laboratories.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 528 MOLECULAR BIOLOGY 2+1

Objective

To develop understanding of students in field of molecular biology through imparting knowledge about the structure and function of RNA and DNA, its organization, isolation, extraction, assay and application.

Theory

UNIT I

History and development of Molecular Biology. Nucleic acids – DNA and RNA as genetic materials. Nucleosides and nucleotides, DNA double helix –properties of DNA – absorbance, ionic interaction, denaturation and renaturation, sedimentation.

UNIT II

Secondary structure of single stranded DNA – inverted repeat sequences, alternative structures of duplex DNA C value and concept of selfish DNA, cell organelle DNA Chloroplast and genes and mitochondrial DNA and genes. DNA replication – semi- onservative replication.

UNIT III

Organization in prokaryotes and eukaryotes. DNA polymerases, replicon, eyes, rolling circle and D-loops, nick translation, okazaki viruses. Reverse transcriptase, primase, helicase, topoisomerases, gyrases, methoylases and nucleases. DNA sequencing.

UNIT IV

Molecular breeding of Forest trees, Constructing molecular maps, Molecular tagging of genes/traits, Market-assisted selection of qualitative and quantitative traits, Physical maps of chromosomes, The concept ofgene synteny, The concept of mapbased cloning. .

UNIT V

Basic structure of DNA, overview of genomics technology, concept of maps: Genetic maps, properties of marker used for creating genetic maps, Physical maps: STSs, ESTs Chromosome separation method, high resolution physical mapping approach, Automated sequencing, sequence annotation. Recent advances in molecular marker technique and genomics with special reference to tree.

UNIT VI

Micro arrays Application: gene expression, SNP detection, detection of environmental agents.

UNIT VII

Micro array design: cDNA micro array, oligonucleotide arrays. Micro array fabrication. Detectin technology. Computational analysis of micro array data.

Practical

Estimation of DNA and RNA. Isolation of total nucleic acids from bacteria. Large-scale preparation of total plant DNA. Isolation of total RNA. Agarose gel electrophoresis. Denaturation of DNA. Ethidium fluorescent assay of nucleic acids. Estimation of C value. Binding of polyamines to DNA. Assay of DNA ploymerase. DNA sequencing. Isolation and quantification of plant DNA, PCR operation and gel electrophoresis, RAPD and ISSR, gene sequencing, sequence annotation.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 529 PRINCIPLES AND TECHNIQUES OF GENETIC ENGINEERING 2+1

Objective

To acquaint students about the concepts of enzymes, vectors and techniques involved in DNA transferred technology.

Theory

UNIT I

Recombinant DNA Technology: Major events, Genomic and DNA clones, Different methodologies and rationale of cloning gene.

UNIT II

The Tools of Genetic Engineering: Concept of restriction and modification, Restriction endo-nucleases, Modifying enzymes, Ligases, Host-vector

system, – Ecoli as a host.Different Kinds of vectors: Plasmids, phage vectors, M 13, cosmids, phagemids, YACS, BACS, PACS and expression vectors.

UNIT III

The Means of Genetic Engineering: Different strategies of cloning, Ligationstrategies, Genomic libraries, cDNA libraries, Gene tagging, Introduction to molecular market technology.

UNIT IV

The product: Sub cloning, Nested deletions, Sequencing and sequence analysis, Site directed mutagenesis, Expression of cloned genes, Isolation and purification of the expressed product.

UNIT V

PCR Technology: Different types of PCR, Applications of PCR in cloning genes, promoters and flanking sequences. Utilizing PCR in the lab for preparation of probes, PCR on molecular marker technology.

UNIT VI

Cloning and Transformation in Prokaryotes, Vector preparations, Insert preparations, Legation.

UNIT VII

Transformation: Methods of direct transformation: PEG mediated, microinjection, particle bombardment, edlectoportation.

UNIT VIII

Method of indirect transformation: *Agrobacterium tumefaciens* and *A. rhizogenes*, Screening for recombinant clones, analysis of the recombinant DNA, Isolation of the recombinant plasmid, Restriction analysis, Excision of the insert, Restriction analysis of the excised insert, Sequence analysis ofthe insert, construction of Genomic and cDNA library, Gene isolation,Promoter analysis, Gene expression. Genetic engineering for insect/disease resistance, Genetic engineering for wood quality improvement, high biomass, adoption to harsh sites and for incorporating male sterility and rooting of tree cutting.

Practical

Isolation of nucleic acids and their sequencing, Experiment with cloning vectors: pUC 18, pUC 19, pBR 322, phase etc. Extraction and purification of plasmid DNA restriction methylation and ligation reactions, preparation and transformation of competent E. coli. Agro-bacterium mediated genetic transformation, Antibiotic resistance, insertional inactivation. Estimation of proteins and enzymes involved in the defense mechanism-glucanase and chitinase activity, mRNA isolation after exposing the plant to stress conditions. Evaluation of gene expression. Identification of recombinants.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 530 ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY 2+0

Objective

To provide the students with concepts and problems of how biotechnology help in solving these problems.

Theory

UNIT I

Environment: Basic concepts and issues. Environmental Pollution: Types of pollution, Methods for the measurement of pollution; Methodology of environmental management – the problem solving approach, its limitations Air pollution and its control through Biotechnology.

UNIT II

Water Pollution and its control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment-physical, chemical and biological treatment processes Microbiology of Waste Water Treatments, Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes: Anaerobic digestion, anaerobic filters. Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

UNIT III

Microbiology of degradation of Xenobiotics in Environment – Ecological consideration, - decay behavior & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation of contaminated soils and waste lands. Biopesticides in integrated pest management. Solid waste: sources and management (composting, wormy culture and methane production). Global Environmental Problems: Ozone depletion, UV-6, green-house effect and acid rain, their impact and biotechnological approaches for management. Bioleaching, Bio-fertilizer for sustainable agriculture & environment (AMF, ECM, PGPRs, PSBs, with special reference to low input agriculture).

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

3. FOREST PRODUCTS AND UTILIZATION

FPU 521 WOOD IDENTIFICATION 0+2

Objective

The course deals with the use of anatomical features of wood in timber classification.

Practical

Planes of wood, Physical characteristics of important woods, Identification of different types of cells and tissues. Anatomical studiesof reaction wood. Identification of different types of cells and tissues. Anatomical studies of reaction wood. Classification of timber using dichotomous and perforated card keys. Modern timber identificationtechniques

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 522 WOOD CHEMISTRY 1+1

Objective

To impart knowledge about the chemical properties of wood, cell wall constituents and wood extractions.

Theory

UNIT I

Chemical composition of wood : Cell wall constituents- cellulose, lignin hemicellulose, peptic substances etc.

UNIT II

Cell Content :Volatile and extractive, cellulose derivatives and their application.

UNIT III

Hydrolysis and fermentation of lignocellulosic materials. Parolysis and gasification of wood.

Practical

Extraction of cellulose, hemicellulose, lignin, extractives and ash content of wood.

Suggested readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 523 GENERAL PROPERTIES OF WOOD 1+1

Objective

To acquaint with the physical characteristics and strength properties of wood.

Theory

UNIT I

Wood density, thermal, electrical and acoustics of wood.

UNIT II

Mechanics and Rheology of wood, elasticity, plasticity and creep (tensile compression and bending strength)

UNIT III

Toughness, torsion, shear, hardness and abression strength. Acoustic and acousto-ultrasonics, based non-destructive evaluation technique.

Practical

Determination of wood density, study of thermal, electrical and ecoustic properties of wood. Determination of tensile and bending properties of wood.

Suggested readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 524 WOOD SEASONING AND PRESERVATION 2+1

Objective

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

Theory

UNIT I

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.

UNIT II

Defects of timber- natural, seasoning defects, defects due to external agencies, machining defects. Effect of defects on utilization.

UNIT III

Detection and diagnosis of discolouration and decay in wood : decaying agencies- fungi, insects, borer etc.

UNIT IV

Wood preservation : preservatives and treatment processes. Advantages and safety concern of wood preservatives.

Practical

Determination of moisture content and swelling coefficients of different woods. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters. Treatment of wood with different types of preservatives.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 525 PAPER & PULP TECHNOLOGY 2+1

Objective

To acquaint with the resources and processes for making pulp and paper.

Theory

UNIT I

Raw materials used in pulp and paper industries and its characteristics and handling

UNIT II

Pulping process, mechanical, chemical, semi-chemical and biopulping. Pelp bleaching, pulp treatment, defibening, de-knotting, brown stock washing, screawing, cleaning, thickening.

UNIT III

Recycled fibers, supplementary pulp treatment and additive. Paper making, paper drying, calendaring, reeling, external sizing, coating etc.

UNIT IV

Structure of paper, its characterization and measuring strength method, optional and structural properties of paper. Type of paper coated paper, corrugated containers, printing quality of paper, ageing of paper. Rayon industry.

Practical

Study of raw materials techniques and pulp yield, making of paper and its quality determination, visit to nearby paper industry.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 526 WOOD MODIFICATION AND COMPOSITE WOOD 2+1

Objective

To impart knowledge regarding the scope and processes for developing composite wood.

Theory

UNIT I

Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.)

UNIT II

Wood impregnation and compregnation, heat stabilization, wood densification.

UNIT III

Modern trends in composite wood. Wood adhesives – types, characteristics and application.

UNIT IV

Playwood, laminated wood and inorganic wood composites- their manufacture, characteristics and application.

Practical

Use of different adhesives in playwood, study of composite boards, study of antishrink efficiency of wood treated with different chemicals impregnation and compregnation of wood with chemicals.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 527 BASICS OF PLANT PRODUCTION AND BREEDING TECHNIQUES 2+1

Objective

To acquaint with the propagation, harvesting and quality improvement methods.

Theory

UNIT I

Mode of plant propagation technique. Factors influencing growth; role of macro and micro nutrients.

UNIT II

Nursery techniques, plant protection measures, methods of harvesting and post harvesting handling.

UNIT III

Role of genetics and related sciences in breeding of Medicinal herbs. Breeding methods, self and cross pollinating.

UNIT IV

Heterosis, sterility and self incompatibility in herbs; mutation andpolyploidy breeding, wide hybridization; production and maintenance of pure seeds. Systems followed in the release of plant varieties.

Practical

Asexual vegetative reproduction techniques- cutting, budding, layering. Methods of seed collection and storage technique.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 528 MEDICINAL CHEMISTRY AND PROCESSING OF MAPS 2+1

Objective phytopharmaceuticals and theirprocessing as industrial products.

Theory

UNIT I

Organic compounds and their classification such as aliphatic, aromatic, alkaloids, steroids, terpenoids, glycosides, phenolic compounds, heterocyclic compounds and carbohydrates.

UNIT II

Primary and Secondary plant metabolites and theurapeutical uses of phytoconstituents such as gums, anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids, alkaloids and terpenoids.

UNIT III

Basic principles of extracting different phytoconstituents.

UNIT IV

Post harvest processing-drying, grading and storage. Extraction of essential oils and their storage.

Practical

Use of thin layer and column chromatography during extraction and purification of phytopharmaceuticals. Preparation of active constituent enriched extracts. Extraction of Essential oils and their quality evaluation, preparation of concretes and absolutes.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 529 BIOTECHNOLOGICAL APPROACHES AND AGROTECHNIQUES FOR MAP SPECIES 2+1

Objective

To equip the student with the conventional and biotechnological procedures for production of medicinal species.

Theory

UNIT I

Scope of Biotechnology in MAP's, Tissue culture technique and in-vitro propagation of *Rauvolfia serpentina, Santalum album, Stevia rebaudiana, Andrographis paniculata, Hyocyamus niger, Carum carvi, Catharanthus roseus, Glycyrrhiza glabra, Atropa belladonna.*

UNIT II

Molecular characterization by RAPD, RFLP etc. Biotransformation, Transganic plants, use of Biotechnology in plant improvement.

UNIT III

Importance & need of cultivation of MAP's species. origin, distribution, morphological features, climate, soil requirement, nursery technique, transplantation, harvesting and post harvest handling of Important MAP's like *Picrorhiza kurrooa, Saussurea costus, Aconitum heterophyllum, Swertia chirayita, Valeriana jatamansi, Chlorophytum borivilianum, Stevia rebaudiana, Andrographis paniculata, Pelargonium graveolens, Rosa damacena* and other important species specific to the region.

UNIT IV

GAP in MAP, organic farming; Crop geometry and crop management.

Practical

Preparation and layout of nursery and field beds/ plots methods of seed sowing, preparation of shoot and root cuttings. Transplanting of seedling and rooted cuttings, irrigation technique, hoeing, weeding and weed control. Raising and harvesting of at least on crop grown in the region.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 530 IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS 1+1

Objective

To acquaint the student with the breeding procedures for quality improvement of important medicinal and aromatic plants.

Theory

UNIT I

Plant genetic resources- general perspective. Ecology and biology ofplant resources of medicinal value. Medicinal and aromatic plant diversity in the Indian gene center. Plant exploration , introduction & exchange.

UNIT II

Conservation of medicinal and aromatic plants; its techniques- in-situ, ex-situ & biotechnological. Evaluation and breeding techniques of important medicinal and aromatic plants-*Picrorhiza kurrooa, Swertia chirayita, Valeriana jatamansi, Viola spp., Gloriosa superba, Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum sanctum, Withania somnifera.*

UNIT III

Distinctiveness, uniformity, stability testing. Drug descriptors for medicinal and aromatic plants

Practical

Identification based on morphological features; pollen viability and germination testing, stigma receptivity. Field practice in emasculation, crossing and selfing in *Hypericum perforatum, Matricaria chamomilla, Solanum spp., Ocimum spp., Gloriosa superba , Mucuna spp., Gentiana kurroo* and other species relevant to the region. Determination of mode of reproduction.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants*. ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 531 ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS 2+0

Objective

To acquaint the student with the importance of plants used in modern and AYUSH methods of treatment.

Theory

UNIT I

Concept of Health Care systems

UNIT II

Brief introduction to Ayurveda, Unani, Sidha, Homeopathy, allopoathy, naturopathy, electrohomoeopathy, etc.

UNIT III

Important medicinal plants used in treating various diseases in modern and complementary systems.

UNIT IV

Biological activity of selected medicinal plants. Methods of preparing poultices, decoctions, powders, tinctures, active content rich extracts.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.
Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.
Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 532 STUDY TOUR 0+1

Objective

Visit and exposure of students in herbal product's manufacturing.

Practical

Visit to government and private Pharmaceutical UNITs/ Institutes in adjoining areas. Visit to large scale herb growing and processing UNITs engaged in commercial cultivation and preparation of purified photochemical/standardized extracts. Visit to nearby marketing/trade centers.

FPU 533 PHARMOCOGNOSY OF MAPS 1+1

Objective

To develop understanding about microscopical, macroscopical and chemical methods of drug identification.

