NEW AND RESTRUCTURED
POST-GRADUATE CURRICULA & SYLLABI

Forestry

Education Division
Indian Council of Agricultural Research
New Delhi

April 2009
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>3-8</td>
</tr>
<tr>
<td>BSMAC Composition</td>
<td>9</td>
</tr>
<tr>
<td>Preamble</td>
<td>10-11</td>
</tr>
<tr>
<td>Requirements for Implementation of New Curriculum</td>
<td>12</td>
</tr>
<tr>
<td>Organization of Course Contents &amp; Credit Requirements</td>
<td>13</td>
</tr>
<tr>
<td>M. Sc. Forestry</td>
<td>14-74</td>
</tr>
<tr>
<td>Course Structure – at a Glance</td>
<td>14</td>
</tr>
<tr>
<td>Course contents</td>
<td>16</td>
</tr>
<tr>
<td>Ph.D. Forestry</td>
<td>75-115</td>
</tr>
<tr>
<td>Course Structure – at a Glance</td>
<td>75</td>
</tr>
<tr>
<td>Course contents</td>
<td>77</td>
</tr>
<tr>
<td>List of Journals</td>
<td>116</td>
</tr>
<tr>
<td>e-Resources</td>
<td>116</td>
</tr>
<tr>
<td>Suggested Broad Topics for Master’s and Doctoral Research</td>
<td>117</td>
</tr>
<tr>
<td>Compulsory Non Credit Courses</td>
<td>118</td>
</tr>
<tr>
<td>Compulsory Non Credit Deficiency Courses for B. Sc. Ag /Horti. Stream</td>
<td>123</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>129</td>
</tr>
</tbody>
</table>
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 and quality 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.
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 would require 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, as experts 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 personnel 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 with forest 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)

<table>
<thead>
<tr>
<th>Name</th>
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<td>Convener</td>
<td></td>
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<td>Professor</td>
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<tr>
<td>Member Secretary</td>
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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.
**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 core courses 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 the mandate of: (i) Defining names and curricula of Masters and Ph. D. disciplines for uniformity; 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:

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

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<tr>
<th>Subject</th>
<th>Master’s programme</th>
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<tr>
<td>Major (Core)</td>
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</tr>
<tr>
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<td>Seminar</td>
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<td>02</td>
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<td>Research</td>
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<tr>
<td><strong>Total Credits</strong></td>
<td><strong>60</strong></td>
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<td>Compulsory Non Credit Courses</td>
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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)**

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<th>CODE</th>
<th>COURSE TITLE</th>
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<tr>
<td>FOR 501</td>
<td>SILVICULTURE</td>
<td>2+0</td>
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<tr>
<td>FOR 502</td>
<td>FOREST BIOMETRY</td>
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<td>FOR 503</td>
<td>FOREST MANAGEMENT</td>
<td>2+0</td>
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<tr>
<td>FOR 504</td>
<td>FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES</td>
<td>2+1</td>
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<tr>
<td>FOR 505</td>
<td>FOREST ECOLOGY AND BIODIVERSITY CONSERVATION</td>
<td>2+1</td>
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<tr>
<td>FOR 506</td>
<td>FOREST RESOURCE MANAGEMENT AND ECONOMICS</td>
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<td>FOR 507</td>
<td>FOREST PROTECTION</td>
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<td>FOR 508</td>
<td>FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS</td>
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<td>FOR 509</td>
<td>TREE IMPROVEMENT</td>
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<tr>
<td>FOR 510</td>
<td>FORESTS AND PEOPLE</td>
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**B. SUPPORTING COURSES**

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<thead>
<tr>
<th>FOR 511</th>
<th>COMPUTER APPLICATION AND INFORMATION TECHNOLOGY</th>
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<tr>
<td>FOR 512</td>
<td>REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM</td>
<td>1+1</td>
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<tr>
<td>FOR 513</td>
<td>GENERAL STATISTICAL METHODS AND RESEARCH METHODOLOGY</td>
<td>1+1</td>
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</table>

