CORRECTED/ REFINED SYLLABUS
(Credit based)

FOR

M.Sc. Programme

In

"Forestry"

AT

FOREST RESEARCH INSTITUTE
DEEMED UNIVERSITY

DEHRADUN- 248006

Forest Research Institute (Deemed) university

M.Sc. Forestry

Programme Objective: Master in Forestry programme aims to provide opportunity to the students wishing to pursue professional careers in the management and policy of forest resources and to make themselves aware about the problems related to forest across the span of urban to rural environments. The syllabus draws from coursework in the natural and social sciences and focuses on the complex relationships among the science, management and policy of forest resources. The structure of the curriculum is designed to synthesis of knowledge in multiple disciplinary exposures in the biological and social sciences. The goal is to prepare students to manage forest resources for various public and private values within a complex social, political and ecological environment. These professional opportunities can be private or public sector forest management, corporate or consulting, government conservation of forest resources or education. Students are also expected to improve their capacities as leaders and managers through summer internships, professional skills courses and other opportunities.

Programme structure: The Programme consists of courses and other requirements worth a total of 90 credits. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. Each semester consists of 18 to 20 weeks of academic work equivalent to 90 actual teaching days. The programme structure and respective credits are given below as:

Programme Structure		Credit
Core courses	:	54
Foundation courses	:	5
Elective courses	:	5
Synopsis	:	1
Master's thesis	:	17
Master thesis seminar	:	2
Term paper I	:	2
Term paper II	:	2
Study tour	:	2
Total	:	90

Allotment of credits to different courses

FIRST SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Foundation Course			
FMS 101	Elements of Mathematics and Statistics	1	1
FCR 102	Computer Application, Remote Sensing and GIS	1	1
FOF 103	Basic Forestry	1	-
Core course			
FBS 111	Elements of Biological Science	1	1
FFF 112	Fundamentals of Forest Ecology	2	1
FSC 113	Silviculture – I	2	1
FGS 114	Basic Geology and Soil science	2	1
FMB 115	Forest Mensuration and Biometry	2	1
FFP 116	Forest Protection	2	1
FTP 117	Term Paper I	2	-
Total credits in first semester: 14[a]+8[b]+2[c]=24			

SECOND SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Core course			
FPL 211	Forest Policy and Law	2	-
FLM 212	Landscape Approach to Management	2	1
FRU 213	Forest Resource Utilization – I (NTFP)	2	1
FFE 214	Forest Economics	2	**-**
FFP 215	Forest and People	2	-
FRM 216	Natural Resource Management	2	**1**
FSC 217	Silviculture–II	2	1
FSN 218	Seed and Nursery Technology	1	1
FTP 219	Term Paper II	2	-
Total credits in first semester: 15[a]+5[b]+2[c]=22			

THIRD SEMESTER

Course Code	Course	Credit	
		Theory	**Practical**
Core course			
FRM 311	Resource Survey and Forest Management	2	1
FWD 312	Wildlife and Eco Development	2	1
FRU 313	Forest Resource Utilization – II (Wood)	2	1
FGT 314	Forest Genetics and Tree Improvement	2	1
FFC 315	Forest Certification	2	-
FCC 316	Forest, Society and Climate Change	2	1
FST 317	Study Tour	2	-
Elective		5	
Total credits in first semester: $12^a + 5^b + 2^d + 5^e = 24$			

LIST OF ELECTIVE COURSE

Course Code	Elective Course	Credit	
		Theory	**Practical**
EFGB 321	Forest Genetics and Biotechnology	3	2
EFRG 322	Remote Sensing and Geographic Information System	2	3
EFWH 323	Wildlife and Habitat Management	3	2
EFSM 324	Sustainable Forest Management	3	2
EFAF 325	Agro forestry	4	1
EFFP 326	Forest Pathology	2	3
EFFE 327	Forest Entomology	2	3
EEIA 328	Environmental Impact Assessment	4	1
EFPT 329	Plantation Technology	4	1
EPTN 330	Plant Taxonomy	2	3

FOURTH SEMESTER

Code	Particulars	Credit
FSY 441	**Synopsis**	**1**
FMT 442	**Master's thesis**	**17**
FTS 443	**Master thesis seminar**	**2**
Total		**20**

a: Theory, b: Practical, c: Term paper, d: Study tour, e: Elective paper.
One lecture credit comprises of one hour teaching of the course in a week, while one practical credit comprises of two hours of practical/assignment work in a week

Descriptions of Course Code

The courses of M. Sc. programme are divided into four series:

- ❖ 100-series courses pertain to first semester
- ❖ 200-series courses pertain to second semester
- ❖ 300-series courses pertain to third semester
- ❖ 400-series courses pertain to fourth semester
- ❖ Credit for Synopsis, Master's thesis and Master thesis seminar is designated by code no. 441, 442 and 443 respectively

Course code is formulated as:

- ➢ First alphabet shows programme
- ➢ Second and third alphabet shows course name
- ➢ First digit shows semester number
- ➢ Second digit shows course type (0= foundation, 1= core, 2= elective)
- ➢ Last digit shows course number

<h1 align="center">1st SEMESTER</h1>

<h2 align="center">FOUNDATION COURSE</h2>

FMS 101   ELEMENTS OF MATHEMATICS AND STATISTICS

LEARNING OBJECTIVES: The objective of this course is to develop an understanding of basic mathematics and statistics and their applications in Forestry.

MODULE I   BASIC MATHEMATICS

- Fundamentals of arithmetic, algebra, geometry, mensuration, arithmetic and geometric series progression
- Functions- polynomial, logarithmic, exponential, absolute value, trigonometric
- Use of graphs, simple, simultaneous and quadratic equations; numbers, variables, parameters and constants
- Basics of differential and integral calculus

MODULE II   COORDINATE GEOMETRY

- Simple coordinate geometry, equation of straight line, parabola, ellipse and rectangular hyperbola, their graphs

MODULE III BASIC STATISTICAL METHODS AND IMPORTANCE IN FORESTRY

- Collection and representation of data-compilation, tabulation
- Frequency distribution; measure of central tendency mean, median, mode for grouped and ungrouped data
- Measure of dispersion, standard deviation, variance, coefficient of variance, skewness, Kurtosis, correlation and regression; correlation coefficient, coefficient of determination, simple regression analysis, examples of multiple regression
- theory of probability (Elementary idea)

MODULE IV SAMPLING TECHNIQUE AND DESIGN OF EXPERIMENT

- Necessity of sampling in forestry, complete-enumeration vs. partial enumeration, principle steps in sample surveys, population, sampling modules, size of sample (sampling intensity), bias, accuracy and precision. Classical sampling design-simple Random sampling stratified random sampling, systematic sampling

- concept of probability Binomial, Poisson and Norma Distributions/Non parametive test.

- Analysis of variance: One way classification (fixed effect model), two-way classification (fixed effect model)

- Parametric and Non-Parametric test

- Principles of experimental design, CRD, RBD, LSD, Factorial experiments introduction to incomplete block design

PRACTICAL

- Computer based Statistical techniques such as 'R', SPSS

- Experimental and Sampling designs

- Research Methodology

FCR 102   COMPUTER APPLICATION, REMOTE SENSING AND GIS

LEARNING OBJECTIVES: The main objective of the course is to familiarize students about computer operating systems and its application like Microsoft office, Adobe and Access. The courses also endeavor to explain the basic concepts of remote sensing, aerial photographs and images and their interpretation and application with special reference to Forest.

MODULE I COMPUTER APPLICATION

- **Handling the system tools:** Disk cleanup, Disk defragmenter, Driver converter (FAT 32), Maintenance wizard, Scan disk, System file checker

- **Microsoft office:** Word, Excel and Power Point

- **Access:** Introduction, Blank access database, Primary key, Table, Datasheet view, Design view, Table wizard, Import table, Relationships, Query, Design view, Simple query wizard, Design view, Report, Report wizard

MODULE II REMOTE SENSING

- Basic principles, type and scope of remote sensing.

- Introduction to aerial photography and photo grammetry. Measurements from aerial photographs, photo-interpretation, area determination and thematic mapping

- Introduction to various types of satellites and sensors, resolution and form of data available. Acquisition and interpretation of satellite data for forestry purpose, vegetation mapping

MODULE III   GEOGRAPHICAL INFORMATION SYSTEM

- GIS and its use in Forest management
- Forest inventory planning, design, alternatives, execution, compilation and reporting
- ERDAS Imagine

PRACTICAL

Computer application

- Word, Excel, Power Point and Access
- Adobe Photoshop, Coral Draw
- Video editing

RS and GIS

- Digital and visual interpretation of satellite image
- Field application of G.I.S. Use of GPS, ERDAS

FOF 103   **BASIC FORESTRY**

LEARNING OBJECTIVES: The objective of the course is to give brief introduction of forestry in terms of education and managerial organizations in the forest development.

MODULE I   FORESTS AND FORESTRY

- History of management of forests in India
- Emerging trends of Forest Management in India, Modern tools and techniques in Forestry, Different schemes/missions on Forest protection and Conservation.
- Deforestation, Degradation and its drivers
- Forest geography of the world- factors influencing the distribution of forests, critical analysis of forest resources
- Forest map of India-Forest Cover and Type.
- Forest Statistics of India (India State of Forest Report).
- Forestry education, research and training

- Different international conferences/commission/conventions and institutions, their relevance to Indian context
- Different organizations relevant to forestry on global basis
- Exposure visit: Forest Survey of India, Dehradun
- Forest Hydrology

CORE COURSE

FBS 111   ELEMENTS OF BIOLOGICAL SCIENCE

LEARNING OBJECTIVES: This course is meant to introduce basic botany and zoology to the students. The course exposes the students to basic and applied aspects of botany and zoology including Histology, Morphology and Phenology of plants and distinguish features of animal kingdom.

