M.Sc. Forestry Two Years (4 Semesters) Course Schedule

Semester-1	Title of the paper	Teaching hours/Cr-edits	Marks		
			Theory (Ext-Int)#	Practical/Term paper	Total Marks
FOR 501	Advanced Silviculture	2+1	40+10	25*	75
FOR 502	Forest Biometry	2+1	40+10	25	75
FOR 503	Advanced Forest Management	2+1	40+10	25*	75
FOR 504	Remote Sensing & GIS	2+1	40+10	25	75
FOR 505	Forest Resource Management & Economics	2+1	40+10	25	75
FOR 513	Tree Improvement	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
Semester-2					
FOR 506	Forest Based Industries	2+1	40+10	25*	75
FOR 507	Chemistry of Forest Products	2+1	40+10	25	75
FOR 508	Forest Protection	2+1	40+10	25*	75
FOR 509	Forest Policy & Legislation	2+1	40+10	25	75
FOR 511	Advanced Forest Ecology	2+1	40+10	25	75
FOR 512	Forest Biodiversity Conservation	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
	Summer placement/ Training				
	Sub Total	**24+12**	**480+120**	**300**	**900**
Semester-3	**SPECIALIZATIONS** **(Every specialization have 6 papers with 18 credits to be completed in IIIrd Sem. In each paper seminar is compulsory to be evaluated for 10 marks as a part of internal assessment)**				
1.	**Plantation Technology**				
PT 521	Seed Collection, Storage and Testing	2+1	40+10	25	75
PT 522	Modern Nursery Production	2+1	40+10	25	75
PT 523	Vegetative propagation techniques	2+1	40+10	25	75
PT 524	Nutrient & Weed Management in Nursery & Plantation	2+1	40+10	25	75
PT 525	Management of Insect-Pests and Diseases	2+1	40+10	25	75
Elective Papers	**Students can choose one elective out of the following two**				
ET 526	Energy Plantations and Bio-Fuels	2+1	40+10	25	75

ET 527	General Statistical Methods and Research Methodology	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
2.	**Agro-Forestry**				
AF 521	Agroforestry Systems	2+1	40+10	25	75
AF 522	Soil and Water Management in Agroforestry	2+1	40+10	25	75
AF 523	Crops and Animals Production & Management in Agroforestry	2+1	40+10	25	75
AF 524	Fruit Plants, Trees & Shrubs for Agroforestry	2+1	40+10	25	75
AF 525	Economics of Agroforestry Systems	2+1	40+10	25	75
Elective Papers	**Students can choose one elective out of the following two**				
ET 526	Range Land and Pasture Management	2+1	40+10	25	75
ET 227	General Statistical Methods and Research Methodology	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
3.	**Forest Biotechnology**				
FB 521	Introductory Forest Biotechnology	2+1	40+10	25	75
FB 522	Plant Tissue Culture	2+1	40+10	25	75
FB 523	Molecular Biology	2+1	40+10	25	75
FB 524	Principles & Techniques in Genetic Engineering	2+1	40+10	25	75
AF 525	Forest Genomics	2+1	40+10	25	75
Elective Papers	**Students can choose one elective out of the following two**				
FB 526	Environmental Pollutants and Biotechnology	2+1	40+10	25	75
ET 227	General Statistical Methods and Research Methodology	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
4	**Natural Resource Management**				
NRM 521	Natural Resource: Concepts & Analysis (NRCA)	2+1	40+10	25	75
NRM 522	Natural Resource: Tools & Techniques (NRTT)	2+1	40+10	25	75
NRM 523	Bio-Resources (Principles & Practices)	2+1	40+10	25	75
NRM 524	Natural Resource: Systems & Practices (NRSP)	2+1	40+10	25	75
NRM 525	Environmental Impact Assessment (EIA)	2+1	40+10	25	75
Elective Papers	**Students can choose one elective out of the following two**				
NRM 526	Natural Resource Planning & Management (NRPM)	2+1	40+10	25	75