**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
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<td>ECOTOURISM- CONCEPTS AND MODERN APPROACHES</td>
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<td>ET 522</td>
<td>ECO SYSTEMS OF THE WORLD</td>
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<td>ET 523</td>
<td>ECOTOURISM IN PROTECTED AREAS</td>
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<td>ET 524</td>
<td>ECOTOURISM LANDSCAPING</td>
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<td>ET 525</td>
<td>ECONOMICS OF ECOTOURISM</td>
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<td>DESIGN AND MANAGEMENT OF ECOTOURISM</td>
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<td>AF 521</td>
<td>AGROFORESTRY SYSTEMS</td>
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<td>AF 522</td>
<td>SOIL AND WATER MANAGEMENT IN AGROFORESTRY</td>
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<tr>
<td>AF 523</td>
<td>CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY</td>
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<td>AF 524</td>
<td>FRUIT PLANTS, TREES &amp; SHRUBS FOR AGROFORESTRY</td>
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<tr>
<td>AF 525</td>
<td>ECONOMICS OF AGROFORESTRY SYSTEMS</td>
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<td>AF 526</td>
<td>RANGE LAND AND PASTURE MANAGEMENT</td>
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<td>FGR 521</td>
<td>BREEDING METHODS IN FOREST TREES</td>
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<td>REPRODUCTIVE BIOLOGY OF FOREST TREES</td>
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<td>TREE SEED ORCHARDS</td>
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<td>FGR 524</td>
<td>QUANTITATIVE GENETICS IN FOREST TREE BREEDING</td>
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<td>FGR 525</td>
<td>FOREST GENETIC DIVERSITY AND CONSERVATION</td>
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<td>FB 521</td>
<td>BIOTECHNOLOGY APPROACHES IN FORESTRY</td>
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<td>FB 522</td>
<td>PLANT TISSUE CULTURE</td>
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<td>FB 523</td>
<td>MOLECULAR BIOLOGY</td>
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<td>FB 524</td>
<td>PRINCIPLES &amp; TECHNIQUES IN GENETIC ENGINEERING</td>
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<td>FB 525</td>
<td>ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY</td>
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<tr>
<td>EM 521</td>
<td>INTRODUCTION TO ENVIRONMENTAL SCIENCES</td>
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<td>ENVIRONMENTAL POLLUTION</td>
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<td>ENVIRONMENTAL ANALYTICAL TECHNIQUES</td>
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<td>EM 524</td>
<td>GLOBAL CLIMATIC CHANGES</td>
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<td>ENVIRONMENTAL POLICY LAW AND INTERNATIONAL CONVENTIONS</td>
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<td>EM 526</td>
<td>ENVIRONMENTAL IMPACT ASSESSMENT</td>
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<td>FBM 521</td>
<td>FOREST RESOURCE ANALYSIS</td>
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<td>FBM 522</td>
<td>FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES</td>
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<td>FARM MANAGEMENT</td>
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<tr>
<td>FBM 524</td>
<td>PRODUCTION MANAGEMENT OF NURSERY AND PLANTATION FORESTRY</td>
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<tr>
<td>FBM 525</td>
<td>PROJECT PLANNING, MONITORING AND EVALUATION</td>
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<tr>
<td>FBM 526</td>
<td>MANAGERIAL ECONOMICS</td>
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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
IBH.
Distributors, Dehradun.
Book Distributors.

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

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

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

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 national parks, wildlife sanctuaries, botanical gardens and arboreta.

Suggested Readings

**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 evaluating forest management alternatives.

**Suggested Readings**

**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 and management 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 mycorrhizal root infection.

Suggested Readings

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

UNIT II
General principles of criminal law; Indian Penel Code, criminal procedure code; Indian evidence act applied to forestry matters.
UNIT III
UNIT IV
Important case studies and landmark judgments.

Suggested Readings

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
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 breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses.
UNIT VI
UNIT VII
UNIT VIII
UNIT IX
Biotechnology in tree improvement. Mutation breeding.
UNIT X
Economics of tree breeding.

Practical

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

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-philosophy.
UNIT II
Afforestation programmes and forest conflicts, wildlife and human conflicts, 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-tribals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management.

Suggested readings
FAO. 1978. Forestry for Local Community Development. FAO Publ.
Shah SA. 1988. Forestry for People. ICAR.