MODULE I INTRODUCTION TO BOTANY
- **Structure of plants***: Histology- Cell, Tissues, Cell division, Histology of stems, root and leaf. Secondary growth in woody species
- **Morphological characteristics:** Parts of plants and their functions. Types of leaves, flowers, inflorescence and fruits
- **Nomenclature and classification**: Systems of classification, Bentham and Hooker system. Important families and their characteristics.
- **General classification of plants**:Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, Fungi, Algae and lower forms. Classification on the basis of habit and habitat
- **Phenology:**- Habitat Foliage,Cauliflorae,Cleistogamy, Protoandry and Protogyny. Flowering and Fruiting behavior-Sporadic, Cyclic, Erratic, Gregarious and proliferation. Germination types

MODULE II INTRODUCTION TO ZOOLOGY
- Classification of animal kingdom, economic importance and distinguishing features of different classes

MODULE III TREE PHYSIOLOGY
- Photosynthesis and Respiration. Concept of C_3 and C_4 plants
- PGRs and Secondary Metabolites

- Growth Hormones and their role
- Artificial propagation including budding, Grafting and Layering techniques in Plant Physiology

PRACTICAL

- Classification, important families (Angiosperms and Gymnosperms) of forestry with distinguishing characters under microscope
- Botanical and Zoological Excursions
- Identification of Bamboo species and important forestry species
- Sampling Techniques and Laying of Quadrates-under Forest Ecology
- Use of flora for plant identification
- Herbarium – Collection, pressing preservation & mounting, classification
- Case studies of propagation/Physiology related practicals

FFF 112   FUNDAMENTALS OF FOREST ECOLOGY

LEARNING OBJECTIVES: The course is planned to impart the knowledge of ecology and ecosystem with special reference to forestry. It also describes the conservation and management practices.

MODULE I INTRODUCTION

- History, scope, principles and concepts of forest ecology, ecology of tropical and temperate forests
- **Ecosystem:** Components and structure, communities, populations, groups and individuals, plant - microbe-animals inter-relationships

MODULE II FOREST ECOLOGY

- **Forest biomes**: Desert – cold and hot deserts, grass lands, tidal forests, wetlands, secondary forests, terrestrial and aquatic ecosystem
- **Principal forest types**: Introduction, classification and distribution in relation to other countries, Factors affecting vegetation: Locality factors, climatic factors, edaphic factors, ecological and physiographic factors, biotic factors, influence of plant competition, parasites, epiphytes, climber- weeds on forests

- **Forest productivity:** Energy and its flow in ecosystem, food chain and food web, biogeochemical cycles, autecology of important tree species, population ecology, ecological genetics, synecology in different forest types

- **Succession and climax**: Kinds of succession, invasive alien species, plant and animal adaptations, mono-climax and poly-climax theories. Ecological adaptation and evolutions, Climate, vegetation types, phyto-geographical zones and zoo-geographical zones of India, Ecological indicators

MODULEIII ECO SYSTEM ANALYSIS

- Eco system modelling, survey and mapping of forest cover, forest change detection, forest damage assessment and monitoring, land evaluation for forestry and forest inventory,Spatial Pattern analysis, Species abundance relationship, species affinity, community classification, community ordination, community interpretation

MODULE IV ENVIRONMENT CONSERVATION

- Environment, its components and importance. Principles of Environmental conservation. Environmental education, policy and legislation in India. Impact of deforestation- forest fires, mining and other disturbances on environment

- Wetland ecosystems and their environmental significance. Introduction to climate change, Global warming, Ozone layer depletion, Acid rains, Environmental impact assessment of projects. Concept of sustainable development, strategy for sustainable energy use

PRACTICAL

- Monitoring of micro-meteorological parameters, relative humidity, Wind speed and wind direction, solar radiation, preparation of wind rose diagram
- Phytosociological analysis
- Species area curve
- Calculations of the species diversity, Similarity Index, Concentration of Dominance, Richness index and Evenness.
- To measure the regeneration status of the Forest Ecosystem.

FSC 113   <u>**SILVICULTURE I**</u>

LEARNING OBJECTIVES: The aim is to impart knowledge of basic concepts of silvicultural practices especially regeneration of tree species.

MODULE I INTRODUCTION

- Definition and objectives of silviculture
- Influence of locality factors on forest: Locality factors, climatic factors, edaphic factors, ecological and physiographic factors, biotic factors, influence of plant competition, parasites, epiphytes, climber- weeds on forests

MODULE II FOREST REGENERATION

- Forest Regeneration: Natural and artificial regeneration, techniques of obtaining regeneration by seeds and coppice, Regeneration Survey in the forest, need and objectives of reforestation and afforestation, choice of species.
- Forest Ecosystem, Theory of Succession, Kinds of succession, Use of succession in Silviculture/Allelopethice effect to be included.

MODULE III CLASSIFICATION OF FOREST TYPES AND THEIR DISTRIBUTION

- Basis for classification, Forest Types of India and their distribution according to Champion and Seth's classification. Use of Forest Types in Silviculture.

MODULE IV SITE MAINTENANCE AND IMPROVEMENT

- Site maintenance in forest stand, structural management of soils, water management, soil and water conservation practices, use of manures and fertilizers in forestry and soil amendmend/Reclamation of soils/   in forestry.

MODULE V

- Tree Morphology: Crown, Canopy structure and Stratification; Branching pattern, Bole, Buttress, Burrs, Barks- Outer and inner color, texture

PRACTICAL

- Field study of forest stands, effect of locality factors on forest species and succession during field tours and excursion
- Technique of Regeneration Survey in the forest during field visit
- Report Preparation
- Forest types practicals/ affirmation/ forest composition and stand

FGS 114   BASIC GEOLOGY AND SOIL SCIENCE

LEARNING OBJECTIVES: The course is designed to provide knowledge to the students about the properties of soil including fertility and nutrients requirement and classification. The course also explains the basic geology and its role in soil science.

MODULE I   BASIC GEOLOGY OF INDIA, SCALES

Concepts of soil and soil science. Composition of Earth crust and its relationship with soils. Geological structure and their topographic expressions. Mineral constituent for various rocks and their effect on soil properties, weathering of rocks and minerals, weathering indices. Soil development : Pedon, Poly pedon, Soil Profile and Horizon. Factors of Soil formation - Pedogenic processes- parent material- climate- organism -relief –time. Other soil forming process- eluviations and illuviation, podozolization, laterization. Formation of various soil, factor influencing parent material Geology of India

MODULE II SOIL FERTILITY AND NUTRIENTS

- Soil biota, Soil microbial ecology, types of organisms. Occurrence and distribution of microorganism in soil and their classification

- Soil fertility: factors affecting soil fertility. Methods of soil fertility evaluation – Soil testing, Plant and tissue tests and biological methods.

- Essential plant nutrients: Micro and Macro nutrients in soil, their role and deficiency symptoms. Fertility management through organic and inorganic fertilizers.

- Nitrogen cycle: Biological nitrogen fixation, nitrogen cycle, ammonification, nitrification, de nitrification and carbon cycleSoil degradation: Nature, properties and development of acid, saline and alkali soils and their management. Lime and Gypsum requirement of soils. Pollution: Types, Causes, Methods of Measurement. Heavy metal toxicity and soil pollution, chemical and Bioremediation of Contaminated soils.

PRACTICAL

- Combined Geology and Soil Field Excursion: Selection of representative sites for soil and geological study, Recording land features (elevation, aspect, slope, vegetation, rocks etc.) of study site, Digging of soil sample/ profile and its study (morphological features), collection, labeling, processing and storage of soil samples for further analysis.

- Basics of soil map preparation with the help of Arc GIS software.

- Laboratory Analysis: Processing of soil samples for analysis, estimation of pH, bulk density, porosity, moisture, texture, nitrogen, phosphorus, potassium, organic carbon and organic matter. Identification of important rocks and minerals

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FMB 115   <u>FOREST MENSURATIONS AND BIOMETERY</u>

LEARNING OBJECTIVES: The objective is to familiarize the students with tools and techniques for efficient measurements in forests.