Theory

UNIT I

History and scope of pharmacognosy, Pharmaceutical products. Classification of natural drugs. Chemical nature of drugs. Pharmacognostic analysis of drug plants based on botanical, chemical and histological features.

UNIT II

Evaluation based on pharmacopoeial standards for both single drugs and compound formulations most commonly used in different systems of medicines.

UNIT III

Pharmacognostic features of Sarpagandha, Jatamansi, Ashwagandha, Turmeric, Punarnava, Ephedra, Gymnema, Senna, Amla, Gokhru, Issabgol, Black pepper, Banafsha, Arjun or any other commercially species specific to the region.

Practical

Identification of drugs by morphological characters. Physical and chemical tests for evaluation of drugs. Gross anatomical studies of Ginger, Ashwagandha, Senna, Gentiana, Kalmegh, Sarpagandha, Mulhathi, Aconitum species or any other important species relevant tothe region.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.
Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.
Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.
Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.
Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.
Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

4. NATURAL RESOURCE MANAGEMENT

NRM 521 WATERSHED CONCEPTS, PROJECT FORMULATION AND PLANNING 2+1

Objective

To impart knowledge on watershed characteristics, watershed project planning, impact assessment techniques and impart practical training on survey of watershed, economic profitability of various land basedenterprises bases in cost and revenue concepts.

Theory

UNIT I

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT II

Components of natural resources for watershed management. Preparation techniques for micro plan of watershed. Impact assessment techniques for upliftment of socio-economic status and environment.

UNIT III

Valuing Inputs and Outputs Introduction –Approach, Using Market Prices in the Financial Analysis, Estimating Future Prices – Treatment of Inflation, Estimating Relative Price Changes.

UNIT IV

The big project effect, Appropriate economic value measure for different types of inputs and outputs. Identifying and valuing remedial measures to maximize benefits of investment.

UNIT V

Comparing costs and benefits- Introduction, constructing value flow tables, discounting benefits and costs. Net Present Value (NPV), Internal Rate Return (IRR), Relationships between NPV and IRR. Sensitivity analysis – introduction, purpose, guidelines, sources and techniques of sensitivity analysis.

Practical

Survey of watershed, Preparation of micro-plan and planning of watershed for effective implementation. Exercises on economic profitability of various land-based enterprises bases in cost and revenue concepts.

Suggested Readings

Datta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 522 APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT 1+1

Objective

To disseminate knowledge on techniques of remote sensing and Geographic Information Systems (GIS), Preparation of thematic layers and their digitization. Software package, Interpretation of satellite data and Digital Image Processing.

Theory

UNIT I

Basic concepts of remote sensing and geographic information systems (GIS), Determination of geo-morphological, physiological, vegetation, soil, land use, parameters of a watershed.

UNIT II

Spatial and non-spatial data analysis. Preparation of thematic layers and their digitization.

Practical

Thematic layers build up, overlaying and their integration using ERDAS and ARCINFO Software package. Interpretation of satellite data and digital image processing. Preparation of thematic maps.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 523 WATERSHED HYDROLOGY AND RESOURCES CONSERVATION 2+1

Objective

To impart knowledge and understanding among the students on hydrological cycle, resource inventory of soil, land use planning, pressurized irrigation, surface runoff, hydrograph, rain water budgeting, wildlife role and conservation.

Theory

UNIT I

Hydrological cycle and characteristics of small and medium watersheds precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration.

UNIT II

Resources inventory soil, land, water and Biota. Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency.

UNIT III

Biota- vegetation types, distribution and utilization. Wildlife –role and conservation.

Practical

Rain water budgeting – run off and soil loss, infiltration, soil moisture, deep percolation and ground water change, rainfall measurements hydrograph.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 524 PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED 3+1

Objective

To develop awareness among the students on cultural practices in rainfed areas on production of fruits, vegetable, and medicinal plants:, afforestation, agroforestry and biodiversity. Identification of medicinal and aromatic plants, plantation models, management of tree, shrubs and grasses in watershed areas.

Theory

UNIT I

Importance of climate, soil requirement and cultural practices for fruits, vegetables, cereals, oil seed, pulses and medicinal plants grown in watershed areas. Area production, economic importance and export potentials of tropical and subtropical fruit, vegetable and medicinal plants. Manuring and irrigation. Methods of plant protection. Nursery practices for fruit and vegetable crops.

UNIT II

Afforestation, reforestation constraints, scope, basic principles and Environmental benefits. Agro forestry- Definition, its role in water development, Diagnosis and design, Agro forestry models for different land types arable, pastures and wastelands. Alley cropping, silvi-pastoral system, high density short rotation plantations/energy plantation. Agri- horticulture and horti-slivimedicinal systems.

UNIT III

Concepts of biodiversity in watershed, threat biodiversity. Biodiversity conservation-*In-situ* conservation and *Ex-situ* conservation. *In-situ* conservation- Natural preservation, standard stand. *Ex-situ* conservation-clone banks/ seedling bank, breeding seed orchard, botanical garden, seed banks, pollen banks, *in vitro* conservation. Tree spp. for watershed. Identification of tree, shrubs and grass for watershed areas. Production and management of important fodder spp.

Practical

Identification of important varieties, species and rootstock. Acquaintance with crop production practices, herbicides, their application and equipment. Identification and description of tropical and subtropical vegetable crops.

Visit to nearly watershed areas; collection and identification of medicinal and aromatic plants in that area. Selection of nursery site, preparation of nursery beds and nursery raising. Field planting techniques. Cultivation, harvesting and processing of at least one medicinal or aromatic crop. Preparation of site for planting, planting layout pattern. Layout of different soil working techniques for hill slopes. Preparation of suitable plantation models for farmlands and catchements area, identification of tree spp. grasses, shrub. Establishment of vegetative barrier in watershed area. Management of tree, shrubs and grasses in watershed areas.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 525 PEOPLE'S PARTICIPATION AND IMPACT ANALYSIS IN WATERSHED MANAGEMENT 2+1

Objective

To make the students aware of people's participation concept, impact analysis and financial analysis in watershed management.

Theory

UNIT I

Community organizations – Definition, Principles advantages, Types and formation processes. Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies.

UNIT II

People's movements for social change. Gender analysis framework. Adoption process.

UNIT III

Participation-meaning scope, objectives, principles and historical perspective. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches.

UNIT IV

Socio economic impact analysis, financial analysis.

Practical

Study of social organization and their formation processes. Community mobilization for watershed management. Application of Gender Analysis in watershed management. Identification of adaptors categories and factors influencing adoption process. Visit to selected watersheds for understanding

concepts of people's participation. Application of participatory research approaches – review and analysis of selected cases. Need assessment, withdrawal strategies benefit sharing mechanism.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 526 INTRODUCTION TO ENVIRONMENTAL SCIENCES 2+0

Objective

To develop understanding of students about environmental and climatic System.

Theory

UNIT I

Definitions and concepts in environmental sciences, components of atmosphere, hydrosphere, pedosphere, biosphere and their interactions.

UNIT II

Ecosystems of the world, energy flow in ecosystems, bio-geographic regions, biological building block, nutrients and nutrient cycling in different eco-systems.

UNIT III

Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity, biotic and abiotic interactions, soil-plant-atmospheric interactions, agriculture and environment pollution, green house and global climatic changes, environmental issues.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

NRM 527 ENVIRONMENTAL ANALYTICAL TECHNIQUES 2+1

Objective

To develop understanding of students about environmental statistics

Theory

UNIT I

Introduction; Principles of physical, chemical and microbiological analysis of environmental pollutions. Sampling procedures for testing water, waste water, air and solid waste, sampling rules, sample collection andpreservation.

UNIT II

Environmental chemical analysis; role and importance. Classical Methods; volumetric and gravimetric analysis, principles of filtration, distillation, paper chromatography, gas chromatography, etc.

UNIT III

Instrumental techniques using atomic absorption and emission spectrophotometery, Gas chromatography, etc. Assessment and interpretation of results using statistical tools.

Practical

Handling of the analytical equipments and analysis of particulate air pollutants and other environmental chemical.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

NRM 528 ENVIRONMENTAL IMPACT ASSESSMENT 2+1

Objective

To train the students in planning and evaluation projects.

Theory

UNIT I

Introduction; Principles and purposes of IEE and EIA and its significance for the society, Cost and benefits of EIA; EIA involvement during project life cycle.

UNIT II

EIA management; principles & management of EIA, main stages in EIA processes; screening, scooping, prediction, mitigation and alternatives auditing.

UNIT III

EIA techniques, checklists, matrices, network method, remote sensing and GIS. Public consultation and participation in EIA process. EIA guidelines and review process. EIS formulation. New approaches to EIA and SEA (strategic environmental assessment).

Practical

Preparation of EIA & SEA reports.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

NRM 529 FOREST RESOURCE ANALYSIS 3+0

Objective

To develop understanding of students about the nature and importance of forest resources, their availability and management strategies.

Theory

UNIT I

Forest resources: wood produce and non-wood produce. Raw materials of forest origin for industries viz; paper and pulp; plywood and board, saw mills, furniture making, packing case, match splints, toys etc.

UNIT II

Minor forest products: edible products, fodder trees, shrub and grasses, bamboo and cane, medicinal and aromatic plants, oil seeds, gum & resins fibre and flosses, spices and miscellaneous products e.g. Katha, latex, insecticides, soapnuts, etc.

UNIT III

Animal products from forest - lac, honey, silk, fur, skins, tusks etc. Dependency of villagers/ tribals on forest resources for different livelihood options.

UNIT IV

Nature, scope and importance of forest resources in regional & national economy, nature, role and functions of forest based industries, reasons for resource degradation. Causes of low productivity of forest resources, remedial strategies, Trends in the production of important forest resources (wood and non-wood products). Government policies on forest resources.

Approaches to achievements under five year plans. Management strategies for improved production and consumption of forest resources.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997.

Natural Resource Economis – Theory and Application in India. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 530 PRODUCTION MANAGEMENT IN NURSERY AND PLANTATION FORESTRY 2+1

Objective

To develop understanding and management skills of the students in respect of commercial nursery production and plantation forestry.

Theory

UNIT I

Introduction to production theory. Production concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of choice and resource allocation in nursery production, Resource combination and cost minimization, Resource allocation and enterprise combination. Technical and economic efficiency, Derivation of cost and supply functions from production functions, break-even analysis managing risk and uncertainty in nursery and plantation forestry.

UNIT II

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis.

UNIT III

Time value of money, Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period.

UNIT IV

Market structure, Functions, Channels, Marketing efficiency and marketing problems of nursery and plantation forestry.

Practical

Exercises on marginal analysis in nursery production, Exercises on time-value of money and investment analysis. Exercises on marketing channels, costs, margin and price spread for different nursery and plantation crops.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commission Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economics – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 531 PROJECT PLANNING, MONITORING AND EVALUATION 2+1

Objective

To develop understanding of the students about fundamentals of project planning, monitoring and evaluation

Theory

UNIT I

Project – importance and steps in project formulation. Ex-ante, concurrent and expost project appraisal. Choice of discount rate. Financial feasibility of project, various techniques used.

UNIT II

Advantage and disadvantages of discounting and non-discounting feasibility criteria. Sensitivity analysis. Introduction of network scheduling techniques. Critical path methods, characteristics, use and preparation of critical path.

UNIT III

Monitoring and evaluation –definition, objectives and types. Project review meeting and preparation of project status reports. Fundamentals of environment impact assessment.

Practical

Project preparation. Application of various methods like Net Present Value, Internal Rate of Returns, Benefit Cost Ratio, annuity, payback period, CPM, PERT approach in the formulation and appraisal of various Agroforestry and forestry projects. Exercises on sensitivity analysis.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 532 FARM MANAGEMENT 3+0

Objective

To develop understanding and management skills of the students with special reference to farm business management.

Theory

UNIT I

Farm: Concept, present scenario, and business application. Nature, scope and functions of farm business management. Principles involved in farm management decision making.

UNIT II

Principles of farm planning and budgeting. Working out existing and alternative farm plans. Application of quantitative techniques in Forestry production. Importance of farm records, Types of physical and financial records. Farm business efficiency measures - Fundamentals of inventory control.

UNIT III

Management of special farm projects like, nursery, plantations, poultry, dairy, fishery, bee keeping, sericulture, mushrooms, etc. Managerial problems of farms.

UNIT IV

Farm labour and its problems. Labour measurement, work allocation,raising labour productivity. Staff control-work progress charts, supervisory management, leadership and leadership styles; good labour relations, training needs reward structure. Farm capital and its problems, farm machinery and its utilization.

Suggesting Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications.* Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

5. WILDLIFE SCIENCES

ET 521 ECOTOURISM - CONCEPT AND APPROACHES 2+2

Objective

To acquaint about the impact of tourism on ecology.

Theory

UNIT I

Eco tourism - study history of tourism, identify various forms of tourism and evolution of ecotourism. Dimensions of tourism and essentialconditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism.

UNIT II

Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Quebec declaration. Different forms of ecotourism like hard and soft ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries.

UNIT III

Organized tours and Free Independent Travelers. World Tourism Organization. Problems with definition of ecotourism and criticisms.

UNIT IV

International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism.

Practical

Students should make detailed reference on the various forms ofEcotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of eco-tourism. Debate on the concept to reach the most viable. Once they agreeon a concept, then the debate. Problems on common property resources and facilitate group discussion for recommendations. Discuss the merits and demerits of the recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Soared groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 522 ECOSYSTEMS OF THE WORLD 2+0

Objective

To impart knowledge about ecosystem dynamics especially of tourist spots.

Theory

UNIT I

Major ecosystems of the world - definitions of a typical ecosystems-concepts and approaches of Odum -Arctic tundra eco system, northern and southern hemisphere ecosystems, coniferous forests, temperate ecosystems, savanna –grass land, tropical rain forests, deciduous forest ecosystems-coastal systems mangroves etc, important features, faunal and floral populations

UNIT II

Adaptations and modifications threat to ecosystems-conservation and preservation-new approaches.

UNIT III

Influence of anthropogenic factors on the adaptation of different eco-systems.

UNIT IV

Studies on localized niches of potential tourist spots.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 523 ECOTOURISM IN PROTECTED AREAS 2+1

Objective

To develop understanding of students about ecology of tourist spots in protected area.

Theory

UNIT I

Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context.

UNIT II

Planning ecotourism in protected areas. Visitor management in ecotourism areas – zoning, carrying capacity. Participation of local people in ecotourism. Conflicts in PA's. Ecotourism for sustainable development of PA's.

UNIT III

New directions in ecotourism industry. Ecotourism in practice in important PA's of India – case studies of Periyar Tiger Reserve, Keoladeo National Park, Kanha National Park and Jim Corbet National Park, Project Tiger Research, Betla and Sunderbans Tiger Reserve. Limitations and problems of ecotourism.