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

Suggested Readings
IASRI 1999. Introduction to MS Office 97 and SPSS. IASRI Publ.
FOR 512  REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

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 georeferenced 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 remote sensing; 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

FOR 513  GENERAL STATISTICAL METHODS & RESEARCH METHODOLOGY

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

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
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. Wood Science and Technology

WST 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 studies of 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 identification techniques

**Suggested Readings**


**WST 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**


**WST 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 abgression 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

WST 524 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

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
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. Pulp bleaching, pulp treatment, defibering, de-knotting, brown stock washing, screwing, 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
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

2. Medicinal and Aromatic Plants

MAP 521    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 and polyploidy 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.
Gupta AK & Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.

MAP 522  MEDICINAL CHEMISTRY & PROCESSING OF MAP  2+1

Objective
To understand the dynamics of phytopharmaceuticals and their processing 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 the therapeutic 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.
Gupta AK & Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.
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, Transgenic 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.


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


Theory

UNIT I

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

MAP 525 ROLE OF MEDICINAL AND AROMATIC PLANTS 2+0 IN HEALTH CARE SYSTEMS

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

MAP 526  STUDY TOUR  0+1
(Visit to Pharmaceutical and Processing Units)

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.

MAP 527  PHARMOCOGNOSY OF MEDICINAL AND AROMATIC PLANTS  1+1

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

Theory
UNIT I

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 to the region.

**Suggested Readings**


### 3. Plantation Technology

**PT 521 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

**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 tetrazolium, 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**

Objective
To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of greenhouse, 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., prickling, 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

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

Practical

Suggested Readings
Objective

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

Theory

UNIT I

UNIT II

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

Practical


Suggested Readings

PT 524  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

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

PT 525  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

UNIT III

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**


**PT 526**

**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, planting 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**


4. Watershed Management

WM 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 based enterprises 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**


**UNIT III**


**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**


WM 522       APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT

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

WM 523       WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS

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

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

WM 524 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

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


WM 525 PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED

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

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 catchments 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**


**WM 526 PEOPLE’S PARTICIPATION AND IMPACT ANALYSIS IN WATERSHED MANAGEMENT**

**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**


5. Eco-Tourism

**ET 521**

**ECOTOURISM - CONCEPT AND APPROACHES**

**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 essential conditions 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**
- **UNIT IV**
  - International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism.

**Practical**

Students should make detailed reference on the various forms of Ecotourism 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 ecotourism. Debate on the concept to reach the most viable. Once they agree on 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- Identify 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

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

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

UNIT III

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 forest tourist spots in India. Exercises on the preparation of location-specific model eco-tourism plans.

Suggested Readings

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

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
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

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

Suggested Readings
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. Use of 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 ecotourism 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

6. Agro-Forestry

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

AF 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

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

AF 523 CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY

Objective
To impart knowledge on interactions between tree and livestock 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 livestock 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

Suggested Readings
Objective

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

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

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

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

AF 526 RANGE LAND AND PARTIAL 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

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

7. Forest Genetic Resources
FGR 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**

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

**FGR 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**

**Suggested Readings**

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

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

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

UNIT VI

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

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

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

UNIT V

UNIT VI

Suggested Readings
Mandal AK & Gibson GL. (Eds.). 1997. Forest Genetics and Tree Breeding. CBS.
8. Forest Biotechnology

FB 521 FOREST BIOTECHNOLOGY 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; biodegradation 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


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


FB 522 TISSUE CULTURE IN FOREST TREES 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

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

UNIT VII

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

Suggested Readings
FB 523 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

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-conservative 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, methyIases 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 of gene synteny, The concept of map-based 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
Practical

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

FB 524 PRINCIPLES & 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, electroporation.

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 of the 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

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

FB 525 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

UNIT III

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

9. Environment Management
EM 521 CONCEPT OF 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

EM 522    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

UNIT III
UNIT IV

UNIT V
Noise Pollution: Causes and consequences of noise pollution. Monitoring and abatement techniques.

Suggested Readings

EM 523  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 and preservation.
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


**EM 524**  
**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 greenhouse 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**


**EM 525**  
**ENVIRONMENTAL POLICY, LAW AND INTERNATIONAL CONVENTIONS**  
3+0

**Objective**  
To impart knowledge about various legislations and acts concerning environmental policy, laws and conventions.