MODULE I BASIC MEASUREMENTS

- Introduction, definition, objectives and scope of forest menstruation. Scales and units of measurement, standards of accuracy imp0lied in their expression.
- Measurement of tree diameter and girth: Objectives, standard rules governing breast height measurement. Measurements using rulers, calipers and tapes. Relation between girth and diameter comparison between tape and caliper measurement. Measurements of upper stem diameter, bark thickness, relation between measurement over bark and under bark, Crown width
- **Height measurement:** Methods, principles - ocular, instrumental, non-instrumental. Christen's, Smythies hypsometer, improvised callipers. Abney's topographical Abney's level-theory demonstration. Haga altimeter, Spiegel relaskop, error sources correction, height of leaning tree, problem solving
- **Tree stem form** - Metzger's theory, form factors, quotient height, taper table, volume measurement of felled trees, stacked logs - empirical formulae and problem solving
- **Volume measurement**- Methods, concept, classification, application, calculation of log volume, volume estimation of standing trees, stack of logs volume tables, bark and cull methods, preparation of volume tables - graphical method, local volume table from general volume table, regression equation method, problem solving
- **Measurement of age:** Methods of estimation, concept of growth rings, incrementand growth of trees
- **Growth of tree:** Increment, relation between CAI and MAI, Stump and stem analysis Theory, demonstration and problem solving

MODULE II FOREST BIOMETRY

- Measurement of forest crop - diameter, height, age and volume, calculation of current annual increment and mean annual increment of stand, yield tables, mathematical models
- Stand structure–even aged and uneven aged, management of sample plots
- Forest inventory–planning and design, alternatives, sampling, execution, compilation and reporting
- **Site quality estimation:** Tree height as a measure of site quality, site index curves, Direct and indirect methods of site quality evaluation

MODULEIII PLANT AND ANIMAL BIOMASS ESTIMATION

- Basic concepts, simple indices of biomass, actual biomass estimation, sample counts

PRACTICAL

- Determination of breast height instruments used in forest mensuration and their working principles, pertaining to tree height, diameter, basal area, bark thickness and crown measurements. Inventories and enumeration
- Visit to timber depot

FFP 116   FOREST HEALTH AND VITALITY/ FOREST PROTECTION

LEARNING OBJECTIVES: Objective of this course is to acquaint the learners regarding principal of forest protection against pests and pathogens. It also explains the causes and factors affecting forest health such as insects, pestand pathogens.

MODULE I   BASIC PRINCIPLES

- Principles of forest protection, factors affecting forest health , outbreak of diseases and insect attack, droughts and floods, anthropogenic activities, pollution, biotic pressures, urbanization and industrial expansion
- Susceptibility of forest to damages, destructive agencies, nature of damage, cause, prevention and protection measures

- Forest fires, causes, prevention and management, harmful and beneficial effects, control measure against fire
- Fencing and its economics, injurious plants / weeds, climbers, noxious pests and their control

MODULE II ENTOMOLOGY

- Introduction to forest Entomology in relation to forests and forest produce
- Insect and pests of nurseries, natural and plantation forests, standing and felled trees, timber in storage (broad leaved and conifers)
- Biology and ecology of the key pests of tree species of economic value and forest nurseries and their management

PRACTICAL

- Visit to insectary, diagnosis of insect attack by symptoms; how to report and send specimens(insect/infested parts) for advice. Spraying equipment and demonstration of spraying. Pesticide application techniques in forest eco-system
- Entomological collection: specimen's preparation and preservation techniques

MODULE III FOREST PATHOLOGY

- History and importance of Forest Pathology, General characteristics of Fungi, becteria, mycoplasma, phytoplasma, parasitic flowering plants, nematodes   and actinomycetes
- Types of diseases, symptoms and Koch postulates, nursery diseases and their management; damping off, leaf blights, seedling blights, rusts, mildews, leaf spices
- Major Diseases: Ganoderma root rot of Khair (*Acacia catechu*) and black wattle(*Acacia mangium*), **Root rot** and wilt of Deodar (*Cedrus deodara*), wilt of Sissoo (*Dalbergia sissoo*) and Casuarina (*Casuarina equisetifolia*), pink disease of Eucalyptus, stem rust of Pine (*Pinus roxburghii*). Disease of natural stands, heart rots, **polyporus root** rot of Sal (*Shorea robusta*). Sandal (*Santalum album*) spike disease
- Environmental factors and disease incidents
- Forest fungi*:* Major species, common characters, Phenomena of parasitism-host and parasite relationship

MODULE IV DISEASE PREVENTION AND INTEGRATED MANAGEMENT

- General principle of integrated pest management (IPM), Importance of plant protection and quarantine, environment friendly control of insects' e.g. biological control, microbial control, kairomones and pheromones
- Role of microbes and fungi in plant nutrition
- Mycorrhizae-characteristics features and economic importance. Other useful microbes- Rhizobia, MHBs, PSBs, Actinomycetes, Frankial association
- Biocontrol agents, PGPRs in Forestry application,

PRACTICAL

- Study of the types of decay in timber- white fibrous rot; white pocket rot; brown cubodial rot, dry rot
- Study of rust diseases of conifers- *Crohatium himalayensis* on Chir; *Peridermium cedri* on Deodar
- Local excursions to acquaint with common tree diseases on Sal, Shisham, Khair and other hard woods
- Isolation of *Rhizobium* species from leguminous root nodules, Gram staining of Bacteria, Isolation of Actinomycetes from forest soil and Gram staining.

FTP 117　　　Term paper I

LEARNING OBJECTIVES: The objective of the term paper is to develop the skill of research writing. In this course generally students have to review of literature in their field of interest related to forestry. They have to prepare a project report on a particular topic under the supervision of faculty and submit it to the university.

<p style="text-align:center">2nd SEMESTER
CORE COURSE</p>

FPL 211   **FOREST POLICY AND LAW**

LEARNING OBJECTIVES: The course imparts the thorough knowledge about the national forest policy and laws related to forest and environment as well as various international agreements like CITES, CBD, ITTA, UNFCC, UNFCCD, Kyoto protocol, TRIPS

MODULEI FOREST POLICY AND LAW
- Forest Policy; Foundation, need and scope. National Forest policies of 1894, 1952 and 1988; salient features
- Forest Law: Legal definitions, objectives of special forest law. Indian Forest Act 1927; Forest (Conservation) Act 1980 and Rules 2003, Indian Biological Diversity Act 2002
- Tribal rights and forest dwellers Act
- Wildlife (Protection) Act 1972
- Important case studies relating to Acts above stated with preliminary idea of Indian Penal code, Cr P.C and other enactments in India

MODULE II ENVIRONMENTAL POLICY AND LAW
- Environmental Policy in India; Public Interest Litigation and their role in the Environmental Protection.
- Environmental (Protection) Act 1986, Introduction to The Air (Prevention and Control of Pollution) Act, 1981 andThe Water (Prevention And Control Of Pollution) Act, 1974

MODULE III INTERNATIONAL AGREEMENTS AND CASE STUDIES
- Major International Agreements: CITES, CBD, ITTA, UNFCCC, UNFCCD, Kyoto Protocol, TRIPS, **Ramsar Convention etc.**

FLM 212   LANDSCAPE APPROACH TO MANAGEMENT

LEARNING OBJECTIVE: The objective of the course is to create the awareness regarding soil and water conservation and their management practices.

MODULE I SOIL AND WATER CONSERVATION

- Types, causes and factors affecting soil erosion. Land capability classification, general practices for soil and water conservation, mulching, windbreaks, shelterbelt, contour farming, strip cropping, terracing, bounding and grassed waterways, gully control, water harvesting tanks

MODULE II LANDSCAPE MANAGEMENT

- Concept and characteristics of watershed management, their role and importance in management plan, restoration of deteriorated watershed. Biological aspects: soil management, crop management, alternate land use in agro forestry**.** Engineering approaches in watershed management

- **Tree landscaping***:* Elements of bio-aesthetic planting and landscaping, choice of species and sites

MODULE III RANGE MANAGEMENT

- Rangelands in different biomes of world. Grass lands and ranges of India. Ecological status of Indian Grasslands. Manmade and natural rangeland. Rangeland Manipulation and Improvement. Sources, gap between optimal requirement and present availability. Environment factors determining rangelands. Principle and practices of range land management. Multiple use of Rangeland

- **Rangeland Manipulation and Improvement.** – control of undesirable vegetation, burning, fertilization, soil and water conservation and protection, carrying capacity**,** fodder banks and livestock management

- Grazing systems (rotational, nomadic, trans- humans, paddock, closure cycle, cut and carry cycle). Resources – input – output flows and system sustainability. Fodder from trees/shrubs and their nutritive value

- Different methods of control against grazing and browsing animals. Effect of wild animals on forest regeneration. Impact of grazing on forests soils and Water

PRACTICAL

- Preparation of an Integrated Watershed Management Plan for a micro-watershed
- Field Excursions and Exercise

- Study of grassland and rangelands in the area

- Herbarium collection of grass species

- Carrying capacity, Estimations method of calculations

FRU 213   FOREST RESOURCE UTILIZATION-I (NTFP)

LEARNING OBJECTIVES: The course is meant for exposing the students to importance and use of non-timber forest products such as medicinal plants, oil, bio-fuels, resin, tannin drugs, lac and shellac including their importance in rural, tribal and national economy.

MODULEI INTRODUCTION

- Non-timber forest products of India and their importance in rural and industrial economy; fiber and flosses, grasses, bamboos, medicinal plants and canes. Their distribution, cultivation, harvesting, processing and uses

MODULE II PLANT BASED NTFP PRODUCTS

- Essential oils, commercial use and the methods of cultivation of soil bearing plants. Oil seeds- important oil seeds obtained from forests

- Gum, Resin and Oleoresin

- Tannin and dyes- vegetable tanning materials obtained from forests

- Drugs, Poisons and Insecticides

- Rubber, Charcoal, charcoal dust briquettes

- Miscellaneous products: leaf fodder;

- Bio fuels

MODULE III ANIMAL BASED NTFP PRODUCTS

- Lac and shellac; silk and tassar

- Composition of animal products- Honey, Lac, Oils, vermin compost etc.