UNIT IV

Ecotourism as a way for sustainable management of natural resources.

Local livelihoods and eco-tourism like nomadic grazing, agropasturatism.

Practical

Visits to surrounding ecotourism destinations- prepare ecotourism activity maps- Preparation of route maps to important National parks and sanctuaries of India. Preparation of information procedure about foresttourist spots in India. Exercises on the preparation of location-specificmodel eco-tourism plans.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 524 ECOTOURISM LANDSCAPING 2+1

Objective

To impart understanding about developing and protecting landscapes of ecotourist spots.

Theory

UNIT I

Introduction - definition and historical background - Components and elements in landscaping - Principles of landscaping - landscape architecture for ecotourism- Landscape ecology with special reference to ecotourism.

UNIT II

walkwaysropeways- turfs, topiaries, live hedges-pergolas, carpets, lawn etc. Urban ecotourism -importance -history of urban planting in India - Planning and planting programmes for institution and industrial complexes

UNIT III

Importance of arboriculture in ecotourism. Landscaping- Management of trees - planning of roads, bridges, parking area.

UNIT IV

Planting methods - balanced lines - unbalanced line and sporadic system – formal and informal planting methods.

Practical

Preparation, planning and designing of recreation parks, thematic parks, practice on topiary, arboriculture, preparation of planting pattern for avenue planting, national highways and village roads.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 525 ECONOMICS OF ECOTOURISM 2+1

Objective

To develop understanding about impact of ecotourism on local economics.

Theory

UNIT I

Ecotourism as a business opportunity- market demand for ecotourism - analysis of ecosystem market demand in India- marketing issues- Investment

of international agencies like World Bank in ecotourism projects.

UNIT II

Ecotourism economics at macro and micro economic level in developing countries. Ecotourism as a green business and role of green consumerism. Business plans. Identifying unique selling points for marketing. Potential of internet in marketing ecotourism. Economic valuation of ecotourism sites (based on methods like travel cost method).

UNIT III

Environmental Impact Assessment. Payments for Environmental services and role of ecotourism. Multiplier effects, opportunity costs and leakage in ecotourism industry. Sharing ecotourism revenues among stakeholders

UNIT IV

Training in ecotourism to deliver quality service- Practical exercise on the economic inflow-out flow in the selection ecotourism area- impact on the economic well being of the local population.

UNIT V

Potential of eco-tourism in the sustainable management of local livelihood. Impact of eco-tourism on the income of local inhabitants. Feasibility plans for effective eco-tourism. Eco-tourism based capacity building.

Practical

Economic analysis of tourism components- case study of some important ecotourism destinations- analysis of primary and secondary beneficiariesreport preparation. Exercises on feasibility studies, environmental impact assessment and economic valuation of natural resources need to be included

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 526 DESIGN AND MANAGEMENT OF ECOTOURISM 2+1

Objective

To impart knowledge regarding regulating ecotourism within sustainable limits.

Theory

UNIT I

Ecotourism plans and management of visitors and other resources including human and natural resources. Types of eco-tourists - commercial eco- tourist – nature tour operators - Quality control, codes of conduct etc. Useof GIS and ICT for effectively managing and planning ecotourism.

UNIT II

Criteria and indicators for sustainable management and monitoring. Charter for Sustainable Tourism. Sustainability issues in ecotourism management and ecotourism certification

UNIT III

Role of socioeconomic factors in decision making. Designing ecotourism products using local technologies. Carrying capacity considerations. Use of GIS in ecotourism design- Existing ecotourism markets and ecotourism market segmentation.

UNIT IV

Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets. Role of local institutes and other grass-root agencies in the design and managerial of specific eco-tourism plans.

UNIT V

The genders dimensions of designing and management of eco-tourism and management of eco-tourism.

Practical

Mapping of major ecotourism destinations with GIS intervention- Identify one area of ecotourism potential – assess the carrying capacity- design suitable ecotourism activities

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

Ph. D. FORESTRY (as per BSMA, 2009)

Course Structure – at a Glance

A. CORE COURSES (MAJOR)

CODE	COURSE TITLE	CREDITS
FOR 601	QUANTITATIVE SILVICULTURE	2+1
FOR 602	ADVANCES IN TREE IMPROVEMENT	2+1
FOR 603	ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS	2+1
FOR 604	ADVANCES IN ECONOMIC ANALYSIS IN FORESTRY	2+0
FOR 605	AGROFORESTRY SYSTEMS AND MANAGEMENT	1+1
FOR 606	FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION	1+1

B. SUPPORTING COURSES

FOR 611	OPERATIONAL RESEARCH IN FOREST MANAGEMENT	2+1
FOR 612	LAND USE PLANNING AND WATERSHED MANAGEMENT	1+1
FOR 613	FOREST ECOLOGICAL MODELING	1+1
FOR 614	ADVANCES IN FOREST BIOMETRICS	1+1
FOR 615	CLIMATE CHANGE AND FORESTRY	1+1
FOR 616	INFORMATION TECHNOLOGY IN FORESTRY	1+1

C. SPECIALIZATION (MINOR)

1. Silviculture		
SILVI 621	ADVANCES IN SILVICULTURE	1+1
SILVI 622	PLANTATION FOREST PRODUCTIVITY	1+1
SILVI 623	FOREST REGENERATION	1+1
SILVI 624	ADVANCES IN FOREST SOIL MANAGEMENT	2+1
SILVI 625	FOREST SEED MANAGEMENT	1+1
2. Forest Genetic Resources		
FGR 621	ADVANCES IN TREE BREEDING	1+1
FGR 622	ADVANCES IN QUANTITATIVE FOREST GENETICS	2+1
FGR 623	FOREST REPRODUCTIVE BIOLOGY	2+1
FGR 624	MOLECULAR GENETICS OF FOREST TREES	2+1
FGR 625	GENETICS OF FOREST ECOSYSTEMS	2+0
3. Wood Science & Technology		
WST 621	ADVANCES IN WOOD TECHNOLOGY	2+1
WST 622	ENERGY AND CHEMICALS FROM WOOD	2+1
WST 623	INSTRUMENTATION IN WOOD SCIENCES	1+2
WST 624	ADVANCES IN WOOD MODIFICATION	2+1
4. Agroforestry		
AF 621	ADVANCES IN AGROFORESTRY RESEARCH & MANAGEMENT	2+0
AF 622	PRODUCTIVITY OF AGROFORESTRY SYSTEM	2+1
AF 623	LAND USE PLANNING AND WATERSHED MANAGEMENT	1+1
AF 624	ADVANCE AGROFORESTRY MANAGEMENT ANALYSIS	1+1
AF 625	ADVANCES IN FOREST SOIL MANAGEMENT	2+1

5. Medicinal and Aromatic Plants		
MAP 621	APPLICATION OF TRADITIONAL KNOWLEDGE	2+0
MAP 622	PRODUCTION OF QUALITY PLANTING MATERIAL	2+1
MAP 623	TECHNOLOGY AND PROCESSING OF MEDICINAL AND AROMATIC PLANTS	2+1
MAP 624	BIOSYNTHETIC ANALYSIS OF SECONDARY METABOLITES	2+1
MAP 625	VALUE ADDITION AND MARKETING OF MEDICINAL AND AROMATICS PLANTS	1+1
6. Forest Biotechnology		
FB 621	ADVANCES IN FOREST BIOTECHNOLOGY	2+1
FB 622	MOLECULAR GENETICS AND GENE MAPPING IN FOREST TREES	2+1
FB 623	MOLECULAR BIOCHEMISTRY	2+1
FB 624	TREE PHYSIOLOGY AND FOREST PRODUCTIVITY	2+1
FB 625	GENETIC ENGINEERING AND BIOINFORMATICS	2+1
7. Natural Resource Economics		
NRC 621	ADVANCED ECONOMETRICS	2+1
NRC 622	NATURAL RESOURCE ECONOMICS	2+0
NRC 623	ENVIRONMENTAL ECONOMICS	2+1
NRC 624	FOREST ECONOMICS	1+1
NRC 625	PROJECT PLANNING AND EVALUATION	1+1

	Specialization Areas	**Possible Discipline of Specialization in M. Sc. Forestry as Feeder**
1.	Silviculture	Plantation Technology, Agroforestry, Environment Management.
2.	Forest Genetic Resources	Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry, Environment Management.
3.	Wood Science & Technology	Wood Science & Technology
4.	Agroforestry	Agroforestry, Medicinal & Aromatic Plants, Forest Genetic Resources, Environment Management.
5.	Medicinal and Aromatic Plants	Medicinal and Aromatic Plants, Agroforestry.
6.	Forest Biotechnology	Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry
7.	Natural Resource Economics	Environment Management, Forest Business Management, Eco Tourism, Agroforestry

Modified as V Deans' Committee Recommendations at NAU, Navsari

Ph.D. (Forestry) - 75 Credits

Sr. No.	Course code	Course	Credit Points
A. CORE COURSES			
	FOR 601	QUANTITATIVE SILVICULTURE	2+1
	FOR 602	ADVANCES IN TREE IMPROVEMENT	2+1
	FOR 603	ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS	3+0
	FOR 604	ADVANCES IN ECONOMIC ANALYSIS IN FORESTRY	2+0
	FOR 605	AGROFORESTRY SYSTEMS AND MANAGEMENT	1+1
	FOR 606	FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION	1+1
			11+4= 15
	FOR. 691	DOCTORAL SEMINAR I	1+0
	FOR. 692	DOCTORAL SEMINAR II	1+0
	FOR. 699	DOCTORAL RESEARCH	0+45
B. SUPPORTING COURSES			
	FOR 611	OPERATIONAL RESEARCH IN FOREST MANAGEMENT	1+1
	FOR 612	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0
	FOR 613	FOREST ECOLOGICAL MODELING	1+1
	FOR 614	ADVANCES IN FOREST BIOMETRICS	1+1
	FOR 615	CLIMATE CHANGE AND FORESTRY	2+0
	FOR 616	INFORMATION TECHNOLOGY IN FORESTRY	1+1
		5 credits will be offered as per the research problem	
C. SPECIALIZATION COURSES			
I) SILVICULTURE AND AGROFORESTRY			
New Code	**Existing Code**	**Course Title**	**Credits**
SAF 621	SILVI 621	ADVANCES IN SILVICULTURE	1+1
SAF 622	SILVI 622	PLANTATION FOREST PRODUCTIVITY	1+1
SAF 623	SILVI 623	FOREST REGENERATION	1+1
SAF 624	SILVI 624	ECOLOGY OF FOREST FARMING	2+0
SAF 625	SILVI 625	ADVANCES IN FOREST SOIL MANAGEMENT	2+1
SAF 626	SILVI 626	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0
SAF 627	SILVI 627	FOREST SEED MANAGEMENT	1+1
SAF 628	AF 621	ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT	2+0
SAF 629	AF 622	PRODUCTIVITY OF AGROFORESTRY SYSTEMS	2+1
SAF 630	AF 623	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0
SAF 631	AF 624	ADVANCED AGROFORESTRY MANAGEMENT ANALYSES	2+1
SAF 632	AF 625	ADVANCES IN SOIL AND WATER MANAGEMENT IN AGROFORESTRY	2+1
		8 credits will be offered as per the research problem	

II) FOREST BIOLOGY AND TREE IMPROVEMENT			
New Code	**Existing Code**	**Course Title**	**Credits**
FBT 621	FGR 621	ADVANCES IN FOREST GENETICS AND TREE BREEDING	1+1
FBT 622	FGR 622	ADVANCES IN QUANTITATIVE FOREST GENETICS	2+1
FBT 623	FGR 623	ADVANCES IN FOREST REPRODUCTIVE BIOLOGY	2+1
FBT 624	FGR 624	MOLECULAR GENETICS OF FOREST TREES	2+1
FBT 625	FGR 625	GENETICS OF FOREST ECOSYSTEMS	2+0
FBT 626	FB 621	ADVANCES IN FOREST BIOTECHNOLOGY	2+1
FBT 627	FB 622	MOLECULAR GENETICS AND GENE MAPPING IN FOREST TREES	2+1
FBT 628	FB 623	INTERMEDIATERY METABOLISMS	2+1
FBT 629	FB 624	MOLECULAR BIOCHEMISTRY	2+1
FBT 630	FB 625	TREE PHYSIOLOGY AND FOREST PRODUCTIVITY	2+1
FBT 631	FB 626	GENETIC ENGINEERING AND BIOINFORMATICS	2+1
		8 credits will be offered as per the research problem	
III) FOREST PRODUCTS AND UTILIZATION			
New Code	**Exist.Code**	**Course Title**	**Credits**
FPU 621	WST 621	ADVANCES IN WOOD TECHNOLOGY	2+1
FPU 622	WST 622	ENERGY AND CHEMICALS FROM WOOD	2+1
FPU 623	WST 623	RESEARCH METHODS	1+2
FPU 624	WST 624	ADVANCES IN WOOD MODIFICATION	2+1
FPU 625	MAP 621	APPLICATION OF TRADITIONAL KNOWLEDGE	2+0
FPU 626	MAP 622	QUALITY IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS	2+1
FPU 627	MAP 623	POST HARVEST AND PROCESSING OF MEDICINAL AND AROMATIC PLANTS	2+1
FPU 628	MAP 624	BIOSYNTHETIC ANALYSIS OF SECONDARY METABOLITES	3+0
FPU 629	MAP 625	PROCESSING AND VALUE ADDITION IN MAP	2+1
		8 credits will be offered as per the research problem	
IV) **NATURAL RESOURCE MANAGEMENT**			
New Code	**Exist.Code**	**Course Title**	**Credits**
NRM 621	NRE 621	ADVANCED ECONOMETRICS	2+1
NRM 622	NRE 622	NATURAL RESOURCE ECONOMICS	2+0
NRM 623		ADVANCED SOIL & WATER CONSERVATION	2+1
NRM 624	NRE 624	FOREST ECONOMICS	1+1
NRM 625	NRE 625	PROJECT PLANNING AND EVALUATION	1+1
NRM 626	WM 523	WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS	2+1
NRM 627	EM 524	GLOBAL CLIMATE CHANGE	2+0
NRM 628	EM 522	ENVIRONMENTAL POLLUTION	3+0
NRM 629	ET. 523	ECOTOURISM IN PROTECTED AREAS	2+1
NRM 630	ET 524	ECOTOURISM LANDSCAPING	2+1
NRM 631	ET 525	ECONONICS OF ECOTOURISM	2+1
NRM 632	FBM 522	FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES	2+1
		8 credits will be offered as per the research problem	

Non Credit six compulsory courses PGS – 501, 502, 503, 504, 505 and 506 (courses will be offered that are not studied in the M.Sc. level)

Ph.D. FORESTRY
Course Contents

A. CORE COURSES

FOR 601 QUANTITATIVE SILVICULTURE 2+1

Objective

To assess growth functions, dynamics of even aged and uneven aged forest. Thinning and growth, self thinning rule or 3/2 power law of self thinning.