**Theory**

**UNIT I**

UNIT II

UNIT III

UNIT IV

UNIT V

Suggested Readings

EM 526      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

10. Forest Business Management

FBM 521 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**


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**FBM 522 FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES**

**Objective**

To develop understanding of students about financial and marketing management tools as applied in forest resources.

**Theory**

**UNIT I**


**UNIT II**


**UNIT III**


**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

FBM 523 FARM MANAGEMENT 3+0

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

Theory
UNIT I

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

FBM 524 PRODUCTION MANAGEMENT IN NURSERY AND 2+1 PLANTATION FORESTRY

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

Theory
UNIT I

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

FBM 525 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

UNIT III

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**


**FBM 526 MANAGERIAL ECONOMICS 3+0**

**Objective**

To develop understanding of students about the managerial aspects of macroeconomic policies on the management of industrial farms.

**Theory**

**UNIT I**


**UNIT II**


**UNIT III**

- Theories of demand and supply and equilibrium of the firm. The concept of elasticity and its significance.

**UNIT IV**


**UNIT V**

- The concept and measurement of national income. Theories of consumption. Saving and investment functions.

**UNIT VI**

- Inflation – concept, consequences and cures. Theories of business cycles.

**Suggested Readings**


73


# Ph. D. FORESTRY

## Course Structure – at a Glance

### A. CORE COURSES (MAJOR)

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR 601</td>
<td>QUANTITATIVE SILVICULTURE</td>
<td>2+1</td>
</tr>
<tr>
<td>FOR 602</td>
<td>ADVANCES IN TREE IMPROVEMENT</td>
<td>2+1</td>
</tr>
<tr>
<td>FOR 603</td>
<td>ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS</td>
<td>2+1</td>
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<tr>
<td>FOR 604</td>
<td>ADVANCES IN ECONOMIC ANALYSIS IN FORESTRY</td>
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<tr>
<td>FOR 605</td>
<td>AGROFORESTRY SYSTEMS AND MANAGEMENT</td>
<td>1+1</td>
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<tr>
<td>FOR 606</td>
<td>FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION</td>
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### B. SUPPORTING COURSES

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
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<tbody>
<tr>
<td>FOR 611</td>
<td>OPERATIONAL RESEARCH IN FOREST MANAGEMENT</td>
<td>2+1</td>
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<tr>
<td>FOR 612</td>
<td>LAND USE PLANNING AND WATERSHED MANAGEMENT</td>
<td>1+1</td>
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<tr>
<td>FOR 613</td>
<td>FOREST ECOLOGICAL MODELING</td>
<td>1+1</td>
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<tr>
<td>FOR 614</td>
<td>ADVANCES IN FOREST BIOMETRICS</td>
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<tr>
<td>FOR 615</td>
<td>CLIMATE CHANGE AND FORESTRY</td>
<td>1+1</td>
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<tr>
<td>FOR 616</td>
<td>INFORMATION TECHNOLOGY IN FORESTRY</td>
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### C. SPECIALIZATION (MINOR)

#### 1. Silviculture

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<thead>
<tr>
<th>COURSE</th>
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<tr>
<td>SILVI 621</td>
<td>ADVANCES IN SILVICULTURE</td>
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<tr>
<td>SILVI 622</td>
<td>PLANTATION FOREST PRODUCTIVITY</td>
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<tr>
<td>SILVI 623</td>
<td>FOREST REGENERATION</td>
<td>1+1</td>
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<tr>
<td>SILVI 624</td>
<td>ADVANCES IN FOREST SOIL MANAGEMENT</td>
<td>2+1</td>
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<tr>
<td>SILVI 625</td>
<td>FOREST SEED MANAGEMENT</td>
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#### 2. Forest Genetic Resources

<table>
<thead>
<tr>
<th>COURSE</th>
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<tr>
<td>FGR 621</td>
<td>ADVANCES IN TREE BREEDING</td>
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<tr>
<td>FGR 622</td>
<td>ADVANCES IN QUANTITATIVE FOREST GENETICS</td>
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<td>FGR 623</td>
<td>FOREST REPRODUCTIVE BIOLOGY</td>
<td>2+1</td>
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<td>FGR 624</td>
<td>MOLECULAR GENETICS OF FOREST TREES</td>
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<tr>
<td>FGR 625</td>
<td>GENETICS OF FOREST ECOSYSTEMS</td>
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#### 3. Wood Science & Technology