ET 227	General Statistical Methods and Research Methodology	2+1	40+10	25	75
	Sub Total	**12+6**	**240+60**	**150**	**450**
Semester-4					
Elective Papers	**Students can choose one elective offered by any other departments of the university.**	2+1	40+10	25	75
Elective Papers	**Self study course**	3	75		75
	Summer Placement Evaluation	0+02	-		50
	M.Sc. Thesis	0+10	-		250
	Sub Total	**0+18**	**115+10**	**25**	**450**
	Grand Total	**96+66**	**2035+490**	**1225**	**4050**

#There will be 02 internal assessments consisting of 8 marks each for each theory paper and one assignment of 9 marks or there can be 03 internal assessments.

***Instead of practical there will be term paper and seminar in which students will be asked to prepare a paper on a particular topic and present the same in seminar.**

Details of the 1st Semester courses

1. ADVANCED SILVICULTURE

Forest Ecosystem Concept: Introduction, composition & structure of forest stand, Pure & mixed stand, even & uneven aged stand, use of mixed stand, irregular stands.
Stand dynamics: Forest succession, competition & tolerance, factor evaluation for silviculture.
Classification of world's forest vegetation: Major divisions of world forest.
Productivity and vegetation form in India
Eco-physiology of Tree growth: Effect of radiation (Photosynthesis), water relationship, mineral nutrients and temperature.
Natural regeneration: Kind & source of regeneration, natural regeneration of species Regeneration in uneven aged silviculture and forest types.
Intermediate Treatment: Role of improvement cutting, salvage & sanitation cutting.
Intensive studies pertaining to important commercial species: Phenology, distribution, regeneration type, Economic importance, insect & Disease of following species *Cedrus deodara, Tectona grandis, Dalbergia sissoo, Pinus roxburghii, Bamboo, Shorea robusta.*
Modern Nursery Tools & Techniques: Environmental controlled green houses, drip irrigation, sprinklar system. Fumigation system, clonal technology etc.

Practical: Instead of practicals, there will be term paper.

2. Forest Biometry

Measurement of trees and stand; diameter (crops), girth, height, volume, tree form, taper equations, bark thickness, crown width and crown length determination of age and volume of felled as well as standing tree. Volume yield and stand tables. Increment, forest inventory and sampling procedures, weight, form class, biomass/ weight equations. Forest inventory and cruising; Line- strip inventory. Introduction to Growth and Yield; Site quality. Stand density and stocking. Canopy density & its importance. Sampling forest stands, and predicting future yields of forest stands. Analysis inventory data using computer software. Simulation techniques, growth and yield models and their application. Modern tools like GPS and remote sensing for measurements.
Practical: Instead of practicals, there will be term paper.

3. Advanced Forest Management

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India. Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies, forest valuation and appraisal in regulated forests. Maximizing present net value and benefits.

Practical: Instead of practicals, there will be term paper.

4. Forest Products Chemistry & Industries

Different chemical constituents of wood. Cells wall constituents. Chemistry of cellulose and its comparison with starch. Chemistry of hemicellulose and lignin. Extraneous components of wood- organic solvent soluble and water soluble. Volatile oils, Resin and its components. Gums. Tannins and phenolic substances. Chemistry of catechin. Bark and its components. Important natural pigments.

Introduction, scope and importance of wood based industries in relation to Indian economy; brief description of types of wood based industries in India; pulp and paper industry- types of paper and raw material; pulp-mechanical, chemical and semi-chemical; beating, bleaching, sizing and sheet formation; description about rayon and other cellulose derived products; composite wood-plywood, laminated wood, core board, sandwitch board, particle board and their manufacturing processes, properties and uses; principles of destructive distillation of hardwood and softwood; preparation of wood alcohol, acetic acid, acetone, charcoal and allied chemicals; Saccharification of wood-chemistry and processes; production of wood molasses, alcohol, yeast and other by products from wood hydrolysis, wood substitution. Manufacture of Katha and cutch.