Theory

UNIT I

Growth functions-empirical, exponential, allometry and Backman's growth function. Growth pattern and growth increment curve. Growth cycle and phases.

UNIT II

Correlation between size and plant population. Probability of individual tree mortality. Models of mortality and yield for unthinned forest stands.

UNIT III

Dynamics of even aged and uneven aged forests. Competition for space, light and nutrients in forest stands and their effect on population. Effect of thinning and growth. Plant geometry and self thinning. Stand structure andallometry of trees during self thinning of pure stand. Interpretation of self thinning rule. Detailed concept 3/2 power law of self thinning and its revaluation and modifications.

Practical

Growth characteristics and effect of temperature, nutrients and water stress on growth behaviour of nursery plants. Preparation of growth and increment curves.

Suggested Readings

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

FOR 602 ADVANCES IN TREE IMPROVEMENT 2+1

Objective

To develop understanding of students in application of mendelian, principles to forest trees and integration of physiological and molecular techniques for tree improvement programmes.

Theory

UNIT I

Mendelian concepts as applied to forest trees. Cytological andchromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees.

UNIT II

Physiological basis of tree improvement. Pollution responses of trees.Pollen handling and hybridization techniques in forest trees. Tissue culture of trees.

UNIT III

Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Inheritance of monoterpene composition in conifers.

UNIT IV

Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT V

Geographic variation in trees, evolution and gene flow. Exploration and conservation of gene resources of trees. Dioecism and moneocism in trees.

Practical

Cytology of pine root tips, kryotypic analysis, mutagenic treatments with colchicine and MH, tissue culture of organs, and transformation experiments, resin tapping and observation of trees for menoecium and dioecium.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FOR 603 ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS 3+0

Objective

To acquaint the students regarding updated and advance technology of timber mechanics, wood derivatives, import and export potential of non timber forest produce and latest computer application in forest produces.

Theory

UNIT I

Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing.

UNIT II

Principles of industrial wood processes, Products derived from wood by chemical processes and value added wood products, Properties of construction, Wood polymers and surface chemistry, Fundamentals of adhesion and fracture in adhesively bonded wood, Adhesive systems used for wood with emphasis in wood based composites.

UNIT III

Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT IV

Computer application system in forest products, Use of information technologies to integrate material, quality and market fluctuations.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR.

Anonymous. 2007. *Year Book of Forest Products*. FAO.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Gamble JS. 2002. *A Manual of Indian Timbers*. International Book Distr.

Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Negi SS. 2007. *Wood Sciences and Technology*. International Book Distr.

FOR 604 ADVANCES IN ECONOMIC ANALYSIS IN FORESTRY 2+0

Objective

To acquaint the students about the latest analytical methods as applied in production forestry and the environment analysis.

Theory

UNIT I

Use of theoretical frameworks of consumer behaviour, market equilibrium, efficiency of perfect and imperfect competition, game theory, and social welfare functions in decision about optimal utilization of forest resources; Issues and dynamics of domestic and international demand & supply of forestry products;

UNIT II

Economic and financial rotations and sensitivity analysis of optimum rotation. Valuation of forestry goods and services. Benefit-cost analysis for forestry investments. National income accounting - issues and methodologies in green accounting.

UNIT III

Environmental pollution as a case of common property management. Policy initiatives for improving the management of common property resources and environmental conservation.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications.* Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FOR 605 AGROFORESTRY SYSTEMS AND MANAGEMENT 1+1

Objective

To impart knowledge on recent development on agroforestry models and its economics.

Theory

UNIT I

Rationale for research proposals: live fences, boundary plantings, hedgerow intercropping, mixed intercropping, fodder banks, woodlots; Possible experimental designs

UNIT II

The use of economics in diagnosis and design of Agroforestry systems; Costs and benefits in Agroforestry; Valuation of inputs and outputs; Environmental outputs

UNIT III

Discounting rates for private and public economic analysis; Discounted measures of economic worth; Non-numerical economic analysis; Methodology for the exploration and assessment of multipurpose trees

UNIT IV

General considerations; Collection of MPTs; Assessment and choice of experimental sites; Assessment of methodologies; Changes in plant species; Tree/crop interface approach; Systematic designs; Bivariate analysis for intercropping experiments; Modelling in Agroforestry; Elements.

Practical

Developing formats for diagnosis and design investigations; Discussion on published cases of discounting in Agroforestry; Valuation of input and output; Case study on B C ratios for community forestry; Scoring formultiple use of different species; Listing a hundred species of tropicalorigin; Market trends in tree based products; Study of impact of agroforestry/social forestry on wildlife; Birds and small animals; General of ergonomic data from Agroforestry practitioners in farmlands; Farmers responses to Agroforestry/community forestry; Studies on light and shade effects of trees on understorey plants. A review; The role of voluntary agencies/industries in promoting afforestation programmes; The impact of training to farmers, agricultural officers and others in promoting Agroforestry; Experience of Birsa Agricultural University. Constraints in

adoption of Agroforestry; Farmers view point; Visit to agave & biofuel plantations and report on its management practices; Industry; Farmer nexus; Wasteland development; Fuel wood plantations, Biomass productivity assessment; Develop models for rehabilitation of saline and alkaline areas.

Suggested Readings

Chandawak BS & Gautam SK. 1993. *A Textbook of Agroforestry*. Oxford & IBH.

Dwivedi AP. 1992. *Agroforestry – Principles and Practices*. Oxford & IBH.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell.

Jeffers JNR. 1978. *An Introduction to System Analysis with Ecological Application*. Edward Arnold.

Jha LK. 1995. *Advances in Agroforestry*. APH Publ.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Singh PO, Pathak PS & Roy MM. 1994. *Agroforestry Systems for Sustainable Land Use*. Oxford & IBH.

Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

FOR 606 FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION 1+1

Objective

To develop understanding of students about environmental sustainability and forestry interventions for environment amelioration

Theory

UNIT I

Environmental amelioration – concept and challenges. Integration of environmental conservation strategies and economic development.

UNIT II

Forestry interventions viz. Plantation forestry, industrial forestry, urban forestry, fuelwood/energy forestry including biofuels, short rotation forestry, Agroforestry, biodiversity parks, Sanctuaries and national parks and catchment plantations.

UNIT III

Impact of soil erosion, soil moisture regimes, fertility improvements, poverty alleviation, micro-environment native biodiversity and overall environmental sustainability.

UNIT IV

Environmental concerns, monitoring methods, health & safety, environmental training, environmental organization.

Practical

Study structure an functions of forestry interventions. Analysis of the micro-environmental attributes viz. temperature, humidity, solar radiations, soil erosion, *in-situ* measurement of sediment load in native water bodies, native fauna and flora, measurement of particulate air pollutants and other gases.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

B. SUPPORTING COURSES

FOR 611 OPERATIONAL RESEARCH IN FOREST MANAGEMENT 1+1

Objective

To develop knowledge about operation research in forest management through inventory models and simulation technique also.

Theory

UNIT I

Case studies in relation of even and uneven aged stands. Project planning.

UNIT II

Operational research methods for Forest Management.

UNIT III

Application of programming-linear and dynamic, network analysis, PERT and CPM, inventory models and simulation technique.

Practical

Application of above techniques through a case analysis using forest inventories.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Ram Prakash 1986. *Forest Management*. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

FOR 612 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective

To develop understanding of students about land use planning and watershed management

Theory

UNIT I

Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.

UNIT II

Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

UNIT III

Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.

UNIT IV

Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions.

UNIT V

Watershed management cases studies.

Suggested Readings

Dhuruva Narayana VV, Sastry G & Patnaik VS. 1990. *Watershed Management.* ICAR.

Murty JVS. 1995. *Watershed Management in India*. Wiley Eastern.

Singh R. 2001. *Watershed Planning and Management*. Scientific Publ.

FOR 613 FOREST ECOLOGICAL MODELING 1+1

Objective:

To develop understanding of students in the concepts of modeling techniques in ecology and analysis of different models for population structure.

Theory

UNIT I

Systems and Models - Descriptive and explanatory models - Dynamic systems and models - Deterministic and Stochastic models -Usefulness of ecological research using models.

UNIT II

Growth of biological populations - measurement of growth rate -population growth models - Discrete one species models - Exponential, Mitscherlich, logistic and Gompertz models - Richards Function Properties of models and estimation to biological data. Growth models with timedelays - properties and their applications - Two species models - System of two constant coefficient - first order differential equations and their solutions - Predator and Prey models - Lotka-Volterra equations and their qualitative solutions

UNIT III

Optimization of resources under constraints - Linear and non-linear programming - Formulation and their applications in ecological modeling. Simulation - Elements and basic concepts - Deterministic simulation - state variables, rate variables and drying variables - Feedback models and their solutions - analytic integration and system behaviour in time-dynamic simulation using numerical integration.

Practical

Computation of growth rates using tools of calculus - problems in discrete models - Fitting of growth models: exponential, Mitscherlich, logistic, Gompertz and Richards function to data and interpretation - Problems in time delay models and predator and prey models - analysis of qualitative solution of Lotka - Volterra equations - Formulation of linear, dynamic and nonlinear programming modelsin ecology - simulation - problems in numeric integration - identification of state variables, rate variables and drying variables - simulation of dynamic models using numeric integration.

Suggested Readings

Braun M, Coleman CS & Drew DA.. 1978. *Differential Equation Models*. Springer-Verlag.

Causton DR & Venus JC. 1981. *The Biometry of Plant Growth*. Edward Arnold.

Leffelaar PA. 1993. *On System Analysis and Simulation Processes*. Kluwer.

Taha HA. 1992. *Operations Research, An Introduction*. Prentice Hall of India.

FOR 614 ADVANCES IN FOREST BIOMETRICS 1+1

Objective

To acquire advance knowledge on estimation of growth of the forest and also study prediction models.

Theory

UNIT I

Measurement of tree parameters. Estimation of volume, growth and yield of forest and plantations

UNIT II

Forest inventory. Sampling methods adopted in forestry. Use of GPS in forest inventory. Various stand density measures. Simulation techniques.

UNIT III

Different growth and yield prediction models – logistic model, etc. and application

Practical

Calculations of volume of felled as well as standing trees, Vol, Application of sampling procedures, Handling of GPS, calculation of data for prediction of growth models.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.

Ram Parkash 1983. *Forest Surveying*. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 615 CLIMATE CHANGE AND FORESTRY 2+0

Objective

To acquaint the students about processes causing climate change and ecological and economic impacts and also strategies to combat climate change.

Theory

UNIT I

Introduction to changes in the earth's climate. Definition of climate change – Scientific evidence, process and consequences for society and ecosystems – Interpretation of past climatic conditions from proxy records – Patterns of climate variability – Trends recorded instrumentally – Synopsis of observations

UNIT II

Processes that cause climate change.An overview of mechanisms – Atmosphere – Climate change and thermohaline circulation – Global warming as a possible trigger for climate change – Limited predictability close to an instability – Changes in natural modes of the atmosphere-ocean system – Possible future changes in the hydrological cycle – Ice sheet changes

UNIT III

Economic and Ecological impacts of climate change. Recent scientific studies in the ecological and social sciences – sectoral approaches – Modeling the impacts of climate change – Impacts on the Indian agricultural sector – Sea-level rise and its effect on coastal resources – Potential impact on Indian water resources

UNIT IV

Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India

UNIT V

Global and regional strategies to combat climate change. Action around the world – European Union: A review of five national programme – US climate policy: Factors and constraints – Climate change mitigation inJapan – Climate change mitigation programs in India – Electric power futures in five developing countries.

Suggested Readings

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change,USA.

Committee on Abrupt Climate Change. 2002. *Abrupt climate change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. 2007. Biodiversity International, Rome, Italy.

FOR 616 INFORMATION TECHNOLOGY IN FORESTRY 1+1

Objective

To explore students to use information technology in forest research, management of information systems and database in forestry.

Theory

UNIT I

Information and communication technology and the forest sector: History; ecommerce in forestry sector. Remote Sensing and Image Interpretation: Basic concepts, elements of photographic system, principles of photogrammetry, introduction to visual image interpretation.

UNIT II

Geographical Information Systems (GIS) and Global Positioning Systems (GPS): Different views (database view, map view, model view) of GIS, geographical positioning systems and their use in forestry. Management information systems: Introduction, databases and data warehouses, decisions support and artificial intelligence, operational management and control in forestry through information systems. Database Management Systems: Introduction and objectives, technical over view, internet technologies.

UNIT III

Fundamentals of Forest Statistics: Application of point process methods in Forest Statistics, spatial statistics.

Practical

Applications of GPS : Data retrieval and Database development.

Suggested Readings

Bergeron BP. 2002. *Bioinformatics Computing*. Prentice Hall.

Ewens WJ & Grant GR. 2001. *Statistical Methods in Bioinformatics: An Introduction* (*Statistics for Biology and Health*). Springer.

Jones NC & Pevzner PA. 2004. *An Introduction to Bioinformatics Algorithims*. MIT Press.

Krane DE & Raymer ML. 2002. *Fundamental Concepts of Bio-informatics*. Benjamin / Cummings.

Lesk AM. 2002. *Introduction to Bio-informatics*. Oxford University Press.

C. SPECIALIZATIONS

1. SILVICULTURE AND AGROFORESTRY

SAF 621 ADVANCES IN SILVICULTURE 1+1

Objective

To develop understanding of students about advance in Silviculture and silvicultural practice. Effect of silvicultural practices on forest stand management and stand development. Advances in coppice silviculture.

Theory

UNIT I

Philosophy of silviculture – Advance reproduction methods and their role in silviculture – Judging successful establishment; Analysis of active and passive site preparation – Silviculture with an ecosystem approach

UNIT II

Advance silvicultural practices in rain forest; Tropical forest; Subtropical forest, Temperate forest; Mechanization and role in Silviculture

UNIT III

Analysis of different techniques of silviculture in forest stand management, Technique for early stand development; Analysis of thinning methods and its impact on wood yield and quality; Stand protection and health management

UNIT IV

Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India and abroad; Advances in coppice Silviculture

UNIT V

Adjusting silviculture to meet industrial demands – Silviculture in perspective – Problem solving procedure for silviculture – Silviculture in retrospect.

Practical

Study of components of silvicultural system for sustained yield; Management strategies for even aged and uneven aged stands; Regeneration methods for specific sites; Choice of site preparation methods, Plantation map, Quality planting stock, Planning for tree planting, Release cutting operation, Selection of thinning methods, Intensity of thinning, Analysis of site quality and biomass production for timber, pulp wood and fuel wood species, Problems in silviculture in tropical, subtropical plantation and their solutions.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silviculture*. IBD, Dehradun.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press.