PRACTICAL

- Field execution/ identification of plants

- Extraction of principal compounds at least two species in chemistry labs

- Nursery techniques of 20 species (Tropical-10 and Temperate 10)

FFE 214   **FOREST ECONOMICS**

LEARNING OBJECTIVES: The course is designed to explain the role and application of economics in management of forest, wildlife and environment.

MODULE I FUNDAMENTALS OF ECONOMICS

- Micro and Macro Economics, utility and marginal analysis, demand–supply of forest products, Law of diminishing marginal utility, Market equilibrium, Production Possibility curve, Production theory as applied to forestry, Production function

- Role of markets, open market economy, different forms and types of market competitions, regulation, cases studies of forest products

- Costs and revenues, Opportunity Cost, Interest, Rent, Wages

- Investment criteria, Benefit cost analysis, Internal rate of return (IRR), Sensitivity analysis and their applications

MODULE II FOREST RESOURCE ECONOMICS

- Goods and services from forests, measuring forest ecosystem values and benefits, Monetization of intangible services from forest

- Soil expectation value

- Total Economic Valuation, Models for direct and indirect benefit estimation market price method, productivity method, Travel Cost Method (TCM), Hedonic Pricing Method (HPM) and Contingent Valuation Method (CVM) and other cost based methods of economic valuation and their application

- Contribution of goods and services from forests to national GDP, Natural Resource Accounting

- Economics of air, water and energy resources

- Economics of carbon sequestration

MODULE III THE ECONOMICS OF FOREST MANAGEMENT

- The Optimal Forest Rotation Optimal Rotation Age in Discrete Format, Optimal Rotation Age in continuous Format, cutting Cycles for an Uneven-aged Stand, Comparisons with other rotation criteria, other impacts on the Optimal Rotation, the Hartman rotation age

- Regulating Harvests over time, the stand and the Forest, Market solutions and limitations, the regulated Forest, Transition to a normal Forest, sustained yield

rational and critique, timber harvests over time in the absence of sustained yield policy, market as a regulator, new approaches to forest regulation, review questions

- 9 Long-tem trends in the Forest sector and Silvicultural: Investment, Long-term trends in the Forest Sector, a conceptual Model for Silvicultural Investment, Factors influencing Silvicultural investment on Private Lands, Silvicultural Investment on Public Lands, Forest Plantation Development in India

- Assignments and case studies to demonstrate the economic valuation of different components of environment

MODULE IV PROJECT FORMULATION, IMPLEMENTATION, MONITORING AND EVALUATION

- Assignments and case studies to demonstrate the economic valuation of different components of environment

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FFP 215 **FORESTS AND PEOPLE**

LEARNING OBJECTIVE: The basic objective of course is to involve the local communities in forestry activities and collective management of land to produce forest products and meet the needs of local people.

MODULE I INTRODUCTION

- Strategy and objectives of social forestry, concept of SFM and participatory approach to SFM, vis-a-vis NFP. Fuel, fodder and timber crisis in developing countries. Mitigation strategies

MODULE II SOCIAL AND COMMUNITY FORESTRY

- **Forest dwellers-** Tradition of forest consecration, rights and concessions
- **Social and community forestry** – Concepts, variation, and their role in rural, tribal and urban development. Choice of species and management of social forestry plantations: energy blocks, wood lots, green belts, sound barriers, smoke and smog reducers, silvi–pastoral systems
- **Management of community lands** – Waste lands and marginal lands. Tree and land tenure issues, conflicts. Parks and recreational sites, Ecological and land use constraints

MODULE III JOINT FOREST MANAGEMENT

- Concept, principles and application, strategies, micro-level planning and participatory, rural appraisal. Rural development, employment generation and distribution of benefits of JFM. Monitoring and evaluation of JFM

MODULE IV FORESTRY EXTENSION

- Communication, extension work; programme planning and methods. Management of extension organizations. Role of voluntary organizations / NGO's and national and international agencies

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FRM 216   <u>NATURAL RESOURCE MANAGEMENT</u>

LEARNING OBJECTIVES: The course is aimed to provide knowledge of natural resources available and its sustainable management.

MODULE I   INTRODUCTION

- Natural resource systems, Elements, Components, Types of natural resources, Non-renewable and renewable resources allocation, Theoretic aspects of resource management

MODULE II FOREST BIODIVERSITY ASSESEMENT

- Forest Biodiversity and its significance in N.R.M. Floristic and Faunistic diversity, Broad classification – Bio-geographical and phyto-geographical assessment of diversity (Genetic and Species) Gene pool, Interdependent elements. Loss of Biodiversity and causes Threat and Conservation value assessment IUCN, Norms of threat Categories Establishment of Conservatories forest Herbaria, Botanical and Zoological gardens and Arboreta.

MODULE III   ESTIMATION OF FOREST CARBON

- Carbon(C) cycle in the forest; carbon related definitions e.g. C-pool, C-stock, C-flux, C-sink, C-source, Sequestration/uptake. Measurement of Carbon in forest ecosystems, Eddy covariance. A broad view of assessment of C in Indian forests

PRACTICAL

- Biomass and Carbon estimation
- Preparation of Diversity report of a site
- Urban Forestry Planning and Management
- Carbon estimation

FSC 217   <u>**SILVICULTURE -II**</u>

LEARNING OBJECTIVE: The objective of the course is to develop understanding about silvicultural systems for the production as well as protection benefits from the forests. The course also introduces the plantation techniques, plantation's management and silvicultural practices of some important timbers species.

MODULE I INTRODUCTION

- Classification of silvicultural systems. High forests and coppice systems. Changing concepts in silvicultural systems

MODULE II MAJOR SILVICULTURAL SYSTEMS

- Clear felling system and its modifications
- Shelter wood system, uniform system, regeneration period, periodic blocks, and group system. Irregular shelter wood system
- Selection system – characteristics, rotation, felling cycle. Application in India. Coppice system: simple coppice system, coppice with standards, pollard system
- Change of systems, types of conversions, conversion from coppice system to high forest

MODULE III PLANTATION FORESTRY

- Plantation Forestry: Need for manmade plantations. Native vs exotics. Single species plantations vs mixed plantations vs multiple purpose tree (MPT) plantations, Selection of planting stock
- Theory and demonstration of tending operation in the natural forests/plantations including weed management cleaning, thinning and pruning etc.
- Failure of plantations – Reasons (i.e. unsuitable species, non –application of standard techniques). Plantation layout and designs. Care for seedling establishment
- Logging operations

MODULE IV   PLANTATION TECHNIQUES IN DIFFICULT AREAS

- Plantation techniques in arid, coastal and hilly areas, water- logged, cold desserts ravines, saline/alkaline areas, sand dune areas, mining areas and salt affected sites, landslide affected and other degraded/vulnerable sites

MODULE V SILVICULTURE OF IMPORTANT SPECIES
- Teak, Sal, Shisam, Deodar. Eucalyptus, Casuarina, Poplar, Khair, Babool, Chir Pine, Bamboo, *Melia dubia,* Sandal wood

PRACTICAL: Visit of logging operations at a govt. site (UKFDC) and Depot Management

FSN 218   SEED AND NURSERY TECHNOLOGY

LEARNING OBJECTIVES: The aim of course is to teach students about seed morphology, nursery practices and propagation houses/shades.

MODULE I SEED TECHNOLOGY AND MANAGEMENT
- **Seed morphology**: Morphology and structuring of seeds, Major types of forest seed, Recalcitrant, Orthodox, Encapsulated and Eglutanized seeds
- **Management of Forestry Seeds:** Seed source, collection, processing, storage, testing and pre-sowing treatments. Seed certification, Pests and pathogens of Forest Seeds and their Management.

MODULE II   NURSERY TECHNIQUES AND MANAGEMENT
- **Nursery practices**: Site selection, type, design and layout, Nursery soil and water management. Seed bed preparation and sowing. Seeding early tending – watering, weeding, and shading
- Nursery soil fertility management. Rhizobial and mycorrhizal associations
- Container and bare-root seedlings. Pricking out, transplanting, lifting, packing and transportation. Media and mixtures
- A quality seedling characteristics/characteristics of Quality seedlings
- **Propagation structures:** Shade house, poly house, mist chambers Glass houses, net houses and growth chambers.

PRACTICAL
- Seed Quality Testing, Seed viability, pre-treatment and sowing techniques

- Nursery Techniques: Poly bag, Nursery raising, lifting, grading and packing of nursery stock, nursery layout, Mist chamber, Glass house, Net house
- Visit to seed bank (Cryopreservation facilities e.g. New Delhi)
- Visit to modern nursery for large scale planting stock production

FTP 219   Term paper II

LEARNING OBJECTIVES: The objective of term paper is to make students to aware about, how to write a scientific research paper/technical report. It helps the student to develop ability to do logical arguments and thought process and also helps students to learn to relate their thoughts in a concise manner. It will also develop the communication and report writing skills.

3rd SEMESTER

CORE COURSE

FRM 311   RESOURCE SURVEY AND MANAGEMENT

LEARNING OBJECTIVES: The objective of the course is to develop the skills regarding the working principles of forest management.