Practical: Instead of practicals, there will be term paper.

5. FOREST ECOLOGY & BIODIVERSITY CONSERVATION

Forest population Estimating abundance based on counts, Estimation of demographic parameters- delectability and demographic rate parameters, analysis of age frequencies. Estimating survival, movement. Population viability analysis (PVA).

Forest community dynamics, structure and analysis: Estimation of community parameters-estimation of species richness, estimating parameters of community dynamics. Modern methods of data acquisition and summary classification and description, vegetation-environment relations, and successional processes. Predictability of vegetation pattern. Spatial and temporal scale of community based analysis. Multivariate data analysis with applications to plant community.

Forest Productivity and Ecology of Forest landscapes:

Spatial heterogeneity and hierarchy issues in ecology, Concept of biodiversity, Biodiversity zones species richness and endemism, state of biodiversity in India. Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserves). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservation laws and acts. Forest genetics resources of India: timber and non timber species. Survey-exploration and sampling techniques. Documentation and evaluation of forests genetical resources (FGR), Conservation, in situ and ex situ 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.

6. General Statistical Methods and Research Methodology

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

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

Correlation and Regression**:** Simple, Rank, Partial, Multiple, Intra-class correlations, Furnival Index and coefficient of determination. Linear and non-linear regressions, parabolic, exponential, power and logarithmic functions.

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 X^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.

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.

Sampling-Theory and Applications**:** Why sample? Simple Random Sampling (with and without replacement), Stratified Random Sampling, Double sampling, Multistage sampling, Cluster sampling

Multivariate Statistical Techniques Multivariate Analysis of Variance, Principal Component Analysis, Factor Analysis, Cluster Analysis

Selection of research problems considering National Forestry Policy- Writing project proposal, Generation of Research questions, Stating objectives of research study, Proposing hypotheses. Planning for literature survey, Use of computer based literature, Planning for field work, Sampling and Enumeration exercises in the field and recording of the data and use of statistical tools. Interpretation of data and derving inference and conclusions, Preparation of thesis/ dissertation/research project report. Writing of scientific articles and technical bulletin, Monitoring and evaluation methods.

Practical: Fitting of probability distributions, Computation of correlations and regressions, Tests of significance –t,F,z, X^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.

Details of 2nd Semester Courses

1. Forest Resource Management and Economics

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory, and inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decision. Valuation of non-market goods and economics of multiple-use, Eco-system Analysis and Modelling. Forest certification, eco-development planning, Sustainability Analysis, SWOT Analysis. 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 forestry products. Exercises on financial and economic appraisal of forestry projects. Numerical exercise on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives. EIA study of a project.

2. Forest Protection

Important diseases and insect pests of nurseries, plantations, standing 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, Biodegrdation 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. 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. Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance in 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 or mycrorrhizal root colonization.

3. Forest Policy Laws and International Conventions

Forest policy- Relevance and scope; National Forest Policy- 1894, 1952 and 1988; General principles of criminal law; Indian Panel Code, criminal procedure code; Indian evidence act applied to forestry matters; Forest laws; Indian Forest Act- 1927, general provision and

detailed study; Forest Conservation Act 1980, Wildlife Protect Act 1972, Important Forest Rules and Guidelines, Important case studies and landmark judgements.

Practical: Instead of practicals, there will be term paper.