Ford ED. 1984. *Nutrition of Plantation Forests*. Academic Press.

Kadambi K. 1993. *Silviculture and Management of Teak*. Vedams Books International.

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Sairll PS, Evans J, Auclair D &Flack J. 1997. *Plantation Silviculture in Europe*. Oxford University Press.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

Smith DM. 1980. *The Practice of Silviculture*. 8th Ed. USED.

Zobel BJ, Wyk G & Stahlper P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

SAF 622 PLANTATION FOREST PRODUCTIVITY 1+1

Objective

To develop understanding of students about plantation forest productivity. Dynamics of plantation growth, thinning and fertilization of plantation.

Theory

UNIT I

Plantation forests - Scope and perspective, International and national scenario

UNIT II

Dynamics of plantation growth – Site quality, Stand density, Dynamics of nutrient cycling, Thinning, Spacing and crown efficiency, Fertilization, Nutrient pools and dynamics, Biological factors in nutrient supply, Fertilization of plantation.

UNIT III

Irrigation – Tending operation and plantation productivity.

Practical

Plantation productivity analysis – Nutrient cycling, Stand density estimation, Fertilizers and fertilizer application in plantation, Stability analysis of forest ecosystem, Response of plantation to irrigation, Productivity of clonal forestry, modern tools in site preparation, Weed management methods, Management strategies for enhancing plantation productivity, Methods of estimating plantation.

Suggested Readings

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press.

Ford ED. 1984. *Nutrition of Plantation Forests*. Academic Press.

Kadambi K. 1993. *Silviculture and Management of Teak*. Vedams Books International.

Sairll PS, Evans J, Auclair D &Flack J. 1997. *Plantation Silviculture in Europe*. Oxford University Press.

Smith DM. 1980. *The Practice of Silviculture*. 8th Ed. USED.

Zobel BJ, Wyk G & Stahlper P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

SAF 623 FOREST REGENERATION 1+1

Objective

To develop understanding of students about the concepts, underlying principles and soil nutrient relationships in forest regeneration.Regeneration in relation to silvicultural systems. Problems of regeneration in important conifers and broadleaved spceis.

Theory

UNIT I

Principles and methodologies of Forest regeneration, Ecological basis of natural regeneration techniques, Tree regeneration and its evolutionary trend; Ecological status of woody plants, Choice of species for varioussites, Regeneration sampling pattern and intensity.

UNIT II

Factors affecting natural and artificial regeneration - Kinds, extent andquality of sites, Relationship of soil characteristics like nutrient, moisture, structure and physiography with tree growth and site productivity; Site manipulation by physical chemical and biological methods.

UNIT III

Regeneration in relation to silvicultural systems, Problems of regeneration in

respect of important confiers (Fir, Spruce, Deodar, Chir) and broadleaved species (Sandal, Sal, Teak, Terminalias, Alnus etc.).

Practical

Monitoring of forest regeneration, Choosing a regeneration method, Preparation of regeneration plans, Factors promoting natural regeneration, Sampling method and accessing success or failure of regeneration, Preparation of regeneration map, Case study of natural regeneration inIndia; Modern approaches in container seedling production, INM and irrigation in quality seedling production, Studies on the regeneration techniques of timber and pulpwood species, Cost benefit analysis of regeneration methods.

Suggested Readings

Barnett J, Baker P & James B. 1991. *Regeneration Methods*. USDA. Proceedings. Reprint.

Boyd RJ. 1991. *The Biology of Planting*. USDA.

Etheringlin JR.1976. *Environment and Plant Ecology*. Wiley Eastern.

Thompson K.1991. *The Functional Ecology of Seed Banks*. *NERC Unit of Comparative Plant Ecology*. Sheffield. UK.

SAF 624 ECOLOGY OF FOREST FARMING 2+0

Objective

To develop understanding of students about designs, concepts and potential of species and their forest farming.

Theory

UNIT I

Introduction, objectives and background of forest farming

UNIT II

Ecological cultivation. Designing of forest farms. Site characteristics, choice and selection of species. Fast growth and energy potential of the species. Ecology of planting and cropping. Nutrient cycling. Use of fertilizers-selection, method and time. Energy flow-accumulation and budget.

UNIT III

Ecology of different farm forestry models-agri-silvi, horti-silvi-pastoral systems. Monoculture versus mixed culture. Ecological effects of biofencing.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell.

Kimmins JP. 1976. *Forest Ecology*. MacMillan.

SAF 625 ADVANCES IN FOREST SOIL MANAGEMENT 2+1

Objective:

To acquire knowledge on advances in forest soil management. Hydrology of forest plantation; Stand development and productivity. Fruit management & long term soil productivity.

Theory

UNIT I

Tropical soils and their management for plantation forestry : Soils of the tropics, Soil requirements for plantation forestry, physical properties of major soils of tropics, soil erosion and erodibility, Erosion control

UNIT II

Dynamics of nutrient supply in plantation soils: variability of nutrientstores in forest soils, changes in nutrient content and nutrient cycling processes, nutrient losses and their assessment, nutrient gains, Nutrienttransformation in soils. Nitrogen fixation in Tropical forest Plantations: N- fixation process, species, rates of N fixation, factors influencing N fixation; Nutrient cycling - comparison of plantation productivity - case studies.

UNIT III

Hydrology of forest plantations : Forest hydrological cycle; Hydrology of forest plantations - Plantation management and hydrology; The role of hydrological modelling in plantation management.

UNIT IV

Organic matter: Decomposition and mineralization; Litter accumulation, litter decomposition, effect of litter on soil, Interpretation of accumulation, decay and mineralisation processes, management of litter and soil organic matter in tropical plantations. Soil and stand management for short rotation plantations; Water availability, Nutrient supply, uptake and tree growth, constraints on production, nutrient amendments and correction of nutrient deficiency.

UNIT V

Stand development and productivity: Definition and measurement of productivity, patterns of stand growth, Nutritional factors controlling stand growth. Reforestation of salt affected and Acid soils, reforestation of salt affected soils, acid soils, coastal soils. Effects of fire on soils: Types of fires, effects of fire on soil properties, effects of fire on air and water quality.

UNIT VI

Management and long term soil productivity - soil compaction and erosion - Harvest removal and nutrient Budgeting - Harvest effect on water quality - strategies for future management

Practical

Nutrient budgeting for different plantation systems, Quantification of physical and chemical soil constraints in plantation and Agroforestry systems, Evolving new strategies for development

Suggested Readings

Ram Prasad. 1988. *Technology of Wastelands Development*. Associated Publishing Co..

Sadanandan Nambiar EK & Grown AG. (Eds.). 1997. *Management of Soil, Nutrients and Water in Tropical Plantation Forests*. ACIAR, CSIR and CIFOR, Australia.

SAF 626 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective

To develop understanding of students about land use planning and watershed management. Developing sustainable Agroforestry system techniques in watershed.

Theory

UNIT I

Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.

UNIT II

Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

UNIT III

Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.

UNIT IV

Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions. UNIT V: Watershed management cases studies.

Suggested Readings

Dhuruva Narayana VV, Sastry G & Patnaik VS. 1990. *Watershed Management*. ICAR.

Murty JVS. 1995. *Watershed Management in India*. Wiley Eastern.

Singh R. 2001. *Watershed Planning and Management*. Scientific Publ.

SAF 627 FOREST SEED MANAGEMENT 1+1

Objective

To develop understanding of students in the concepts of seed maturity, dormancy, stratification, seed storage and forest seed management.

Theory

UNIT I

Concepts, classification, seed fortification, use of adjuvants, diluents, stickers, encapsulation materials, dyes, chemicals, pesticides, fungicides, animal repellents, biological materials, antibiotic and growth regulators, biofertilizers, minerals salts, bioactive substances.

UNIT II

Seed infusion and involvement in synergistic factors dormancy and stratification, Physical treatment with abrasives, hot and cold temperature, radio - frequency waves, UV rays, X-rays and gamma rays.

UNIT III

Methods of application and their effects on germination, seed hardening, osmotic priming in relation to stress management.

UNIT IV

Seed pelleting, use of bio-fertilizers, mineral salts, growth regulators, hydrophilic substances, seed-coat polymers in stress management, sequences in seed inoculation.

UNIT V

Planting value determination and storage potential evaluation, aerial seeding and its implication, use of IDS for separation of viable seed from non viable seeds mid-storage correction treatment

Practical

Influence of seed fortification with different treatments on germination and vigour of seeds. Studies on seed infusion effects on germination - Vigour and planting value; Use of physical treatment of seeds on seed germinationand vigour - Seed hardening treatments and their influence on the planting value of seeds, Studies on osmotic priming on stress tolerance of seedlings

- Seed pelleting studies in tree seeds. Evaluation of pelletted seeds for survival percentage both in laboratory and field. - Determination of storage potential of pelleted seeds. - Use of organic solvents for seed infusion and

their influence on the seed quality - Standardisation of IDS method to separate viable seeds from non-viable seeds in tree species - Evaluation of effectiveness of separation by IDS method by germination test, cutting test radiographic analysis. - Studies on the evaluation of mid-storage correction treatments on the viability and vigour of seeds in storage by accelerated aging test.

Suggested Readings

FAO. 1985. *A Guide to Forest Seed Handling. Food and Agriculture Organization of the United Nations.* FAO Publ.

Faulker R. 1979. *Seed Orchards*. Her majesty's Stationary Office.

Mema NP. 1989. *Principles of Seed Certification and Testing*. Allied Publ.

Ram Prasad & Kandya RK. 1992. *Handling of Forestry Seeds in India*. Associated Publ.

William RL. 1985. *A Guide to Forest Seed Handling with reference to the Tropics*. FAO.

Zobel B & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

SAF 628 ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT 2+0

Objective

To teach how to refine the Agroforestry systems' management practices and their integration for developing suitable Agroforestry systems.

Theory

UNIT I

Recent trends in Agroforestry research and development. Agroforestry land use systems and their salient features.

UNIT II

Study of systems specification, prioritizing potential interventions and technology specifications; space and time related considerations.

UNIT III

Introduction to on farm and on station research experiments. Factors affecting biomass production.

UNIT IV

Soil-site sustainability and environmental resource sharing. Site-Species compatibility. Competition predation, mutualism, commensalisms. Simulation modeling of Agroforestry systems.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 629 PRODUCTIVITY OF AGROFORESTRY SYSTEMS 2+1

Objective

To acquaint the students with concepts in tree-crop systems productivity, managing the factors of production and sustained yield levels.

Theory

UNIT I

Concept of crop productivity. Productivity potential in relation to light, water and nutrients.

UNIT II

System complementarity, supplementarity, competetiveness, sustainability and management techniques. Tree root architecture, reallocation of resources within the plant system.

UNIT III

Biological yield and harvest index. Growth and yield functions. Land equivalent ratio. Water use efficiency, photosynthetic efficiency, radiation balance, canopy transmissivity, canopy management, plant geometry and crop yield.

UNIT IV

Allelopathic effects. Strategies to improve the efficiency and productivity of different land use systems

Practical

Techniques for leaf area index, photosynthetically active radiation, soil moisture and leaf water potential and canopy density measurements.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 630 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective

To impart knowledge to the students on developing skills in thedevelopment of watershed plans leading to sustainable management of watershed resources.

Theory

UNIT I

Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.

UNIT II

Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

UNIT III

Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.

UNIT IV

Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions.

UNIT V

Watershed management cases studies.

Suggested Readings

Dhuruva Narayana VV, Sastry G & Patnaik VS. 1990. *Watershed Management*. ICAR.

Murty JVS. 1995. *Watershed Management in India*. Wiley Eastern.

Singh R. 2001. *Watershed Planning and Management*. Scientific Publ.

SAF 631 ADVANCED AGROFORESTRY MANAGEMENT ANALYSES 2+1

Objective

To expose the students towards advanced tools of management with regard to Agroforestry systems.

Theory

UNIT I

Advances in Agroforestry management with emphasis on production, marketing and financial management.

UNIT II

Farm and other landuse principles and systems under perfect and imperfect knowledge situations. Simulation of Agroforestry situations. Evaluating relative profitability of different Agroforestry systems vis-à-vis other competitive agro-based systems.

UNIT III

Role of various financing agencies in Agroforestry and critical evaluation of different credit systems with emphasis on Agroforestry.

UNIT IV

Financial, economic and social accounting of Agroforestry projects. Advances in marketing management of Agroforestry products.

Practical

Exercises on developing alternative optimal Agroforestry plans under perfect and imperfect knowledge situations. Socio-economic and financial evaluation of Agroforestry projects.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

SAF 632 ADVANCES IN SOIL AND WATER MANAGEMENT IN AGROFORESTRY 2+1

Objective

To impart knowledge on managing soil nutrients and water in Agroforestry systems.

Theory

UNIT I

Soils and their management for agroforestry : physical and biochemical properties of major soil groups in different agroclimatic regions; soil erosion and erodibility; Erosion control

UNIT II

Dynamics of nutrient supply in different soils, changes in nutrient content, nutrient losses, nutrient gains and their assessment; Nitrogen fixation in Agroforestry systems; N fixation process; species; rates of N fixation;factors influencing N fixation; Nutrient cycling; comparison of productivity; case studies.

UNIT III

Hydrology of Agroforestry systems : Soil water relations, moisture management and soil plant water cycles; The role of hydrological modelling in agroforestry system management.

UNIT IV

Organic matter: Decomposition and mineralisation: Litter accumulation - litter decomposition, effect of litter on soil; Interpretation of accumulation - decay and mineralisation processes; management of litter and soil organic matter in Agroforestry systems; Soil and tree management for energy plantations and SRF plantations: Water availability; Nutrient supply, uptake and tree growth, constraints on production, nutrient amendments and correction of nutrient deficiency.

UNIT V

Management and long term soil productivity; soil compaction and erosion; Harvest removal and nutrient Budgeting; Harvest effect on water quality, strategies for future management

Practical

Nutrient budgeting for different plantation systems - Quantification of physical and chemical soil constraints in social and Agroforestry systems - Evolving new strategies for development

Suggested Readings

Ram Prasad. 1988. *Technology of Wastelands Development*. Associated Publ..

Sadanandan Nambiar EK & Grown AG. (Eds.). 1997. *Management of Soil, Nutrients and Water in Tropical Plantation Forests*. ACIAR, CSIR and CIFOR, Australia.

Young A. 1997. *Agro-Forestry for Soil Management*. CABI.

2. FOREST BIOLOGY AND TREE IMPROVEMENT

FBT 621 ADVANCES IN FOREST GENETICS AND TREE BREEDING 1+1

Objective

To develop understanding of students about methodologies involved in the study of gene flow of forests tree through pollen, seed and gene flow development of hybrids.