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<th>COURSE</th>
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<tr>
<td>WST 621</td>
<td>ADVANCES IN WOOD TECHNOLOGY</td>
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<tr>
<td>WST 622</td>
<td>ENERGY AND CHEMICALS FROM WOOD</td>
<td>2+1</td>
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<tr>
<td>WST 623</td>
<td>INSTRUMENTATION IN WOOD SCIENCES</td>
<td>1+2</td>
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<tr>
<td>WST 624</td>
<td>ADVANCES IN WOOD MODIFICATION</td>
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#### 4. Agroforestry

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<tr>
<td>AF 621</td>
<td>ADVANCES IN AGROFORESTRY RESEARCH &amp; MANAGEMENT</td>
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<tr>
<td>AF 622</td>
<td>PRODUCTIVITY OF AGROFORESTRY SYSTEM</td>
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<tr>
<td>AF 623</td>
<td>LAND USE PLANNING AND WATERSHED MANAGEMENT</td>
<td>1+1</td>
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<tr>
<td>AF 624</td>
<td>ADVANCE AGROFORESTRY MANAGEMENT ANALYSIS</td>
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<tr>
<td>AF 625</td>
<td>ADVANCES IN FOREST SOIL MANAGEMENT</td>
<td>2+1</td>
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#### 5. Medicinal and Aromatic Plants
### 6. Forest Biotechnology

<table>
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<tr>
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<td>APPLICATION OF TRADITIONAL KNOWLEDGE</td>
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<tr>
<td>MAP 622</td>
<td>PRODUCTION OF QUALITY PLANTING MATERIAL</td>
<td>2+1</td>
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<tr>
<td>MAP 623</td>
<td>TECHNOLOGY AND PROCESSING OF MEDICINAL AND AROMATIC PLANTS</td>
<td>2+1</td>
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<tr>
<td>MAP 624</td>
<td>BIOSYNTHETIC ANALYSIS OF SECONDARY METABOLITES</td>
<td>2+1</td>
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<tr>
<td>MAP 625</td>
<td>VALUE ADDITION AND MARKETING OF MEDICINAL AND AROMATICS PLANTS</td>
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### 7. Natural Resource Economics

<table>
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<tr>
<td>NRC 622</td>
<td>NATURAL RESOURCE ECONOMICS</td>
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<td>NRC 623</td>
<td>ENVIRONMENTAL ECONOMICS</td>
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<td>NRC 624</td>
<td>FOREST ECONOMICS</td>
<td>1+1</td>
</tr>
<tr>
<td>NRC 625</td>
<td>PROJECT PLANNING AND EVALUATION</td>
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</tr>
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### Specialization Areas

<table>
<thead>
<tr>
<th>Specialization Areas</th>
<th>Possible Discipline of Specialization in M. Sc. Forestry as Feeder</th>
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</thead>
<tbody>
<tr>
<td>2. Forest Genetic Resources</td>
<td>Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry, Environment Management.</td>
</tr>
<tr>
<td>3. Wood Science &amp; Technology</td>
<td>Wood Science &amp; Technology</td>
</tr>
<tr>
<td>5. Medicinal and Aromatic Plants</td>
<td>Medicinal and Aromatic Plants, Agroforestry.</td>
</tr>
<tr>
<td>6. Forest Biotechnology</td>
<td>Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry</td>
</tr>
<tr>
<td>7. Natural Resource Economics</td>
<td>Environment Management, Forest Business Management, Eco Tourism, Agroforestry</td>
</tr>
</tbody>
</table>
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 and allometry 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

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 and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colcheploid 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 monoterpane 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

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 menoeium and dioecium.

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

FOR 603   ADVANCES IN WOOD AND NON-WOOD 3+0
FOREST PRODUCTS

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. 2007. *Year Book of Forest Products*. FAO.
Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

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

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
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 for multiple use of different species; Listing a hundred species of tropical origin; 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
Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

FOR 606  FORESTRY INTERVENTIONS FOR ENVIRONMENT AMELIORATION

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


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


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

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 time delays - 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

Suggested Readings
Causton DR & Venus JC. 1981. The Biometry of Plant Growth. Edward Arnold.