4. Forest Genetics and Tree Improvement (3t+1p)

- Population Genetics- Selection definitions, Hardy Weinberg equilibrium, complete elimination of homozygous receive trees, partial selection against recessives, selection favouring recessive (against dominants), selection for genes with additive effects, "Fitness and Fisher's Fundamental Theorem". Selection for and against heterozgotes, selection in small populations, how to increase selection pressure, mutation, migration and isolation.
- Tree Breeding- Variation in trees, importance and its causes. Natural variation as a basis for tree improvement. Geographic variation, ecotype, clinal races and land races. Selection and management, selection of forest trees – selection criteria; plus tree selection, breeding methods selection and genetic gains species and provenance selection.
- Quantitative genetics – General principles and practical application in forest tree improvement, heritability, general and specific combining ability
- Controlled crossing systems and designs- purpose, self pollination, crossing system with unknown father, crossing system with known father, crossing plans, complete dialect, modified dialled, partial dialled, factorial.
- Seed orchards- Types of seed orchards planning and design, establishment, management, harvesting.
- Progeny trials – Definitions and importance types of progeny, crossing systems, experimental designs, cultivation techniques, evaluation, records etc.
- Genotype – environment interaction
- Planning and strategies of a tree improvement programme. Breeding trees for specific purpose (Pest, disease and adverse environment).
- Species and racial hybridization and its application

Practicals: Numerical analysis of population genetics questions, Plus tree selection, variation analysis in a forest population. Numerical questions on quantitative genetics, pollen viability, vegetative propagation techniques, clonal experiments.

5. Computer Application and Information Technology

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

Practicals: As per theory

6. Remote Sensing and Geographic Information System

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-referenced forest resources data and information. Acquisition and interpretation of satellite data for forestry purpose. The integration of spatial data analysis system with knowledge-based systems and/ or simulation systems for the development of information/ decision support systems for forest management; satellite system; satellite imageries- techniques, uses and limitation; future prospects of remote sensing in India; softwares used in remote sensing; GIS versus remote sensing.

Practical: Uses of various photogrammetry instruments; recognition and identification of objects on photography; compilation of maps and interpretation. Hands on practice on remote sensing and GIS, software. Digital and visual interpretation of satellite image.

Details of 3rd Semester Courses

SPECIALIZATION

FOREST BIOTECHNOLOGY

I. Introductory Forest Biotechnology (2+1)

Historical development of biotechnology in forestry, different methods of biotechnology related to forestry; plant tissue culture and response pattern; application of plant tissue culture in tree improvement; in vitro selection and micro propagation in forestry for conservation; gene regulation, genetic engineering techniques; basis of operation in DNA manipulation; transgenic plants; molecular markers and its application in forestry.

Practicals: No practicals

II. Plant Tissue Culture (2+1)

Plant tissue culture –principles, progress and prospects with special reference to tree crops. Culture conditions. Stages of micro propagation. In vitro propagation via enhanced release of auxiliary buds, somatic organogenesis and somatic embryo genesis, Problems and Progress in vitro propagation of tree crops. In vitro pollination and fertilization for distant hybridization. Somaclonal variation- factors influencing- exploitation for crop improvement, Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration; Protoplast fusion for somatic hybridization and its application. Techniques for direct gene transfer to protoplasts.

Need of in vitro conservation. Short and medium term conservation. Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, pre-freezing treatments- use of cryoprotectants, dry freezing, incubation. Alteration/ modifications in cell components during cryo-preservation. Recalcitrant species. Thawing and reculture. Survival of freeze preserved cells/tissues. Clonal fidelity and karyotpye stability of cryopreserved cultures and regenerates. Use of biochemical and molecular markers for testing the stability, Protocol development.

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

III. Molecular Biology

History and development of Molecular Biology. Nucleic acids –DNA and RNA as genetic materials. Nucleosides and nucleotides, DNA double helix –properties of DNA- absorbance, ionic interaction, denaturation and renaturation, sedimentation. Secondary structure of single stranded DNA inverted repeat sequences, alternative structures of duplex DNA, C value and concept of selfish DNA, cell organcelle DNA Chlorplast and genes and mitochondrial DNA and genes. DNA replication semi- conservative replication. Organization in prokaryotes and eukaryotes. DNA polymerases, replicon, cyes, rolling circle and D-loops, nick translation, okazaki viruses. Reverse transcriptase, primase, helicase, topoisomerases, gyrases, methoylases and nucleases. DNA sequencing.