MODULE I OBJECTIVES AND PRINCIPLES

- **Introduction-** Definition and scope. Peculiatrities of forest management.
- History of forest management, Principles and practices of forest management and their applications. Object of Management, Purpose and Policy. Multiple use of forest management. Management of farm plantations

MODULE II YIELD MANAGEMENT

- Sustained and progressive Yield concept and meaning.
- General definitions and management and administrative units, felling cycle, Cutting sections and conversion period.
- Rotations definition, kinds of rotations, choice of rotations, conversion period and length of rotations, Normal forest: definition and concept, even aged and uneven aged, models. The actual growing stock and its increment distribution of age gradations. Classes in regular, irregular forests and coppice systems. Estimation of growing stock, density, quality and increment.
- Yield regulation: general principles of even aged and uneven aged forest crop Yield regulation based on area volume, area and volume, increment and number of trees.
- Application and control of various methods of yield regulations in the forests of India.

MODULE III VALUATION AND APPRAISALS

- **Forest valuation**: Valuation principles, interest and investment, valuation of forest land and timber stand, valuation of stumpage, tree, non-wood forest outputs, valuation of financial alternatives
- **Appraisal of forest damage:** Valuating intensive management decision- spacing and thinning; working plans- preparation and control

MODULE IV MANAGEMENT AND WORKING PLANS

- Working plan-definitions, objects and necessity, preparation and control
- National Working Plan Code
- Management plans (WC Protected Areas)

PRACTICAL
- Preparation of working plans
- Field visit for observing application of working plans

FWD 312   WILDLIFE AND ECO DEVELOPMENT

LEARNING OBJECTIVES: The course is designed to develop the understanding of concept and importance of biodiversity, wildlife and their management in support of conservation.

MODULE I WILDLIFE MANAGEMENT
- Biodiversity and Wildlife. Principles of management, animal-habitat studies, conservation biology, management of animal communities, habitat management. Wildlife Management Plan

MODULE II CONSERVATION STRATEGIES
- Wildlife behavior studies, Man animal conflict,
- Conservation strategy – Objects of Conservation, life support systems, ex situ and in situ, protected area network, agencies for conservation, human dimension, wildlife in managed forests
- Wildlife (Protection) Act, 1972 and amended Act 2002
- Forest Conservation Act, 1980
- FCA in relevance to Wildlife areas

MODULE III ECO- DEVELOPMENT
- Eco development in support of conservation & protected area management, animal habitat studies, Scope of eco development, thrust areas in eco development, planning and implementation
- Eco development: Macro and micro planning, Case studies

PRACTICAL
1. Field Visits and Field Exercises, Audio video Demonstrations

2. Case studies related to man animal conflict, habitat development and biodiversity conservation

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FRU 313   FOREST REOURCE UTILIZATION-II (Wood)

LEARNING OBJECTIVE: The course is planned to acquire the knowledge of wood products and advanced technology of seasoning, preservation and composites.

Module I: Introduction to Wood and Histology:

MODULE I WOOD SEASONING AND PRESERVATION

- Introduction – object, need and importance of seasoning and preservation; general principles of seasoning; air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. Types of wood preservatives and treatment methods

MODULE II WOOD ADHESIVES AND COMPOSITE WOOD

- Adhesive preparation, properties, uses
- Composite wood manufacturing, properties and uses of plywood, fiber boards, particle boards, MDF(Medium Density Fiber board)

MODULE III WOOD BASED INDUSTRIES

- Status of composite wood industries in India and future expansion plans, classification and grading of Indian timbers for various wood based products. Wood substitution utilization of plantation wood; problems and possibilities

PRACTICAL

- Exposure to wood seasoning, preservation, composite wood
- Determination of wood physical and mechanical properties
- Practical on Wood Histology

FGT314   FOREST GENETICS AND TREE IMPROVEMENT

LEARNING OBJECTIVES: The objective of the course is to develop of concept of genetics, and biotechnology in relation with conservation and quality/productivity improvement of forests.

MODULE I TREE GENETICS

- Introduction to genetics and its application to Tree and improvement, Introduction, definition and scope in tree improvement and genetics, variation:

causes and kinds of variation, variation in natural and artificial stands forces that shape variation, uses of variation. Hardy Weinberg law and its application in forestry, dominance and epitasis. Quantitative characters, heritability (broad and narrow sense), genetics advance, genetics gain and combining ability and their application.

- Tree Improvement: Species and provenance testing, plus tree selection, progeny trials and elite trees. Genotype x environment interaction. Quality seeds and seed certification. Seed orchards and seed production areas, their establishment and management. Advanced generation seed orchards. Techniques of tree breeding: Definition and scope of tree breeding, its objectives and application. Selective methods of breeding. Clonal testing and clonal selection polyploidy and mutation breeding. Controlled pollination and hybrids and tree improvement. Breeding for wood properties, resistance to insect and diseases. Concept of ideotype

MODULE II TREE PROPAGATION AND BIOTECHNOLOGY

- Vegetative propagation: Macro-propagation methods. Tissue culture techniques, clonal micro-propagation, somatic organogenesis and embryogenesis, production of virus free plants, Application of vegetative propagation in tree improvement.
- Biochemical characterization, Fundamentals of Genomics and proteonomics, Basic concepts of DNA finger printing, Genetic markers, Molecular genetics, Conservation genetics, Transgenic, and gene editing technologies.

PRACTICAL – 18 (36 HOURS)

- Tissue Culture techniques –
- Vegetative propagation methods
- Seed production areas, clonal banks, provenance trials
- Techniques of selecting superior or plus trees or clumps in natural stands
- Progeny trials and estimation of genetic parameters: Estimation of broad sense and narrow sense heritability and phenotypic and genetic coefficient of variation, genetic and phenotypic correlation.
- Seed orchard designs and Management
- Pollination (selfing and cross), Controlled crossing techniques
- Biochemical and DNA isolation, data analysis
- Molecular genetics: Estimation of genetic diversity and distance, population size, F- STATs

FFC 315   FOREST CERTIFCATION

LEARNING OBJECTIVES: The objective of the course is to introduce concept and importance of forest certification and its programmes in India.

MODULE I INTRODUCTION

- Forest certification: concept, definition, origin, evolution, relevance and needs and limitation of forest certification, Scope and opportunity, Emerging issues, trends and schemes, certification and labelling, type of certification- Detail about FM, CoC, fact and figures of certification(Global and India)

MODULE II FOREST CERTIFICATION PROGRAMME

- Standards, certification process, accreditation, auditing, managing audit, organizational process, national and international schemes, certificate processes at global level, Bhopal-India Process

MODULE III CERTIFICATION OF FOREST PRODUCTS

- NTFPs and their role in forest management, certification of NTFPs, issues, merits and demerits of NTFPs certification, Need of certification for wood based Industries

MODULE IV SUSTAINABILITY, CHALLENGES AND POTENTIAL OF FOREST CERTIFICATION

- Framework for forest certification in India, Government policies and their objectives, Indian forest certification agencies, Standards of certification for sustainable utilization, and management of forest resources, progress of certification in India, stakeholder expectation and economics of forest certification, Visit to certified Industry/Govt. Organization

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FCC 316   FOREST, SOCIETY AND CLIMATE CHANGE

LEARNING OBJECTIVES: The course is designed to develop understanding of social dimensions on climate change, climate vulnerability and its assessment.

MODULE I   SOCIAL DIMENSIONS ON CLIMATE CHANGE

- Community social structure, status and role, norms and values, Concepts of equality, inequality, exclusion, poverty and deprivation, Social Stratification (class, status groups, gender, ethnicity and state, citizenship, democracy, civil society, ideology)
- Land use and Forest Cover Change
- Sociological issues related to climate change- Social causes, consequences, conflicts over resources etc.

- People and forest interface in managing natural resource and Common property resources, gender perspective and priorities in relation to resource use and management, Gender impact analysis, Social drivers of Climate Change

MODULE II CLIMATE CHANGE ISSUES AT GLOBAL AND NATIONAL LEVEL

- Global environmental and social issues such as acid rain climate change disaster management, Global regional and local common resources
- Policies and initiatives related to global climate change, Montreal Protocol, UNFCCC, Kyoto Protocol, REDD +
- Regulations and policies for environment and social safeguards in selected national contexts
- Concept of carbon cycle and carbon sequestration.
- Various carbon pools in forest ecosystems

MODULE III RESPONSE TO CLIMATE CHANGE

- The concept of Mitigation and Adaptation
- Climate vulnerability exposure, sensitivity, resilience and adaptive capacity of society
- Role of forests, Trees outside forests and agro forestry in climate change resilience and adaptation
- Bonn Challenge: aim and objectives
- National action plan on Climate Change of India: aim and objectives

MODULE IV METHODS AND TOOLS FOR ASSESSING VULNERABILITY AND ADAPTATION POTENTIAL

- Participatory process, Stakeholders and SWOT Analysis
- Introduction of approaches for qualitative data collection and synthesis: Rapid Rural appraisal (RRA)
- Communicating and connecting to people on social and environmental concerns
- Data and Information: Data types, population and sample, methods for collecting information; development of field survey questionnaire; data collection, processing, presentation and interpretation
- Spatial and non – spatial data handling using Geographic Information Systems (GIS) Criteria for selecting study area; Analysis and interpretation using GIS;

Data base creation tools for handing large data sets

- Analysis of trends and scenarios

- Methods for assessing climate change vulnerability and adaptation potential

- Scientific writing of results

PRACTICAL

- Assignment

- Data collection from field for opted problem

- Data analysis, report writing, presentation and communication of important findings

- Process based methods for measuring carbon sequestration rate of Forestry species.