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
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
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 in Japan – Climate change mitigation programs in India – Electric power futures in five developing countries.

Suggested Readings

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

UNIT III

Practical
Applications of GPS: Data retrieval and Database development.

Suggested Readings

C. SPECIALIZATIONS

1. Silviculture
SILVI 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
Smith DM. 1980. The Practice of Silviculture. 8th Ed. USED.

SILVI 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

SILVI 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 species.

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 various sites, Regeneration sampling pattern and intensity.

UNIT II
Factors affecting natural and artificial regeneration - Kinds, extent and quality 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 conifers (Fir, Spruce, Deodar, Chir) and broad leaved 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 in India; 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

**SILVI 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**

**UNIT III**
Ecology of different farm forestry models-agri-silvi, horti-silvi-pastoral systems. Monoculture versus mixed culture. Ecological effects of biofencing.

Suggested Readings

**SILVI 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

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

SILVI 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

SILVI 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 germination and 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 pelleted 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

2. Forest Genetic Resources
FGR 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 tree species (dioecious, monoecious and bisexual). Pollen vector analysis and traplining distances.

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

**FGR 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**

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

**FGR 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**

**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**

**Practical**
Phenological studies in forest trees, nectar collection and analysis, pollination trapping distances, foraging behaviour, pollinator identification and visitation.

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

FGR 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

UNIT V
Biochemical and molecular aspects - water logging - physiology of resistance to water logging - Salt and ion stress.

UNIT VI

Suggested Readings

3. Wood Science & Technology

WST 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
Suggested Readings

WST 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

UNIT III
Chemicals produced as by-product in pulp industry. Destructive distillation of wood. Future of wood chemical industry.

Practical

Suggested readings

WST 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

Suggested readings

WST 624 ADVANCES IN WOOD MODIFICATION 2+1

Objective
To develop understanding of students about advances in wood modification

Theory
UNIT I
UNIT II
UNIT III
Environmental issues related to wood modification.

Practical

Suggested readings
4. Agroforestry

**AF 621 ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT**

**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**

**AF 622 PRODUCTIVITY OF AGROFORESTRY SYSTEMS**

**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, competitiveness, sustainability and management techniques. Tree root architecture, reallocation of resources within the plant system.

**UNIT III**

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

AF 623 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective
To impart knowledge to the students on developing skills in the development 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

AF 624 ADVANCED AGROFORESTRY MANAGEMENT 2+1 ANALYSES

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

Practical
Exercises on developing alternative optimal Agroforestry plans under perfect and imperfect knowledge situations. Socio-economic and financial evaluation of Agroforestry projects.

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

AF 625 ADVANCES IN SOIL AND WATER MANAGEMENT IN AGROFORESTRY

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..
Young A. 1997. Agro-Forestry for Soil Management. CABI.

5. Medicinal and Aromatic Plants
MAP 621 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**


**MAP 622 QUALITY IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS**

**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**


MAP 623  POST HARVEST AND PROCESSING OF MAP  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.
Gupta AK & Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.

MAP 624  BIOSYNTHETIC OF SECONDARY METABOLITES  3+0

Objective
To develop understanding of students about biosynthetic analysis of secondary metabolites.

Theory
UNIT I

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

MAP 625 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 eiphytes 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. Preparation 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.
6. Forest Biotechnology

FB 621 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
Suggested Readings

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Van der Laan PA. 1967. *Insect Pathology and Microbial Control North Holland.*

FB 622  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

Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
FB 623    INTERMEDIARY METABOLISMS  2+1

Objective
To develop understanding of students about intermediary metabolisms

Theory
UNIT I

UNIT II
Protein metabolism; catabolism of protein, Catabolism of protein, catabilism and biosynthesis of individual amino acids. Urea cycle.

UNIT III

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

FB 624    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
UNIT II

Practical
Isolation, purification and quantitation of native DNA and RNA. Effect of chemical and physical mutagen. 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
Mandal AK & Gibson GL. (Ed.). 1997. Forest Genetics and Tree Breeding. CBS.