Practical : Estimation of DNA and RNA. Isolation of total nucleic acids from bacteria. Large scale preparation of total plant DNA. Isolation of total RNA. Agarose gel electrophorests. Denaturation of DNA. Ethidium fluorescent assay of nucleic acids. Estimation of C value. Binding of polyamines to DNA. Assy of DNA polymerase. DNA sequencing.

IV. Principles of Genetic Engineering

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

The Tools of Genetic Engineering: Concept of restriction and modification, Restriction endo-nucleases, Modifying enzymes, Ligases, Host-vector system, - E-coli as a host.

Different Kinds of vectors: Plasmids, phage vectors, M 13, consmids, phagemids, YACS, BACS, PACS and expression vectors.

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

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

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

Techniques in genetic enginerring-

Cloning and transformation in Prokaryotes, Vector preparations, Insert preparations, Ligation

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

Methods of indirect transformation-

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

V Forest Genomics

Molecular breeding of Forest trees, Constructing molecular maps, Molecular tagging of genes/ traits, Marker-assisted selection of qualitative and quantitative traits, Physical maps of chromosomes. The concept of gene synteny. The concept of map-based cloning. 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.

Mirco arrays Application: gene expression, SNP detection, detection of environmental agents. Micro array design: cDNA micro array, oligonucleotide arrays. Micro array fabrication. Detectin technology. Computational analysis of micro array data.

Practical: Isolation and quantification of plant DNA, PCR operation and gel electrophoresis, RAPD and ISSR, gene sequencing, sequence annotation.

VI Environmental Pollutants and Biotechnology

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.

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

Microbiology of degradation of Xenobiotics in Environment- Ecological consideration, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation of contaminated soils and waste lands. Biopesticides in integrated pest management.

Solid waste: sources and management (compositing, wormy culture and methane production). Global Environmental Problems: Ozone depletion, UV-6, green-house effect and acid rain, their impact and biotechnological approaches for management. Bioleaching, Bio-fertilizer for sustainable agriculture & environment (AMF, ECM, PGPRs, PSBs, with special reference to low input agriculture).

PLANTATION TECHNOLOGY

I. Seed Collection, Storage and Testing

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems – limiting factors in tree propagation and afforestation. Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/fruit. Modes of seed dispersal. Determination of optimal harvest time and maturity indices. Factors influencing choice of seed collection. Methods of seed collection and processing. Eco-physiological role of seed storage. Classification of seed storage. Factors affecting seed longevity Physiological change during ageing.. Modern classification of seed dormancy and dormancy-breaking treatment. Seed testing techniques. Seed certification Viability and vigor test. Fumigation and seed treatment. Seed pelleting and counting.

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

II. Modern Nursery Production

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery. Bare root nursery –nursery soil
and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out –planting. Containerized nursery –type and size of container including root trainers, selection of growing medium. Types of green house and mist propagation.

Practical: Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Maintenance of nursery records. Identification of nursery insects and diseases and their control measures. Visit to nurseries.

III. Vegetative propagation techniques

Introduction and importance of propagation. Structures, media fertilizers, sanitation and containers, source selection of superior phenotype and management in vegetative propagation, Techniques of propagation by cutting, grafting, budding and layering and its natural modification. Propagation of selected plants and rootstock for the important wild fruit species. Bud orchards.

Practical: Techniques of propagation by cutting, grafting, budding and layering. Precautions required in vegetative propagation. Use of plant bio-regulators for rooting. Handling of field propagated cuttings.

IV. Nutrient and Weed Management in Nursery and plantations

Weed management

Principles of weed control. Methods of weed control - cultural, biological, mechanical and chemical. Herbicide/weedicide classification, properties and their application. Mode of action of herbicides/weedicides. Equipments used in applying herbicides/weedicides.

Nutrient management

Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/Interactions. Concept of nutrient availability. Climatic and soil conditions promoting micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors. Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers. Mycorrhizal associations and their significance. Economic implications of nutrient management . Importance of renewable waste and their recycling.