- Estimation of water use efficiency of forestry species

- Evaluation of forestry tree response to climate change and environmental pollution

FST 317	STUDY TOUR

LEARNING OBJECTIVES: A study tour is organized every year for the students of M.Sc. Forestry to acquaint themselves with the knowledge in the relevant fields. The study tours are intended for giving actual field exposures to students. It provides them an opportunity to visualize the professional efforts and measures taken by different industries and institution in tackling the problems of forest.

ELECTIVE COURSE

FGB 321   FOREST GENETICS AND BIOTECHNOLOGY

LEARNING OBJECTIVES: The course is designed to impart advance knowledge of tree improvement using genetics and biotechnology.

MODULE I: FOREST GENETICS
- Basic principles – Introduction to forest genetics. Molecular basis of inheritance & genome organization. Variation: causes and kinds of variation, variation in natural and artificial stands, forces that shape variation, uses of variation.

- Population Genetics – Gene frequencies, Hardy-Weinberg Equilibrium, evolution and migration

- Evolutionary Genetics – Natural selection, mutation, genetic drift, gene flow, speciation

- Quantitative Genetics – Selection

- Conservation Genetics – Objectives in gene conservation, genetic structure, *In situ* and *ex situ* gene conservation, forest fragmentation, forest tree gene conservation methods

MODULE II : BIOTECHNOLOGY

- Tissue culture: Principles, history and development, fields of application, progress and prospects with special reference to tree crops. Components and preparation of culture medium. Collection, handling and surface sterilization of explants. Inoculation and incubation. Culture conditions.
- Low cost techniques for micro-propagation. Essential features of tissue culture laboratories. Commercial micro propagation. Scope and challenges in *In vitro* propagation of tree crops. Production of virus free plants. Somaclonal variation, factors influencing, exploitation for crop improvement. Haploid culture and production of homo diploids, protoplast isolation, culture and regeneration.
- Molecular Genetics: The structure of the genome: chromosomes, chromosomal structure, and extrachromosomal inheritance. The molecular basis of transmission of genetic information: nucleic acids and proteins.
- DNA replication, DNA repair, mutations, recombination, transposition, transcription, and translation. Inheritance of genetic information: meiosis, sexual reproduction and classical genetics. F-STATs, Adaptive and neutral variation, molecular clock, Mutation model (SMM).
- Gene technology: Restriction mapping, genetic libraries, cloning, DNA/RNA-sequencing, PCR. Molecular markers i.e. RAPD, ISSR, AFLP and SSR and their applications in forest tree improvement.
- Proteonomics and bio-informatics and data mining in molecular genetics.
- Genetic engineering- Principles, methods and application. Identification and isolation of genes. DNA cloning strategies. Characteristics of vectors. Plasmids, phages and cosmids as cloning vehicles. PCR techniques for cloning. Separation and isolation of nuclear acids and proteins- their sequencing. Enzymes for molecular cloning- ligases, nucleases, DNA polymerases. Restrictions and DNA methylation. Preparation and screening of genomic and cDNA libraries, c DNA cloning. Structural and regulatory genes. Gene editing using CRISPER.

- Biotechnology for forest conservation: Biotechnological tools for forest conservation. Mapping gene diversity with DNA marker technology. Genetic diversity linked forest conservation and seed production. Effective population size for forest conservation. Cryopreservation and plant regeneration for conserving and micropropagating specific plant material for *ex situ* conservation. Forensic applications of biotechnology for conservation and management.

MODULE III: APPLIED TREE IMPROVEMENT

- Clonal testing and clonal selection: Establishment of VMGs and their management. Propagation structures and their management. Hardening of clonal plantlets. Development and deployment of clones. Clonal testing across the sites. Release and registration of clonal material.

PRACTICAL

- Estimation and isolation of DNA and RNA. Agarose gel electrophoresis. Denaturation of DNA. Ethidium fluorescent assay of nucleic acids. Estimation of C value. Binding of polyamines to DNA. Assay of DNA polymerase
- DNA sequencing, Estimation of total protein
- SDS page electrophoresis for estimation of protein
- Preparation and storage of stock solutions, preparation of culture media
- Collection, handling and pre-treatment of explants
- In vitro propagation of crops via different route
- Ex vitro establishment of plantlets
- In vitro conservation
- Application of genetic and taxonomic markers (RAPD, PCR RFLP, ISSR, microsatellite markers etc.) using PCR technology.
- Estimation of genetic diversity and distance, population size, F- STATs, chi square and AMOVA.
- Application of online and offline bioinformatics tools in molecular genetics.
- Cryopreservation
- Vegetative propagation methods
- Vegetative multiplication Garden and clonal multiplication Area
- Statistical design for clonal testing

FRG 322   REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

LEARNING OBJECTIVES: This is the advance course designed to focus on fundamental characteristics of electromagnetic radiation and their application in forestry and allied areas through RS and GIS.

MODULE I   REMOTE SENSING

- Introduction to Remote Sensing, Electromagnetic Energy, Sensors and Scanners
- Aerial Cameras, Visual Image Interpretation, Digital image Classification, Image Enhancement and Visualization, Geometric Aspects
- Software of remote sensing, Application of remote sensing in forestry and allied fields. Ground truthing and accuracy assessment

MODULE II   GEOGRAPHIC INFORMATION SYSTEM

- Introduction to GIS, Spatial and non-spatial database for GIS analysis
- Use of global positioning system, Data entry and processing system, Data analysis and visualization

- Application of GIS in Forestry and allied subjects

PRACTICAL

1. Stereo text, determination of photo / imagery scale, orientation of stereo model, identification of features on stereo pair and aerial photograph
2. Interpretation of colored details on multispectral and monochromatic images
3. Remote sensing data acquisition from different sources
4. Software operation for image stretching, histogram equalization, rationing, filtering and principal component analysis. Image classification
5. Training in operating software on basics of GIS. Geo referencing, geocoding and mosaicing
6. Entry of spatial and non – spatial data
7. Rasterization and labeling of attributes
8. Measuring height and crown diameter of a tree
9. Forest cover and density mapping
10. Land use and land cover use/mapping
11. Multistage sampling for change detection

FWH 323   WILDLIFE AND HABITAT MANAGEMENT

LEARNING OBJECTIVES: This course aims to provide a comprehensive understanding of wildlife and their conservation strategies with ecosystem development.

MODULE I   INTRODUCTION

- Objective of wildlife conservation and wildlife biology, biological basis for conservation of wildlife. Review of biology of major groups of vertebrates, fish, amphibians, reptiles, birds and mammals with emphasis on importance in wildlife management
- The IUCN categories of conservation status of species. Importance of invertebrate conservation

MODULE II WILD LIFE BEHAVIOUR

- Animal habitat interactions, pattern of habitat utilization, feeding ecology of herbivores, carnivores, insectivores and omnivores, temporal and spatial variation in

food resources, animal body conditions, reproductive ecology, dispersion, pattern of growth, study of signs and symptoms of wildlife presence, role of minerals in animal health, adaptation with respect to temperature and water

- Wildlife behavior – Instinct and learning Behavioral ecology, study method and significance for conservation, Group living in animals, Territory in animals, Social organization

- Management of Wildlife Animals in Distress - Causes of distress; trapping, snaring, accidents, injuries, affected by disease and physical disability. Orphaned young, Approach to the handling of animals in distress in consideration to safety of humans and animals concerned, crowd control, techniques for animal capture, restraint and immobilization

MODULE III ECO DEVELOPMENT AND HABITAT MANAGEMENT

- Habitat Ecology – Major Wildlife Habitats, forests, grasslands, wetlands, deserts, Wildlife cover requirement, Edge effect and interspersion, physical and biological features of habitats. Grassland habitats, Habitat Dynamics, Habitat Evaluation Procedures, Forage quality and quantity

- Definition and classification. Wetland values and functions, wetland degradation and loss. Wetland management principles. Identifying major problems and setting objectives and priorities. Management of wetland habitats for ecological processes and wildlife

- Rationale for undertaking eco-development, Basic concepts, significance of commodities participation in eco-development, significance of   Local Traditional Knowledge in conservation, dependencies of local communities on PA's/ Natural resources, Stakeholders in conservation and their conflicts, SWOT Analysis, Linkage between conservation and development, Livelihood strategies in context of eco-development, Protected areas , mutual impact zone analysis, participatory tools and methods for gathering data for planning eco-development, Micro-planning

- Significance of research in wildlife, wildlife habitat management -- creation of water sources, wallows and saltlicks. Vulnerability of resources and protection, fire as a management tool, livestock grazing, weeds eradication

MODULE IV WILDLIFE TOURISM

- Translocation and reintroduction. Tourism in protected areas. Development of Interpretative facilities, visitor characteristics, expectations and motivations, sustainability in Wildlife Tourism
- **Ecotourism**

MODULE V POPULATION DYANAMICS

- Population dynamics, Population estimation, Meta-population, Census techniques, Wildlife health management, Need for wildlife health management, History of wildlife diseases in India, Importance of wildlife health monitoring, problems and solutions, Determinants of disease, Infectious and non-infectious diseases

Practicals:

- Case studies of man-animal conflict/s biodiversity conservation aspects, habitat development related with management of animal communities.
- Field exercise/s, and visits, audio video demonstrations, along with specific assignment to students.

FSM 324   SUSTAINABLE FOREST MANAGEMENT

LEARNING OBJECTIVES: The course will develop the skills of students to manage forest and natural recourses.