Theory

UNIT I

Assessment of genetic diversity, gene conservation, breeding populations, taxonomy and phylogenetic studies, pollen collection storage, extension, theories of pollen dispersal, mating designs.

UNIT II

Gene structure and expression, gene regulation, bioregulators, protein synthesis and polygenic inheritance, genetics of heterosis, overcoming incompatability, hybrid embryo rescue and studies in hybrid development in forest trees.

Practical

Emasculation and pollination studies in conifers and broadleaved treespecies (dioecious, monoecious and bisexual). Pollen vector analysis and traplining distances.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Miksche JP. 1976. *Modern Methods in Forest Genetics*. Springer Verlag.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Suzuki D, Gryfiths AJF, Miller JH & Lewontin RC. 1986. *An Introduction to Genetic Analysis*. WH Freeman.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 622 ADVANCES IN QUANTITATIVE FOREST GENETICS 2+1

Objective

To develop understanding of students about principles of biometry as applied to forest genetics to determine, genotypes phenotypic and gene flow values along with discriminate function.

Theory

UNIT I

Quantitative genetics in forestry, sampling, planning and layout, design analysis, variance allocations (components, genotypic and environmental concepts), heritability, correlations.

UNIT II

Incomplete block design, trend-free block design and generalized lattice

designs and their analysis.

UNIT III

Discriminate function, D2 analysis, correlation and path co-efficient analysis Software's in forest genetic analysis and their interpretations.

UNIT IV

Models of gene action (one locus, multiple locus), theories of selection, inbreeding, migration, mutation and population drift.

Practical

Problems in gene and phenotypic frequencies, Hardy - Weinberg equilibrium. Problems on effect of linkage on gene and genotype frequency change. Problems on demonstrating in breeding effects of random mating populations through graphs. Problems on demonstrating the effect of mutation, selection, sib-mating and migration through graphs. Study of genetic variability in different tree species. Problems on assessment of variability.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Miksche TP. 1976. *Modern Methods in Forest Genetics*. Springer.

Namkoong G. 1981. *Introduction to Quantitative Genetics in Forestry*. Castle House Publ.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 623 ADVANCES IN FOREST REPRODUCTIVE BIOLOGY 2+1

Objective

To develop understanding of students about phenology, phenodynamics breeding behaviour pollination biology and breeding systems in forest trees.

Theory

UNIT I

Reproductive biology of gymnosperms and angiosperms, Reproduction and population genetic structure, population dynamics. Floral morphology, floral initiation and breeding systems. Flowering manipulation. Reproductive abnormalities.

UNIT II

Pollination, biology, pollination ecology of tropical and temperate forest tree species, plant-pollination interactions. Pollinator energetic and nectar production

UNIT III

Genetic consequences of variation in reproductive biology. Pollen biotechnology for improved production.

UNIT IV

Gene expression during pollen development. Pollination efficiency of insects. Self-incompatibility.

Practical

Phenological studies in forest trees, nectar collection and analysis,pollination trapling distances, foraging behaviour, pollinator identification and visitation.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*. FAO Publ.

Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ.

Mandal AK & Gibson GL.(Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT 624 MOLECULAR GENETICS OF FOREST TREES 2+1

Objective

To develop understanding of students about molecular markers, gene mapping, genotypic influences, protein and DNA markers.

Theory

UNIT I

Molecular markers, quantification of genetic diversity, characterization of cellular molecules and their variants, assessment of morphological and quantitative traits.

UNIT II

Genotype verification and delineation, influences of environmental factors on developmental stages.

UNIT III

Isozymes, RFLPs, RAPDs, microsatellites, and genetic finger-printing in forest trees, marker assisted selection, binary vectors, selectable and screenable markers, and transgenics, gene maps of selected forest trees.

Practical

Isolation of DNA, RNA from forest tree species, isozyme analysis, use of molecular markers and RAPD and RFLPs for clonal identification.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*. FAO Publ.

Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ.

Mandal AK & Gibson GL.(Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Foreste*. John Wiley & Sons.

FBT 625 GENETICS OF FOREST ECOSYSTEMS 2+0

Objective

To make the students understand the mechanisms responsible for farm and structure in trees and how physiological and genetic concepts mingle to develop an ecosystem.

Theory

UNIT I

Introduction - tree forms in relation to environmental factors - mechanism responsible for differences in tree forms - stand structure and micro- climate.

UNIT II

Carbon fixation by tree canopies - leaf area, interception of solar adiation and tree growth - Leaf area index and dry matter production – Radiation attenuation through canopies - strategies for maximising solar energy utilisation - stomatal conductance.

UNIT III

Carbon consumption and export - carbon balance in trees - canopy photosynthesis - Transport and partitioning - Factors influencing net photosynthesis in trees - Relationship between the CO2 compensation point and carbon fixation efficiency in trees - Physiology of formation of early and late woods-Resource sharing in mixed Agroforestry system.

UNIT IV

Evapo-transpiration - factors affecting evapo-transpiration - potential evapo-transpiration - Moisture stress - osmotic adjustment - stomatal response to moisture stress - water use efficiency - drought tolerance.

UNIT V

Biochemical and molecular aspects - water logging - physiology of resistance to water logging - Salt and ion stress.

UNIT VI

Forest as biological community, Amplification of conceptual and quantitative models of variation in trees. Changes in gene frequencies, genetics and theory of selections, adaptations and conservation. Gene flow and genetic drift, polymorphism. Population structure and migration.

Suggested Readings

Kozlowski TT. 1971. *Growth and Development of Trees*. Vol. I. Academic Press.

Kramer PJ & Kozlowshi TT. 1979. *Physiology of Woody Plants*. Academic Press.

Larcher W. 1980. *Physiological Plant Ecology*. Springer-Verlag.

Raghavendra AS. 1991. *Physiology of Trees*. John Wiley & Sons.

Zimmerman RH. 1972. Juvenility and Flowering in Woody Plants: A Review. *Hort. Science* 7(5): 447-455.

Zimmermann MH & Brown CL. 1971. *Trees Structure and Function*. Springer Verlag.

FBT 626 ADVANCES IN FOREST BIOTECHNOLOGY 2+1

Objective

To expose the students to the recent concepts of micro-propagation in different species along with ethical and commercial aspects of transformation.

Theory

UNIT I

Principles of micro-propagation - Prospects - Organogenesis -

embryogenesis - Shoot tip cultures - Micropropagation of tree species such as *Eucalyptus, Sandal,* Teak, Bamboo, *Acacias*, *Albizias Casuarina*, etc. Problems and prospects

UNIT II

Hardening of tissue culture raised plants - green house designs - protoplast isolation - Culture and fusion techniques cybridization – applications

UNIT III

Genetic engineering for gene transformation - Disease elimination in trees - synthetic seeds - commercial applications.

UNIT IV

Microbial strain improvement by biochemical and molecular techniques - Transfer of nif-genes from Microorganisms to higher plants – Industrial important microbes – Antibiotics, enzymes, pigment producers – Bioremediation and bioleaching – Fermentation techniques.

UNIT V

Microbial control of forest insect pests - Genetic improvement of entomopathogens - Recombinant DNA - technique and cloning B.t toxin gene into other microbes - Transgenic plants with B.t toxin gene - trypsin inhibitor gene in plants - Genetic control of insects - Genetic improvement of parasitoids and predators.

Practical

Preparation of media - shoot tip culture callus initiation - organogenesis - embryogenesis - in *Eucalyptus, Sandal, Acacias, Albizias*, Bamboo, and teak - protoplast isolation, culture, fusion and plant regeneration. Strain improvement of different types of microbial inoculants - Testing the efficiency of microbial mutants – *Rhizobium*, phosphate solubilizers and cellulose and lignin degrading microorganisms. Study of entomopathogen of forest insects – study of entomophages – Mass production of B.t – inducing pesticide tolerance in Trichogramme – Inducing sterility in forest insects by ionizing radiation.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

DeBach P. 1974. *Biological Control by Natural Enemies*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Jayaraj S. 1983. *Microbial Control and Pest Management*. Tamil Nadu Agrl. University, Coimbatore.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Pedigo R. 1994. *Entomology and Pest Management*. MacMillan.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Sadasivam S & Manickam A. 1996. *Biochemical Methods*. New Age.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

Steinhausm EA. 1967. *Principles of Insect Pathology*. Hafner Publ.

Subba Rao N.S. 1988. *Biofertilizers in Agriculture*. Oxford & IBH.

Van der Laan PA. 1967. *Insect Pathology and Microbial Control* North Holland.

FBT 627 MOLECULAR GENETICS AND GENE MAPPING IN FOREST TREES 2+1

Objective

To develop understanding of students about molecular genetics and gene mapping in forest trees

Theory

UNIT I

Molecular markers, quantification of genetic diversity, characterization of cellular molecules and their variants, assessment of morphological and quantitative traits,

UNIT II

Genotype verification and delineation, influences of environmental factors on developmental stages,

UNIT III

Isozymes, RFLP,s, RAPD's, microsatellites, and genetic finger-printing in forest trees, marker assisted selection, binary vectors, selectable and screenable markers, and transgenics, gene maps of selected forest trees.

Practical

Isolation of DNA, RNA from forest tree species, isozyme analysis, use of molecular markers and RAPD and RFLP's for clonal identification.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 628 INTERMEDIARY METABOLISMS 2+1

Objective

To develop understanding of students about intermediary metabolisms

Theory

UNIT I

Carbohydrate metabolism: Glycolysis, TCA, HMP, Glyoxylate cycle, Gluconeogenesis, Glycogenesis and Glycogenolysis. Lipid metabolism: b-oxidation of saturated and unsaturated fatty acids, propionate degradation and phospholipid metabolism.

UNIT II

Protein metabolism; catabolism of protein, Catabolism of protein, catabilosm and biosynthesis of individual amino acids. Urea cycle.

UNIT III

Nucleic acid metabolism: Biosynthesis of purine and pyrimidine nucleotides and their degradation. Salvage pathway. Electron transport chain and oxidative phosphorylation.

Practical

Seperation of various cell organelles. Fermentation of sucrose by yeast and

separation of products by paper chromatography. Startch hydrolysis by salivary amylase and analysis of the products.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 629 MOLECULAR BIOCHEMISTRY 2+1

Objective

To acquaint the students about the structure and properties of genetic material, nuclear acids, replication and regulation of gene expression alongwith extraction and native of DNA and RNA.

Theory

UNIT I

Structure and properties of nucleic acids. Nature of genetic material.

UNIT II

Replication, Molecular mechanism of mutagenesis and DNA repair, transcription and translation. UNIT III: Regulation of gene expression. Mechanism of genetic recombination, transformation and transduction.

Practical

Isolation, purification and quantitation of native DNA and RNA. Effect of chemical and physical mutagene. Induction and isolation of bacterial, mutations and demonstration of genetic recombinations in microbes metabolism. Nucleic acids as genetic materials. Protein biosynthesis and regulation of protein biosynthesis.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FBT 630 TREE PHYSIOLOGY AND FOREST PRODUCTIVITY 2+1

Objective

To make the students understand the physiological factors responsible for the tree growth and how CO2 fixation and consumption lead to growth.

Theory

UNIT I

Introduction - tree forms in relation to environmental factors - mechanism responsible for differences in tree forms - stand structure and micro-climate

UNIT II

Carbon fixation by tree canopies - leaf area, interception of solar radiation and tree growth - Leaf area index and dry matter production - Radiation attenuation through canopies - strategies for maximising solar energy utilisation - stomatal conductance.

UNIT III

Carbon consumption and export - carbon balance in trees - canopy photosynthesis - Transport and partitioning - Factors influencing net photosynthesis in trees - Relationship between the CO_2 compensation point and carbon fixation efficiency in trees - Physiology of formation of early and late woods-Resource sharing in mixed Agroforestry system

UNIT IV

Evapo-transpiration - factors affecting evapo-transpiration - potential evapo-transpiration - Moisture stress - osmotic adjustment - stomatal response to moisture stress - water use efficiency - drought tolerance

UNIT V

Biochemical and molecular aspects - water logging - physiology of resistance to water logging - Salt and ion stress.

UNIT VI

Avoidance and tolerance mechanisms - temperature stress - low temperature stress - physiology of resistance to frost - Heat stress - Heat injury - Heat avoidance and tolerance mechanism - Radiation stress - mechanism of shade tolerance - Physiological basis of pollution stress - Ozone injury - acid rain - Heavy metals

Practical

Chlorophyll stability index - Leaf water potential by pressure bomb technique - porometry - Steady state porometer - leaf temperature - transpiration rate stomatal resistance and conductance, seed germination test for drought - tolerance and pre-treatment of seeds for drought tolerance - water use efficiency - measurement of photosynthesis

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kozlowski TT. 1971. *Growth and Development of Trees*. Vol. I. Academic Press.

Kramer PJ & Kozlowshi TT. 1979. *Physiology of Woody Plants*. Academic Press.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

Larcher W. 1980. *Physiological Plant Ecology*. Springer Verlag.

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Raghavendra AS. 1991. *Physiology of Trees*. John Willy & Sons.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.
Zimmerman RH. 1972. Juvenility and Flowering in Woody Plants: A Review. *Hort. Science* 7(5): 447-455.
Zimmermann MH & Brown CL. 1971. *Trees Structure and Function*. Springer Verlag.

FBT 631 GENETIC ENGINEERING AND BIOINFORMATICS 2+1

Objective

Providing insight to the students about gene technologies and advanced bioinformatics techniques.

Theory

UNIT I

Genetic Engineering : Fundamentals of genetic engineering. Gene vectors techniques of gene transfer. Production of transgenic plants for Biotic and biotic stress genetic engineering of microbes/bacteria for industrial use. Applications, potential and future prospects of genetic engineer.

UNIT II

Bioinformatics : Functional genomics of microbes, plants and animals; Transcriptome analysis methods, microarrays and serial analysis of gene expression. Data basss of expressed sequence tags. Data mining.

UNIT III

Proteomics of selected systems, methods and applications of proteome analysis. Expression proteomics; 2D and multidimensional chromatography. MALDI method and applications in protoemics.

Practical

Genetic Engineering : DNA isolation and purification. Restriction of DNA Recombinant DNA. Gene transer techniques. Selection of transformants and their analysis for integration and expression the gene.

Bioinformatics: Sequence annotation and analysis: Protein interaction analysis.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.
Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.
Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.
Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

3. FOREST PRODUCTS AND UTILIZATION

FPU 621 ADVANCES IN WOOD TECHNOLOGY 2+1

Objective

To develop understanding of students about advances in wood technology

Theory

UNIT I

Ultrastructure and composition of softwoods and hardwoods

UNIT II

Transverse, volumetric and longitudinal shrinkages in wood

UNIT III

Biopulping, enzyme pulp bleaching, biotechnological production of wood composites, bioremediation of wood treated with preservatives, bioactive wood polymer composites, non-conventional wood bonding, wood degradation by chemicals, treatment of pulp effluents.