Practical: Identification of weeds in forest nurseries and plantations. Economic evaluation of weed control methods in nursery and plantations. Calculation of spray volume and herbicide concentration. Preparation of weed herbarium.

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

V. Management of Insect-Pests and Diseases

Insect pests responsible for damaging nursery stock and forest plantation. Principles and methods of integrated pests management –physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques. Diseases of forest nurseries and plantations. Abiotic and biotic agents of tree diseases and their relationship with hosts. Methods of diseases control – exclusion, cultural, biological and chemical. 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 their use.

Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation diseases.

VI. Energy plantations and bio-fuels

Introduction and advantages of energy plantations, Energy and biomass consumption patterns in India. Environment impacts of biomass energy. Assessment of bio-energy programmes in India. Power generation from energy plantation. Producer gas. High Density Energy plantations (HDEP). Land and biomass availability for sustainable bio energy. Impact of energy efficiency in power sector. Need for research and development on environment friendly and socioeconomically relevant technologies. Energy from plants – problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation. Network of NGOs in renewable energy use. Recent energy technologies in the production 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 units.

AGROFORESTRY

I. Agroforestry System

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation. 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. Concepts of community forestry and social forestry. Linear strip plantations 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.

II. Soil and Water Management in Agroforestry

Soil and water management- objectives and scope in relation to agroforestry system. Soil and water conservation, land classification and carrying capacity. Irrigation potential and methods. Optimization of waters use in agroforestry systems and dry land farming. Interpretation of agro-meteorological data for water management. Problem soils and their management, soil organisms and nitrogen fixation. Biogeochemical cycling of nutrients including organic matter decomposition. Nutrients budgeting and soil productivity under different agro-forestry systems.

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

III. Crop and animals Production Management in Agroforestry

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. 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 agroforestry systems. Feed and fodder resources in agroforestry systems and live stock management.

Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with agroforestry forages and tree leaves. Forage and tree leaves preservation. Calendar for forage crop production in agroforestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing. Integrated agroforestry farming system.

Practical: Measurement of crop growth rates. Study of crop association and management methods. Quantitative evaluation of tree-crop, livestock, Analysis of forages and feeds for

mineral and incrementing constituents, Digestibility of some agroforestry forages. Preparation of leaf meal and forage conservation. Familiarity with common veterinary instruments, AI equipment and common feeds and fodders.

IV. Fruit plants Trees and Shrubs for Agroforestry

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agroforestry systems. Fodder from trees/shrubs and their nutritive value and propagation techniques. 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. Role of nitrogen fixing trees/shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for Agroforestry.

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.

V. Economics of Agroforestry Systems

Basic principles of economics applied to agro-forestry. Optimization techniques –Planning, budgeting and functional analysis. Role of time, risk and uncertainty in decision making. Financial and socio-economic analysis of agro-forestry projects. 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 agroforestry products.

VI Range land and Pasture Management

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. 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. Production potential of different silvi-pasture system.

Practical: No practicals

NATURAL RESOURCE MANAGEMENT

I: Natural Resource: Concepts & Analysis (NRCA)

Natural resource systems, elements, components, types of natural resources, non renewable and renewable resources, resource allocation, theoretic aspects of resource management. Ecosystem Analysis, Environmental Impact Assessment and monitoring; Ecosystem modeling, survey and mapping of forest cover, forest change detection, Forest Damage assessment and monitoring, land evaluation for forestry and forest inventory; forest certification, eco-development planning.

Practicals: Ecological sampling of an area (line transect, centre point method and quadrat method), Phytosociological analysis, Species area-curve, Measurement of biomass and productivity, measurement of tree height and diameter, Determination of homogeneity of the system using Raunkier's frequency class, Population structure and regeneration status of ecosystem.