FB 625 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 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

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

FB 626 GENETIC ENGINEERING AND BIOINFORMATICS 2+1

Objective
Providing insight to the students about gene technologies and advanced bioinformatics techniques.

Theory
UNIT I
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 proteomics.

Practical
Genetic Engineering: DNA isolation and purification. Restriction of DNA. Recombinant DNA. Gene transfer techniques. Selection of transformants and their analysis for integration and expression the gene.
Bioinformatics: Sequence annotation and analysis: Protein interaction analysis.

Suggested Readings

7. Natural Resource Economics & Policy

NRE 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 of Linear 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

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

NRE 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


**NRE 623 ENVIRONMENTAL ECONOMICS 2+1**

**Objective**

To develop understanding of students about theoretical and applied aspects of environmental economics

**Theory**

**UNIT I**


**UNIT II**

Environmental management models. Economic tools for environmental protection and resource conservation.

**UNIT III**

Problems of rural and urban environmental planning. Domestic and international public and private initiatives for environmental conservation.

**Practical**

Exercises on valuation of Environmental resources and damages. Exercises on EIA. Case studies of environment management model.

**Suggested Readings:**


113


**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**

**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**


**NRE 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**

**UNIT II**

**UNIT III**
Project management and control. Network techniques for project management.

**Practical**

**Suggested Readings**
**List of Journals**

<table>
<thead>
<tr>
<th>Journal</th>
<th>Publisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest Genetic Resources</td>
<td>FAO</td>
</tr>
<tr>
<td>Indian Forester</td>
<td>ICFRE, Dehradun.</td>
</tr>
<tr>
<td>Indian Journal of Agroforestry</td>
<td>NRCAF, Jhansi.</td>
</tr>
<tr>
<td>Indian Journal of Forestry:</td>
<td>M/s Bishen Singh Mahender Pal Singh, 23-A, Connaught Place, Dehradun (Uttarakhand)</td>
</tr>
<tr>
<td>Journal of Tree Sciences</td>
<td>Indian Society of Tree Scientists, Dr. Y. S. Parmar University of Horticulture and Forestry, P.O.: Nauni, Solan.</td>
</tr>
<tr>
<td>Myforest</td>
<td>Karnataka Forest Department, Bangalore-560003.</td>
</tr>
<tr>
<td>Silvae Genetica</td>
<td>Institute for Forest Genetics and Tree Breeding, Germany.</td>
</tr>
<tr>
<td>Tree Physiology</td>
<td>Kluwer Academic Publishers, The Netherlands</td>
</tr>
<tr>
<td>Unasyla</td>
<td>FAO</td>
</tr>
<tr>
<td>Wood Science and Technology</td>
<td>Springer-Verlag.</td>
</tr>
</tbody>
</table>

**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.iass.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/
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
COMPULSORY NON-CREDIT COURSES
(Compulsory for Master’s programme in all disciplines; Optional for Ph.D. scholars)

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
<td>0+1</td>
</tr>
<tr>
<td>PGS 502</td>
<td>TECHNICAL WRITING AND COMMUNICATIONS SKILLS</td>
<td>0+1</td>
</tr>
<tr>
<td>PGS 503</td>
<td>INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE</td>
<td>1+0</td>
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<tr>
<td>PGS 504</td>
<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
<td>0+1</td>
</tr>
<tr>
<td>PGS 505</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES</td>
<td>1+0</td>
</tr>
<tr>
<td>PGS 506</td>
<td>DISASTER MANAGEMENT</td>
<td>1+0</td>
</tr>
</tbody>
</table>

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, to carry out literature survey, to formulate information search strategies, and to 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 COMMUNICATIONS 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**


**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 biodi-
versity 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**


**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**


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 System (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 capacities at national and regional levels; International fellowships for scientific mobility.

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
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
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
### 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**

**UNIT III**
Soil profile - physical and chemical properties, mineral nutrient and their role, soil moisture and its influence on forest production.

**UNIT IV**

**UNIT V**

**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

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

UNIT IV

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

Suggested Readings

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

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

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
UNIT II
UNIT III
Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities.
UNIT IV

UNIT V

Practical

Suggested Readings

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

Practical
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

UNIT II

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

UNIT V

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
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 by the 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.