Practical

Study of major cell types of softwoods and hardwoods. Cell inclusions. Shrinkage and swelling of wood. Determination of antishrink efficiency of treated wood. Pulping, pulp yield and bleaching.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 622 ENERGY AND CHEMICALS FROM WOOD 2+1

Objective

To develop understanding of students about energy and chemicals from wood

Theory

UNIT I

Energy and its measurements. Wood as sources of energy and its comparisons with other sources. Criteria for evaluation of different fuel wood species for energy.

UNIT II

Utilization of wood waste material as fuel. Gasification of wood. Production of chemicals from forest biomass-cellulose, lignin and hemicellulose. Important wood extractives. Wood plastics. Wood refinerytechniques.

UNIT III

Chemicals produced as by-product in pulp industry. Destructive distillation of wood. Future of wood chemical industry.

Practical

Determination of calorific value of different wood species and lignocellulosic wastes. Making of charcoal and briquettes. Hardwood and Softwood extractives.

Suggested readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 623 RESEARCH METHODS 1+2

Objective

To develop understanding of students about advances in research methods

Theory

UNIT I

Principles and utilization of research instruments-microtomes, gas liquid chromatography, HPLC, amino acid analyzer.

UNIT II

CHN analyzer, atomic absorption spectrophotometer, IR, UV, NMR and mass spectrophotometer.

UNIT III

Chemical analysis of pulp. Physical strength properties of paper, breaking length, stretch, tear index and burst index.

Practical

Estimation of terpenes, amino acids and different elements. Chemical analysis of pulp. Determination of physical strength of paper. Preparation of research project. Writing of research report.

Suggested readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ..

FPU 624 ADVANCES IN WOOD MODIFICATION 2+1

Objective

To develop understanding of students about advances in wood modification

Theory

UNIT I

Engineered wood products. Wood polymer hybrid composites. Stabilization of wood preservatives.

UNIT II

Testing of biological performance of modified wood products. Degradation of cellular structure of wood during use.

UNIT III

Environmental issues related to wood modification.

Practical

Different preservative treatments of wood. Chemical modification of wood. Testing of biological performance of modified wood. Treated wood finishing.

Suggested readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.

Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.

Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.

Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

FPU 625 APPLICATION OF TRADITIONAL KNOWLEDGE 2+0

Objective

To develop understanding of students about application of traditional knowledge

Theory

UNIT I

Traditional remedies for treating specific diseases like cardiovascular disease, mental disorders, rheumatic arthritis, diabetes, cough & asthma, fatigue, liver diseases, kidney and bladder stones, wounds stomach disorders etc. Traditional therapies vis-à-vis modern therapies.

UNIT II

Scientific validation of traditional therapies – case studies. Identity of important herbs used in traditional medicines. Integration of herbal remedies with allopathic system of medicine. Allopathic drugs based on traditional herbs.

UNIT III

National and international research and other institutions involved in scientific validation of traditional knowledge eg. CDRI, CIMAP, PRL's, WHO etc., their role and major achievements.

UNIT IV

Composition of major herbal formulations eg. Chavanprash, Vasavaleha, Arjunarishta, Pachakchurna etc. Major herbal pharmaceutical companies and their products like Dabur, Zandhu, Baidyanath, Himalayan Drug Company, Charak Pharmaceuticals etc. Role of local health traditions in primary health care.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 626 QUALITY IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS 2+1

Objective

To develop understanding of students about production of quality planting material

Theory

UNIT I

Concept of quality in the context of medicinal and aromatic plants. Quality parameters of different medicinal and aromatic plants.

UNIT II

Role of genotype and environment in affecting quality. Selection and development of hybrids in medicinal and aromatic plants.

UNIT III

Breeders seed, foundation seed and certified seed. Marker assisted breeding. Authentication of nursery produce for quality parameters. Different approaches including biotechnological tools for production of quality planting material.

Practical

Production of inbreed seed of commercially important species. Selection of superior genotypes on the basis of agronomical characters from an existing population of medicinal and aromatic plants followed by their quality evaluation. Evaluation of germplasm for yield attributes.

Suggested readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 627 POST HARVEST AND PROCESSING OF MEDICINAL AND AROMATIC PLANTS 2+1

Objective

To develop understanding of students about nutritional and post harvest aspects

Theory

UNIT I

Identification of harvesting period based on active content. Harvesting method of underground parts, leaves, stem, bark, fruits, flowers etc.

UNIT II

Processing of harvested crops of medicinal and aromatic plants. Storage and value addition. Deterioration degradation of active principles during storage and their control.

UNIT III

Isolation of major proactive contents from medicinal plants, preparation of active content enriched extracts.

UNIT IV

Latest methods of extraction of essential oil.

Practical

Harvesting, drying, garbling, grading and packaging of medicinal and aromatic plants. Assessment of deterioration of active principles during storage and their control. Preparation of active content enriched extracts of important medicinal plants.

Suggested readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants*. ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Mann J 1994. *Chemical Aspects of Biosynthesis*. Oxford Chemistry Primers.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 628 BIOSYNTHETIC OF SECONDARY METABOLITES 3+0

Objective

To develop understanding of students about biosynthetic analysis of secondary metabolites

Theory

UNIT I

Primary and secondary metabolites. Building blocks for secondary metabolites. Common reactions involved in the biosynthesis of secondary metabolites. Effect of environmental factos on production of secondary metabolites.

UNIT II

Biosynthetic pathways of terpenoids (mono, sesqui, di, tri and tetraterpenoids) and stgeroids.

UNIT III

Biosynthesis of alkaloids of phenylethylamine. Pyrrolidine piperidine, pyrrolidine – pyridine, tropane, quinoline, isoquinoline and phenanthrene groups.

UNIT IV

Biosynthesis of flavonoids, lignans (podophyllotoxin) and Vitamins E & K.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Mann J 1994. *Chemical Aspects of Biosynthesis*. Oxford Chemistry Primers.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

FPU 629 PROCESSING AND VALUE ADDITION IN MAP 2+1

Objective

This course will educate students, methods of harvesting of yieldable plant/plant parts of herb shrub, trees, climber, lianas and epiphytes besides this to increase the value of product post harvest technology will be known to them, practical classes will make them aware about instruments/ equipment used to extract essential oil and also operation of machine for tablets and mixture preparation.

Theory:

UNIT I

Value addition for higher economic returns. Concepts and procedures. Preparatio0n of powders, aqueous and alcoholic extracts, essences etc. Preparation of tablets, mixtures, balms, ointments, etc. Bulk storage and packaging.

UNIT II

Basic and advanced concepts of trade and marketing, marketing under disorganized and organized sector. Village and regional markets, state, national and international market of herbs and herbal products. Internet marketing practices for latest market value and other pattern of fluctuations for high value medicinal and aromatic plants/plant parts and products.

Practical

Visit to nearby pharmaceutical concern for understanding value addition processes. Visit to local market and data collection of sale and sale procedure – organized and unorganized. Internet surfing for latest market value of high value of medicinal and aromatic plants.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Mann J 1994. *Chemical Aspects of Biosynthesis*. Oxford Chemistry Primers.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

4. NATURAL RESOURCE MANAGEMENT

NRM 621 ADVANCED ECONOMETRICS 2+1

Objective

To develop understanding and expose the students to advanced econometric techniques as applied in Natural Resource Management.

Theory

UNIT I

Ordinary least square method. Maximum likelihood estimation. Use ofLinear and non-linear models in forestry/ agroforestry decision making.

UNIT II

Multiple regression analysis. Problems of multicollinearity, heteroscedasticity and autocorrelation – their tests and methods for their removal/mitigation.

UNIT III

Use of binary and dummy variables. Chow test, Theil test, Principal component , logit, probit analyses. Distributed lag models.

UNIT IV

Simultaneous equation systems - identification problem. Generalized Aitkin least square methods of estimation. Forecasting models.

Practical

Exercises on the use of OLS, maximum likelihood methods, homoscedasticity, heteroscedasticity, multicollinearity, autocorrelation etc. Exercises on logit, probit and distributed lag models and forecasting models etc.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economics – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management*. Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 622 NATURAL RESOURCE ECONOMICS 2+0

Objective

To develop understanding of students about inter-relationship between natural resources and economics.

Theory

UNIT I

The theory of optimal use of non-renewable and renewable natural resources.

Resource scarcity and environmental degradation. Natural resource accounting; measurement of sustainable income and issues relating to green accounting;

UNIT II

Economic efficiency in the context of inter-temporal resource use; Property rights and efficiency; Sources of inefficiency; optimum and actual resource use under different market situations; Economic theory of common property resources –forests, fishery, wildlife, etc.

UNIT III

Methods and decisions about un-priced values of forestry goods and services; Estimating recreation demand; Consideration of risk and uncertainty in natural resource planning and management. Welfare theory and pricing of natural resources.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

Cameron MR & Carson RT. 1989. *Using Suirveys to Value Public Goods : The Contingent Valuation Method*. Resources for the Future, Washington, D.C.

Cohen KJ & Cyert RM. 1981. *Theory of the Firm : Resource Allocation in a Market Economy*. Prentice-Hall of India.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramasamy C & Bentley WR. 1997. *Natural Resource Economics: Theory and Applications in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

Walsh RG. 1986. *Recreation Economic Decisions*. Venture Publ.

NRM 623 ADVANCED SOIL & WATER CONSERVATION 2+1

NRE 624 FOREST ECONOMICS 1+1

Objective

To consolidate and develop understanding of students in respect of theory and applications of forest economics

Theory

UNIT I

Forest Resource Economics – meaning, objectives and importance scope. Integrating biological economic and mathematical basis for forest resource analysis. Renewable resources – biological growth curbs, decisions concerning inter mediate harvests. Costs and revenues, preservation value, Coase's theorem. The problem of commons.

UNIT II

Optimal rotation period. Externalities and property rights and forest resource conservation incentives. The linear and non-linear forests and supply of wood. The behaviour of self employed forest farmer.

UNIT III

The forest product market under perfect and imperfect conditions. Welfare theory and optimal pricing of natural resources.

UNIT IV

Forest valuation – introduction, interest on capital, models used in forest valuation. Cost benefit rules of forest resources.

Practical

Exercises on estimation of demand and supply functions; optimal rotation period and financial analysis. Exercises on biodiversity valuation, valuation of non marketed forest products.

Suggested readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications.* Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 625 PROJECT PLANNING AND EVALUATION 1+1

Objective

To develop understanding of students about the formulation of the forestry projects and its financial aspects.

Theory

UNIT I

Identification of investment opportUnities. Market and demand analysis. Technical analysis. Financial estimates and projections. Cost of capital.

UNIT II

Financial and economic appraisal of projects. Risk and sensitivity analysis. Multiple projects and capital budgeting. Portfolio theory and capital asset pricing model and approaches. Risk analysis.

UNIT III

Project management and control. Network techniques for project management.

Practical

Exercises on demand forecasting, time value of money. Cost of capital. Formulation of cash flows. Exercises on capital budgeting, financial and economic analysis. Exercise on risk analysis. Project control exercises (PERT & CPM).

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

NRM 626 WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS 2+1

Objective

To impart knowledge and develop understanding of students about watershed survey, leveling, contour maps, design of soil and water conservation structures and water harvesting.

Theory

UNIT I

Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed.

UNIT II

Terraces and bunds- types & design. Soil and water conservation and water harvesting structures – types & design. Sedimentation- sources, estimation of sediment bank treatment techniques.

Practical

Preparation of contour maps, Estimation of earth work, Design of check dams, Acquaintance with water lifting devices, Use of measurement, Conveyance and control structures.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

NRM 627 GLOBAL CLIMATIC CHANGES 2+0

Objective

To develop understanding of students about global climatic changes and their effect on forest aquatic ecosystems.

Theory

UNIT I

Climate change: History and future - Earth's climate systems, major green house gases, future climatic predictions.

UNIT II

Adaptability and vulnerability of forest and aquatic ecosystems, responses of biotic communities and changes in reproductive biology of flora and fauna.

UNIT III

Ozone depletion and UV radiation effects interactions with weather.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

NRM 628 ENVIRONMENTAL POLLUTION 3+0

Objective

To develop understanding of students about sources, causes, monitoring and mitigation of environmental pollution.

Theory

UNIT I

Definition of pollution, Causes of Pollution of the biosphere, classification of pollutants, National and International Environmental Standards of important Pollutants.

UNIT II

Air Pollution: Types and major sources of air pollutants, dispersal and deposition, response of biotic and abiotic ecosystem components to pollutants. Ionizing radiation, acid rain- causes and consequences. Monitoring of gaseous pollutants and particulate matter. Air pollution mitigation and control. Vehicular Pollution monitoring and abatement technologies. Biological abatement of air pollution, Development of green belt.

UNIT III

Water Pollution: Important pollutants, sources and transformation in nature, eutrophication effects of organic pollutants on organisms and communities. Impact of heavy metals, halogens, and radio-nuclides on aquatic flora and fauna, treatment technologies for industrial effluents/ wastewater. Monitoring water pollution and water quality studies. The pollution problem, pollution categorization, sewage, infectious agents, nutrients, chemicals, organic and inorganic sediments. Radioactive materials, heat, causes, consequences and control of eutrophication. Biomanipulation and eco-restoration of lakes: Top-down and Bottom-up approaches. Environmental Health and sanitation.

UNIT IV

Soil Pollution: Types and sources of soil pollution. Solid waste generation, soil pollutants. Heavy metal toxicity in soil. Hazardous wastes and their Management. Impact of pesticides, industrial waste and fertilizers on soil physico-chemical properties monitoring soil pollution.

UNIT V

Noise Pollution: Causes and consequences of noise pollution. Monitoring and abatement techniques.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

NRM 629 ECOTOURISM IN PROTECTED AREAS 2+1

Objective

To develop understanding of students about ecology of tourist spots in protected area.

Theory

UNIT I

Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context.

UNIT II

Planning ecotourism in protected areas. Visitor management in ecotourism areas – zoning, carrying capacity. Participation of local people in ecotourism. Conflicts in PA's. Ecotourism for sustainable development of PA's.

UNIT III

New directions in ecotourism industry. Ecotourism in practice in important PA's of India – case studies of Periyar Tiger Reserve, Keoladeo National Park, Kanha National Park and Jim Corbet National Park, Project Tiger Research, Betla and Sunderbans Tiger Reserve. Limitations and problems of ecotourism.

UNIT IV

Ecotourism as a way for sustainable management of natural resources.
Local livelihoods and eco-tourism like nomadic grazing, agropasturatism.