MODULE I FOREST IN RURAL DEVELOPMENT

- Forest – People symbiotic linkage; forest and employment generation, Management of local commodities action, forest management strategies of social forestry programme and Joint Forest Management (JFM). Various strategies of micro level planning and participatory rural appraisal (PRA). Behavioral dimensions in peoples centric forest management

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MODULEII NATURAL RESOURCE MANAGEMENT

- Land Management and Agro-forestry (LMAS)
- Natural resource poverty and development, Conflict Resolution in NRM (Natural Resource Management), Natural Resource Accounting, Plantation Management, Sustainable Forest Management and Certification (SFM) , Multi-stakeholder

Partnerships in managing forest resources, NTFP (Non Timber Forest Product) based Micro-Enterprises, Management and Business Models, Economics of Forest and Forest based Industries. Marketing Research, Finance, Micro Finance

PRACTICAL
- Study of working plans and natural resource management control systems through preparation of field work reports on Preliminary Working Plan, Micro – plan
- Formulation of an integrated watershed development project comprising various sectoral development plans, forest products marketing research and field work, Stock mapping
- Checking of maps, compartment description, sample plot lay out, collection of statistical data, collection of other data, and evaluation of management alternatives; socioeconomic survey

FAF 325   **AGROFORESTRY**

LEARNING OBJECTIVES: The course aims to provide concept of agroforestry and tree management techniques.

MODULE I   INTRODUCTION
- Agro forestry- definition, meaning, objectives, importance, potential and impediments
- Goals, objectives and strategies of National Agro forestry Policy 2014
- Land capability classification and land use, agro-climate zones of India
- Concepts of community forestry and social forestry
- Elements of Agronomy (cultural practices of agro forestry crops and compatibility with tree)
- Elements of horticulture in forestry

MODULE II   AGROFORESTRY SYSTEMS
- Classification of agro forestry systems: structural, functional and socio-economic
- Major agro forestry practices, their characteristics and examples

- Overview of important agro forestry systems in temperate zone
- Characteristics of agro forestry trees; Multipurpose tree species ,nitrogen fixing trees;C3,C4 and CAM plants
- Important agroforestry trees, shrubs, grasses and medicinal plants in different regions of India for various uses (fodder, fuel, industrial wood, medicines, fruit , wasteland development, urban landscaping)
- Design and diagnosis, criteria of good agro forestry design
- Example of improved agro forestry models

MODULE III   MANAGEMENT AND TECHNIQUES

- Tree management (Planting pattern, nutrient, irrigation and weed management, pruning, coppicing)
- Tree-crop interactions
- Calculation of volume of standing trees
- Measurement of felled trees, volume and weight tables
- Estimation of volume of felled trees through sectional areas

MODULE IV   ECONOMICS

- Basic principles of Economics applied to Agroforestry
- Optimization techniques, Planning, Budgeting and Functional analysis
- Market intelligence, Demand study, MIS
- Marketing of agro forestry products including benefit sharing
- Agro forestry potential under REDD regimes
- Economic security and incentives to tree growers‑ Access to credit, insurance,
- Support prices, Taxes etc.

MODULE V   PEST AND DISEASE MANAGEMENT

- Insect-pest problems in agro forestry systems
- Basic principles and practices of integrated pest management in agro forestry ecosystems with emphasis on cultural practices
- Disease Management in Agro forestry models

PRACTICAL

- Visit of agro forestry sites with different crop combinations
- Harvesting and marketing of agro forestry produce

FFP 326   **FOREST PATHOLOGY**

LEARNING OBJECTIVES: The course is designed to impart knowledge of tree disease and its management.

MODULE I INTRODUCTION

- History of Forest Pathology, Disease Concept, Plant Pathogens, Disease Triangle, Disease Cycle, Major Tree Disease Epidemics, Climate Change and Forest Diseases, Forest Pathology Today and Future Directions

MODULE II DIAGONOSIS AND TYPES

- Basic Procedures in the Diagnosis of Tree Diseases, Symptoms and Signs, Koch's Postulates.

- Infectious and Non-infectious Diseases

- Classical and Modern Techniques for Pathogen Detection.

- Seed Pathology and Detection of Seed-borne Pathogens

- Types of Diseases, Parasitism and Pathogenicity, Effects of Pathogens on Plant Physiological Functions

- Chemical Weapons of Pathogens and Plant Defense Mechanisms

- Forest Nursery Diseases, Tree Diseases of Economic Importance, Heart rot in Natural and Plantation Forest, Shisham Mortality, Diseases Management

MODULE III BIODETERIORATION

Biodeterioration of Stored Non-wood Forest Products with Special Emphasis on Medicinal and Aromatic Plant Produce, Mycotoxins, White Rot, Brown Rot and Soft Rot, Sap Stain and Wood discoloration, Management of Fungal Deterioration in Stored Products.

MODULE IV DISEASE

Principles of Disease Management

- Quarantines and Inspections, Genetic Resistance , Chemical Control, Biological Control

- Diseases management in Nursery, Plantation and Natural Forests.

- Concept of Integrated Disease Management

- Tree Disease Problems in Urban Plantations and Their Management

- Molecular Tools in Forest Pathology

PRACTICAL

1. Isolations of fungi and bacteria, identification, maintenance of cultures

2. Disease survey and preparation of herbarium

3. Management of nursery diseases – seed treatment, soil treatment and foliar application

4. Assessing heart rot and root rot diseases in plantations

5. Extraction of nematodes from soil and roots

6. Extraction of spores of Arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection

7. Fungal DNA extraction, RAPD-PCR, Data analysis, use of molecular tools in fungal taxonomy

FFE 327   **FOREST ENTOMOLOGY**

LEARNING OBJECTIVES: The course is formulated to enrich the knowledge with the information about insect, insect-pest of economically important trees and timber species and their management along with industrially important insects.

MODULE I GENERAL ENTOMOLOGY

- **Introduction:** Definition and scope, Importance of insects in Forestry: History and development of forest entomology in India
- **The Insects:** Classification of class insect, biological success of insects and adaptation
- **Development and Growth:** Life-cycles and types of metamorphosis of insects
- **Economic losses by forest insects**: Type of injury (direct and indirect), estimation of economic losses
- **Seed insect pests:** Factors influencing insect infestation, insect pests of seeds under field conditions, insect pests of seeds and grains in storage, economic losses, preventive and remedial measures.
- **Nursery pests:** Major nursery pests (white grubs, chafer beetles, cut worms, surface caterpillars),Minor nursery pests (defoliators, sap suckers, non-insect pests, management practices)

MODULE II TREE DEFOLIATORS

- Bio ecology of the pest, life history, nature of damage, natural enemy complex, management of different tree defoliators *i.e.* Ailanthus (*Atteva fabriciela*, *Eligma narcissus),*Deodar, Gamhar, Kadam, Poplar, Shisham, Teak etc.

MODULE III TREE BORERS

- Bio ecology of the pest, life history, nature of damage, natural enemy complex, management of different tree borers *i.e.* Babul, Meliaceae, Poplar, Sal heartwood, Semul etc.

MODULE IV   INSECT INDUCES DEFORMITIES

- Malformations and plant galls in forest trees, teak canker grub, gall insects, teak stem galls, bamboo aphid, tendu leaf gall, bio ecology of the pest, nature of damage and its management.

MODULE V TERMITES IN FORESTRY

- Recognition of termite infestation, distribution and sociobiology, termite classification, termite relationship with other insect including cochroaches, ants etc., termite canabalism, wood dwellers, damp-wood termites, dry-wood termites, economic importance, termites as pests of forestry and their management, termite damage in buildings and human dwellings, pre-constructions and post-construction control measures

MODULE VI TIMBER ENTOMOLOGY

- **Borers of felled and harvested wood –** Bio ecology of borers, nature of damage and its management, ecological succession of borer attack, borers of freshly felled timber, Ambrosia and bark beetles, Buprestid borers, cerambycid borers, curculionid borers, powder, post beetles
- **Bamboo ghoon borers:** Borers of felled and stored bamboos and their management. Insects pests of imported wood

MODULE VII   ECONOMIC ENTOMOLOGY

- **Honey Bee:** Fauna; its community, social organization; development, division of labour, swarming, communication, bee keeping, economic importance
- **Lac and Lac insect:** History definition and composition, life cycle, strains of lac insects, host plants, lac cultivation, natural enemies, control measures
- **Silk and silk worms**: History of sericulture, definition and composition, mulberry silk worm, univoltine and multivoltine species, wild silk worms, sericulture, silk production

MODULE VIII   INSECT PEST MANAGEMENT

- Natural control of insect pests: Climatic control, nutritional restrictions, host resistance, biotic factors etc.
- Integrated Pest Management: Definition, scope, population dynamics, factors affecting natality/mortality of insect pests, economic threshold, economic injury level etc.
- Methods of pest management: Mechanical, silvicultural, chemical, bio logical, behavioral and genetic control.
- Mechanical methods of pest controls: Hand picking, trapping, barrier, tree bands, debarking, pruning, heating, submersion in water etc.
- Silvicultural control: Food web; crop rotation; mixed crops; clear felling; choice of silvicultural system.