II: Natural Resource: Tools & Techniques (NRTT)

Statistics in natural resource management: Role of statistics in resource management, statistical tools & Techniques, computer application, Database development: Inter-organizational and interdisciplinary support & networking and approaches. Natural resource evaluation and suitability studies by Remote Sensing and GIS, techniques of Land use/ land cover map preparation, Migration and habitat analysis of Wildlife (Flora and fauna); Application of remote sensing in forest geology and in mineral/ oil exploration; spectral response of vegetation and mapping.

Practicals: Habitat analysis and resource mapping using RS and GIS. Case studies of NRM in different senerio.

III: Bio- Resources (Principles & Practices)

Forest biodiversity: Significance in Natural Resource Management; floristic and faunistic diversity, Ecosystem diversity; Broad classification- Biogeographical, Phytogeographical, Quantitative & Qualitative measurement; Inventorization monitoring and characterization of species inventory: Patterns & predications; Assessment of diversity (Genetic & species), Gene pool, interdependent elements. Centres of genetic & species diversity: Hotspots, Endemic centers, microhabitats Values of bio-resources and biodiversity: tangible and intangible benefits timber, food and fodder yielding species; Non Wood Forest Produce-NWFP- Bamboos, Rattans, Medicinal Plants, Orchids. Animal produce- Honey, vermifuse Role of litter and compost in nutrient cycling. Loss of biodiversity and causes: Threat and conservation value assessment, IUCN norms of threat categories. Management strategies for biodiversity conservation: World conservation strategy. Conservation of key areas of protection- Natural & protected areas, Principles of management of habitat, communities. Establishment of conservatories, Forest Herbaria, Botanical & Zoological Gardens and Arborcta. In situ and ex situ conservation strategies; Enthobiological conservation of biodiversity and indigenous knowledge collection, Access and benefit sharing.

Practicals: To make a single species inventory with locational habitats, study of the area of occupancy and extent of occurrence of species in naturalized colonized area with emphasis on habitat viability indices, Biodiversity impact assessment studies, Threat and conservation value assessment on the biodiversity of different ecosystem., characterization and categorization of threatened species and habitat for biodiversity conservation in peri-urban forest ecostytems.

IV: Natural Resource: Systems & Practices (NRSP)

Watershed management for sustainable development, ground water and aquifers survey and characterization, water quality management case studies; Forest soil and vegetation surveys; Rural and forest resources and community management; Protected area and networking systems; Human resources development and management; capacity building, Empowerment, Gender Analysis. Participatory Resource Management: Forest Villages Management Committees (Vanpanchayat, Village Council, etc.), Biodiversity Management Committees of local, regional and their management strategies on natural resources; Urban, Rural Energy, Agroecosystem management Ecotourism: NWFP management strategies.

Practicals: Watershed delineation, characterization, landuse change detection studies, PRA tools and field exercise.

V: Environnemental Impact Assessment (EIA)

Introduction ; Principles and purpoase of IEE and EIA and its significance for the society, Cost and benefits of EIA; EIA involvement during project life cycle. EIA management; principles & management of EIA, main stages in EIA processes; screening, scooping, predicition, mitigation and alternatives auditing. 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).

Practicals: Preparation of EIA & SEA reports of different developmental projects like; Hydroelectric plants, rope ways, paper and pulp mills etc.

VI: Natural Resource Planning & Management (NRPM)

Organization/ institutions involved in NR management: Organization structure, Functioning and behaviour: Group behaviour, Knowledge management, attitudinal behaviour towards schedules castes and tribes; Right of information transparency at working place and disposal desk, sensitivity analysis, critical path methods, SWOT analysis. Microplanning: Tools, Techniques and Methodologies of microplanning, PRA and RRA Exercises. Research management, monitoring and evaluation, Action plan development and implementation: ISO and organizational or Institutional level implementation. Conflicts Concerning the Resources and their management: Status, Related and involved, costs and benefits of management. Financial and administrative analysis; Project formulation and implementation.

Practicals: Instead of practicals there will be term papers