Practical

Visits to surrounding ecotourism destinations- prepare ecotourism activity maps- Preparation of route maps to important National parks and sanctuaries of India. Preparation of information procedure about foresttourist spots in India. Exercises on the preparation of location-specificmodel eco-tourism plans.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

NRM 630 ECOTOURISM LANDSCAPING 2+1

Objective

To impart understanding about developing and protecting landscapes of ecotourist spots.

Theory

UNIT I

Introduction - definition and historical background - Components and elements in landscaping - Principles of landscaping - landscape architecture for ecotourism- Landscape ecology with special reference to ecotourism.

UNIT II

walkwaysropeways- turfs, topiaries, live hedges-pergolas, carpets, lawn etc.
Urban ecotourism -importance -history of urban planting in India -
Planning and planting programmes for institution and industrial complexes

UNIT III

Importance of arboriculture in ecotourism. Landscaping- Management of trees - planning of roads, bridges, parking area.

UNIT IV

Planting methods - balanced lines - unbalanced line and sporadic system – formal and informal planting methods.

Practical

Preparation, planning and designing of recreation parks, thematic parks, practice on topiary, arboriculture, preparation of planting pattern for avenue planting, national highways and village roads.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

NRM 631 ECONOMICS OF ECOTOURISM 2+1

Objective

To develop understanding about impact of ecotourism on local economics.

Theory

UNIT I

Ecotourism as a business opportunity- market demand for ecotourism - analysis of ecosystem market demand in India- marketing issues- Investment of international agencies like World Bank in ecotourism projects.

UNIT II

Ecotourism economics at macro and micro economic level in developing countries. Ecotourism as a green business and role of green consumerism. Business plans. Identifying unique selling points for marketing. Potential of internet in marketing ecotourism. Economic valuation of ecotourism sites (based on methods like travel cost method).

UNIT III

Environmental Impact Assessment. Payments for Environmental services and role of ecotourism. Multiplier effects, opportunity costs and leakage in ecotourism industry. Sharing ecotourism revenues among stakeholders

UNIT IV

Training in ecotourism to deliver quality service- Practical exercise on the economic inflow-out flow in the selection ecotourism area- impact on the economic well being of the local population.

UNIT V

Potential of eco-tourism in the sustainable management of local livelihood. Impact of eco-tourism on the income of local inhabitants. Feasibility plans for effective eco-tourism. Eco-tourism based capacity building.

Practical

Economic analysis of tourism components- case study of some important ecotourism destinations- analysis of primary and secondary beneficiariesreport preparation. Exercises on feasibility studies, environmental impact assessment and economic valuation of natural resources need to be included

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to International Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.
Neale G. 1999. *Green Travel Guide*. Earth Scan.

NRM 632 FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES 2+1

Objective

To develop understanding of students about financial and marketing management tools as applied in forest resources.

Theory

UNIT I

Finance- definition, aims and objective. Goals of financial management, organization of finance functions in business firms. Working capital management; need, concepts and sources of working capital. Gross and net working capital; factors influencing working capital requirements.

UNIT II

Importance and preparation of Financial Statements, Balance Sheet and Profit and Loss accounts. Ratio analysis. Sources of long term finance. Purpose and essentials of budgeting, important components of master budget, preparation of operation, responsibility, financial and capital budgets.

UNIT III

Market-concept, components and classification. Demand and supply and factors affecting the market. Simple market model and price determination. Market structure, conduct and performance.

UNIT IV

Market integration-meaning, types, degree, measurement and effects of market integration. Marketing cost, margin and price spered-concepts and applications. Marketing efficiency-definition, approaches to the assessment of marketing efficiency and empirical assessment of marketing efficiency. IPRs and their implications for forestry and allied sectors in the country.

Practical

Library review of studies in marketing and trade of national and international timber and non timber forest products. Analysis of price and market arrival data of forestry products for examining trends, seasonal, cyclical, secular variations. Exercises on analysis of demand and supply of important forest products. Marketing efficiency. Exercises on marketing channels, costs, margins and price - spread of important forest products. Case studies based on visits to selected markets, marketing institutions and forest based industries.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.
Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commission Research Station, Surveys.
FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.
FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.
Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management*. Cambridge Univ. Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, tocarry out literature survey, to formulate information search strategies, andto use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS 0+1

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing **-** Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction,

review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills **-** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.

James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.

Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively*. MacMillan India.

Richard WS. 1969. *Technical Writing*. Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.

Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503 (e-Course) INTELLECTUAL PROPERTY AND ITS MANAGEMEN IN AGRICULTURE **1+0**

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives;Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material

transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel,condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 (e-Course) AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems(NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacitiesat national and regional levels; International fellowships for scientificmobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.

Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.

Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

PGS 506 (e-Course) DISASTER MANAGEMENT 1+0

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches,

Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.

Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

COMPULSORY NON-CREDIT DEFICIENCY COURSES FOR B. Sc. Agri./ Hort. STREAM

CODE	COURSE TITLE	CREDITS
FOR 451	PRINCIPLE AND PRACTICES OF SILVICULTURE	3+1
FOR 452	FOREST MENSURATION	2+1
FOR 453	PRINCIPLES OF TREE IMPROVEMENT	2+1
FOR 454	WILD LIFE MANAGEMENT	2+1
FOR 455	WOOD PRODUCTS AND UTILIZATION	1+1
FOR 456	FOREST MANAGEMENT, POLICY AND LEGISLATION	2+1

FOR 451 PRINCIPLE AND PRACTICES OF SILVICULTURE 3+1

Objective

To acquaint the students about general principles and practices of silviculture in India with examples of important trees.

Theory

UNIT I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

Site factors - climatic, edaphic, physiographic, biotic and their interactions. Classification of climatic factors. Role played by light, temperature, rainfall, snow, wind, humidity and evapo-transpiration in relation to forest vegetation. Bioclimate and micro climate effects. Edaphic factors - influence of biological agencies, parent rock, topography on the soil formation.

UNIT III

Soil profile - physical and chemical properties, mineral nutrient and their role, soil moisture and its influence on forest production.

UNIT IV

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. Impacts of controlled burning and grazing. Influence of forests on environment.

UNIT V

Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

UNIT VI

Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering

and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford & IBH. Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors.

Khanna L. 1996. *Principles and Practices of Silviculture*. InternationalBook Distr.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology*. John Wiley & Sons.

FOR 452 FOREST MENSURATION 2+1

Objective

To acquaint the students about measurements of growth, wood production, biomass production and forest inventory.

Theory

UNIT I

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression.

UNIT II

Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Finish Parabolic Calliper, Relaskop, Pentaprism.

UNIT III

Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient.

UNIT IV

Volume estimation of felled and standing trees and formulae involved. Volume tables-definition and their classification, (general, regional andlocal volume tables), merchantable volume tables. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees.

UNIT V

Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables.

UNIT VI

Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

Practical

Units of measurement and their uses. Instruments used in forest mensuration and their working principles, pertaining to tree height, diameter, basal area, bark thickness and crown measurements. Measurement of bark thickness, bark volume, bark area and crown parameters. Volume estimation of logs, felled trees and standing trees. Preparation of volume tables, volume estimation of forest stands. Stump analysis and increment boring. Determination of age of standing trees. Calculation of CAI and MAI. Sampling exercises including Point sampling. Calculation of crop diameter, crop height and crop volume. Estimation of form factor. Estimation of canopy density. Use of aerial photographs in forest inventory. Study of different satellite images and theirapplication in forestry.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.

Ram Parkash 1983. *Forest Surveying*. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 453 PRINCIPLES OF TREE IMPROVEMENT 2+1

Objective

To acquaint the students about basic concepts and general principles of tree improvement.

Theory

UNIT I

Introduction, history and development of tree improvement, its relation to other disciplines for forest management. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding.

UNIT II

Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees.

UNIT III

Genetic basis of tree breeding and selection practices in forest trees. Patterns of environmental variation- species and provenance trials in forest trees. Seed stands (seed production areas) Plus tree selection, progeny trials and establishment of seed orchard.

UNIT IV

Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties.

UNIT V

Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement.

Practical

Floral biology & phonological observations in some important species. Estimation of pollen sterility and viability. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Different breeding methods-flow chart. Species and provenance selection techniques. Recording observation in provenance trial of some important species-recording variation & working out coefficient ofvariation. Sampling in seed collection. Recording stand density in seed stands, seed output; season of seed collection. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability andGCA. Exercise in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Genetic engineering techniques in tree improvement.

Suggested Readings

Burley J & Styles BT. 1976. *Tropical Trees: Variation, Breeding and Conservation.* Academic Press.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

White JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talber J. 1984. Applied Forest Tree Improvement. John Wiley & Sons.

FOR 454 WILD LIFE MANAGEMENT 2+1

Objective

To acquaint the students about wild life status in India, need of biodiversity conservation and efforts in progress for wild life management in India.

Theory

UNIT I

History of wildlife management and conservation in India; cultural background. Habitat management: Purposes, principles, practices and tools-fire, cutting, grazing. Habitat interspersion and edge effect. Provision of water, saltlicks and food. Zoning – core, buffer, tourism and multiple use in protected areas.

UNIT II

Wildlife damage control : Mitigating human – wildlife conflict: fences, trenches, walls, lure crops, repellents, translocation and compensation. Captive wildlife : Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India.

UNIT III

Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities.

UNIT IV

Wildlife (Protection) Act, 1972. Protected areas – Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES.

UNIT V

Conservation: Meaning, principles and strategies, in-situ and ex-situ conservation, conserving biodiversity. Politics-socioeconomics, role of education and extension.

Practical

Field/laboratory studies of distinct and characteristics morphological and other features of fishes, reptiles, birds and mammals. Identification and study of wildlife in a nearby zoo. Bird watching : Preparation of inventory of an area. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control : Questionnaire survey.

Suggested Readings

Khati AS. 2004. *Indian National Parks and Sanctuaries : A Living Portrait of Wild India*. Pelican Creations International.

Negi SS.2006. *India's Forests, Forestry and Wildlife*. Indus Publ.

Pathak R. 2006. *Indian National Parks*. Sumit Enterprises.

Sawarkar VB. 2005. *A Guide to Planning Wildlife Management in Protected Areas and Managed Landscapes*. Natraj Publ.

FOR 455 WOOD PRODUCTS AND UTILIZATION 1+1

Objective

To acquaint the students about various wood products, availability of raw material and best utilization practices in India.

Theory

UNIT I

Pulp and paper industry. Introduction and raw material; pulping- mechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT II

Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT III

Adhesives used in manufacture of composite wood. Improved wood- definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR Publ.
Anonymous. 2007. *Year Book of Forest Products*. FAO.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ.

FOR 456 FOREST MANAGEMENT, POLICY AND LEGISLATION 2+1

Objective

To acquaint the students about general principles of forest management, working plan, forest policies and forest legislation in India.

Theory

UNIT I

Introduction: definition and scope. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section.

UNIT II

Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Normal forest: definition and concept. Evenaged and unevenaged models. Estimation of growing stock, density, quantity and increment.

UNIT III

Yield regulation – general principles of even aged and unevenaged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees.

UNIT IV

Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope.

UNIT V

Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927.

Practical

Visit to plantations of different age gradations, record the actual growing stock and workout increments. Visit to forests and enumerate the stock and test one of the method for yield regulation. Study the various units adopted in the forest management. Study of various records and forms maintained in the office of the RFO with regard to management of forests under their control. Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributors.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ.
National Forest Policy 1988. Ministry of Environment and Forests. Govt. of India.
Ram Prakash 1986. *Forest Management*. International Book Distributors.

List of Journals

Journal	Publisher
○ ***Agroforestry Systems***	Kluwer Academic Publishers, The Netherlands.
○ ***European Journal of Forest Pathology***	Kluwer Academic Publishers, The Netherlands.
○ ***Forest Ecology and Management***	Kluwer Academic Publishers, The Netherlands.
○ ***Forest Genetic Resources***	FAO
○ ***Indian Forester***	ICFRE, Dehradun.
○ ***Indian Journal of Agroforestry***	NRCAF, Jhansi.
○ ***Indian Journal of Forestry***:	M/s Bishen Singh Mahender Pal Singh, 23-A, Connaught Place, Dehradun (Uttrakhand)
○ ***Journal of Tree Sciences***	Indian Society of Tree Scientists, Dr. Y. S. Parmar University of Horticulture and Forestry, P.O.: Nauni, Solan.
○ ***Myforest***	Karnataka Forest Department, Bangalore-560003.
○ ***Silvae Genetica***	Institute for Forest Genetics and Tree Breeding, Germany.
○ ***Tree Physiology***	Kluwer Academic Publishers, The Netherlands
○ ***Unasyla***	FAO
○ ***Wood Science and Technology***	Springer-Verlag.

e-Resources

- www.hau.ernet.in/ejournals.htm
- www.manage.gov.in/managelib/onlinejrnls.htm
- www.gbpuat.ac.in/acads/cfor/index.htm
- www.uasbangalore.edu.in
- www.kuvempu.ac.in/libraryweb/lib-cjour.htm
- www.clickindia.com
- www.gbpihed.nic.in/library/catalog.htm
- www.tnau.ac.in/lib/libej.html
- www.ames.lib.umn.edu/dalenv.phtml
- www.elibrary.icrisat.org/
- www.icfre.org
- www.ias.ac.in
- www.hmlibrary.ac.in
- www.yspuniversity.ac.in/library/library-int.htm
- www.du.ac.in/du/achievementsoftheyear07.pdf
- www.andhrauniversity.info/inagurationmessage.html
- www.elsevier.de/ufug.
- www.btisnet.nic.in/wordfiles/E-Journal.doc
- www.teriin.org/
- www.icar.org.in
- www.knowledgecommission.gov.in
- www.mail.iari.res.in/library
- www.lib.iastate.edu/collections/eresourc/ag-for-toc.html
- www.wood-report.de
- www.geocities.com/utmfc/forestry_links.htm
- www.bfw.ac.at
- www.donnelly.nmhu.edu/articles/databases.asp?subject=Forestry
- www.ucd.ie/library/electronic_resources/e-lib/forestry.html
- www.cabi.org

Suggested Broad Topics for Master's and Doctoral Research

- Breeding for biotic and abiotic stresses in important tree species
- Domestication and breeding of unexploited tree/shrub species
- Epidemiology and management of tree diseases in nursery and plantations
- Etiology and management against tree decline/mortality
- Problems and management of insect-pests and nematodes in forest tree species
- Studies on biomass production, nutrient cycling and carbon sequestration in different agroforestry systems
- Studies on above and below ground interactions in different agroforestry systems
- Studies on phytoremediating potential of different tree species
- Identification of tree species for biodrainage in reclamation of waterlogged areas
- Use of conventional breeding, biotechnology and mutation breeding in development of fast growing and transgenic trees for short rotation agroforestry systems
- Genetic improvement and development of short statured, early bearing and high seed yielding genotypes in different tree borne oilseeds (TBOs)
- Agroforestry systems and their effects on sustainable productivity

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