- Chemical control: **Insecticides and plant origin –** pyrethrum; nicotine; rotenone; neem products
- **Synthetic organic insecticides –** Chlorinated hydrocarbon insecticides; organo phospate insecticides; carbonate compounds; synthetic pyrethroids.
- **Insecticide formulations –** Contact insecticides; systemic insecticides; stomach poisons; fumigant insecticides.
- **Insecticide application –** Insecticide application equipment; safer dosages of pesticides; mode of action; aerial spraying of insecticide.
- **Bio logical control approach / strategy:** Survey for presence or absence of bio control agents; selection of promising bio control agents; Mass rearing / mass culture of bio control agents; release of promising bio control agents in deficient areas; post release study – establishment of released bio control agents; effect on pest population
- **Microbail control:** Entomo phathogenic fungi, bacteria, virus, protozoans, nematodes etc, mass production technique of entomo pathogen; quantification of effective dozes, field application; post release studies etc.
- **Behavioral control –** Pheromones; Sex pheromone; aggregation pheromones; trail pheromones; Kairomones; allomones; phago deterrents etc.
- **Insect growth regulators –** Juvenile hormones; moulting hormones precocenes.
- **Genetic control**
- Breeding resistant trees / clones; male sterilization technique, radiation sterilization; chemosterilization
- **Quarantine regulations**
- Legislation – Quarantine laws; import quarantine regulations – importers obligations, quarantine transit facilities; post-entry quarantine regulations; export quarantine inspection and certification system.

PRACTICAL
- Insect collection and Identification
- **Methods of insect collection and preservation –** Hand picking of crawling and walking insects, using butterfly nets, scissors nets; collection of aquatic insects by water nets insect killing, pinning and drying, leveling; collection of at least 50 insects belonging to at least 10 different order, their preservation and display in insect collection box and submission at the time of practical examination for evaluation.

- **Dissection –** Study of mouth parts of insects, dissection of mouth parts and preparation of temporary (glycerin) slides.
- **Study of insect pests of standing trees –** systematic position, morpholical / taxonomical characters, damaging behavior and method of control; study of sal – heartwood borer; teak defoliator; teak canker insect; toon flower, seed and shoot borer; mahogany collar borer; shisham defoliators; babool stem and root borer; poplar stem borer; semul shoot borer; ailanthus defoliator, champ bug; gambar defoliators; termites – different casts; termite nests; bark beetles; pine shoot borers; bamboo shoot borer.
- **Nursery pests –** cutworms; cockchafer grubs; crickets etc.
- **Seed pests –**bruchid weevils, microlepidoptera etc.
- **Wood boring insects:** Insect pests of felled timber; bark beetles; pin hole borers; ambrosia beetles; sapwood borers; heartwood borer; dry wood borers etc.
- **Beneficial insects:** Systematic position, diagnostic / taxonomical characters, economic importance etc – parasitoids – wasps and flies; predators – praying mantids; predatory bugs beetles and wasps; lac insect, honey bees, silkworm etc.
- Visit to entomology museum, nursery and plantation, felling site, timber depots etc. – study and collection of insect and to maintain a field notebook recording details of site, insect damage, and condition of nursery / plantation etc. diagnosis of insect attack by symptoms.
- How to report insect damage and sent insect specimen to Forest Research Institute for identification and advice.

FEI 328   **ENVIRONMENTAL IMPACT ASSESSMENT**

LEARNING OBJECTIVES: To acquaint students about the importance of strategic environmental assessment in cumulative, regional and landscape level impact assessment.

MODULE I METHODS FOR EIA
- Elaboration of steps in traditional EIA process

MODULE II STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)
- The importance of SEA as a tool for assessing impacts of policy, plan and programmes. Relevance of SEA as a global tool for addressing cumulative, regional and landscape level impacts.

- Examples of SEA and SEA like approaches from India; Key example of good SEAs from around the world. Introduction to tools and techniques.

MODULE III ENVIRONMENTAL ECONOMICS

- Introduction to some recent approaches of economic valuation of impacts and their application in impact assessment and presentation of case studies.

MODULE IV ADVANCED LEANING ON MITIGATION STEPS

- Principles and concepts of offsets, type o1 offsets, examples of bio-banking and wetland banking and market based mitigation strategies.
- Comparison of EIA approaches in other countries in South Asia.
- Life Cycle Assessment Approach in Impact assessment.
- Impact Assessment for addressing climate change.

PRACTICAL

Students will be exposed to practical aspects of the Environmental Impact Assessment through Self Learning Modules-

1. Scoping for Hypothetical or real EIA study
2. Scoping based on scenario projection through visuals (Some select films can he used)
3. Review of EIA Reports and preparing comments for appraisal of project
4. Development of Alternatives based on details available for project planning to ensure least impact option
5. EIA Report writing with case studies
6. Seminar on select topics (e.g.: Merits of EIA using case study, shortfalls of EIA; What best practices would improve benefits of EIA for decision making)
7. Review and observations on Public Participation and Public Hearing
8. Conduct of environmental review for evaluating mitigation compliance
9. Essay on Road map for making EIA a tool for good governance
10. Review of decision support software for EIA

FPT 329   <u>**PLANTATION TECHNOLOGY**</u>

LEARNING OBJECTIVES: The course is designed to enrich the knowledge about forestry and general techniques of raising tree seedlings in the nursery, their establishment in the field and nurturing into mature tree. It also covers the   management, economic and post harvest operations with legal aspects.

MODULE I INTRODUCTION

- Sustainable management of plantations.
- Various adopted forest plantation in India, Environment considerations, Environmental impacts, existing management techniques, general considerations

MODULE II PLANTATION TYPES

• Industrial Plantations	Paper and, Pulp wood plantation, commercial timber plantation
• Energy Plantations	Energy consumption pattern, properties of fuel wood, choice of species, energy from biomass
• Strip Plantations	Avenue plantations, canal- bank plantations, plantation along railway line, wind breaks and shelter belt Agriculture and Horticulture
• Crop mixtures	

MODULE III MANAGEMENT

- Silvicultural systems applicable, coppices systems clear felling systems. Management of specific plantation systems, thinning, need for thinning and types of thinning, improvement felling. Rotation
- Pest and Disease management. Control of pest and diseases at nursery and plantations

MODULE IV PLANTATION MENSURATION

- Measurement of felled trees. Estimation of volume of felled trees through sectional areas. Calculation of volume of standing trees. Volume Table: Kind of volume table. Different methods to prepare volume table. Sample Plots: Details of sample plots, object of sample plots, laying process and use of observations from sample plots.

MODULE V ECONOMICS

- Economics of Plantations (tree crops), Monitoring and evaluation of plantations, budgeting for Harvesting, Depot and Transportation. Marketing

MODULE VI HARVEST AND POST HARVEST OPERATIONS

- Harvest and post harvest operations
- Saws: Peg-toothed, raker toothed, bow Saw, maintenance tools. Wedges
- Depot Management :- Depot planning, depot types, functioning, landings, duration and system of storage, systems of loading and unloading, grading, layout, depot planning, staffing and management
- Transportation: - Transport system. Problems of transport in India. Type of transport. Basis of classification. Off road transportation. Present practices.

MODULE VII PLANTATION MANAGEMENT OF IMPORTANT SPECIES

- Plantation management of important species e.g. Poplar, Eucalyptus, Casurina, Bamboo, Kadamb, Gmelina

MODULE VIII LEGAL AND POLICY ISSUES

- Legal issues. Laws of transportation, Exim policies, Agriculture Income Tax, IPR, NPV.

PRACTICAL

Visit to:

- Timber Depot and felling Area in Uttarakhand
- Plantation Areas of Poplar/Eucalyptus (Haryana/Rudrapur)
- Timber Markets of Haryana and Uttarakhand

PTN 330   **PLANT TAXONOMY**

LEARNING OBJECTIVES: The objective of the course is to impart knowledge about nomenclature and classification of genus, species and variety and to develop skills and abilities to identify plants in the field.

PRACTICAL

- Description of different types of stems; different types of leaves; flowers; inflorescences and different types of fruits.

- Floral parts, dissection and characteristics of one specimen each of ten families with identification, drawing of floral parts with floral formula and floral diagram of species with the help of local flora
- Field botanization, collection and making herbarium for identification of plant or tree species during various tours with the help of flora/
- Virtual Herbariums (Use of Digitalization Flora)

THEORY
MODULE I INTRODUCTON
- Importance of plant taxonomy
- History of Plant Taxonomy in India
- Taxonomy in relation to: Anatomy, Chemotaxonomy, Numerical taxonomy, Cytotaxonomy, Molecular Taxonomy/ Phylogeny, Palynology, Ecology
- Phytogeography, GIS Tools use in Taxonomic explorations
- Plant conservatories (Herbarium, Botanical Garden etc)
- Taxonomic Keys (Dichotomous & polyclave keys)
- History of the classification of Angiosperms, Classifications propose by Bentham and Hooker, Engler and Prantl, De candolle, Hutchinson, Takhtajan, Cronquist. Their merits and demerits. APG classification (*Angiosperm Phylogeny Group* system of plant *classification)*

MODULE II BOTANICAL NOMENCLATURE
- International code of Botanic Nomenclature (ICBN and ICN); principles; Rules and recommendations; priority; typification; Rules of effective and valid publications; retention and choice of names.

MODULE III DESCRIPTION OF IMPORTANT FAMILIES
- Dendrology
- Description of families viz. Magnoliaceae, Dipterocarpaceae, Meliaceae, Sterculiaceae, Leguminosae, Rosaceae, Lythraceae, Myrtaceae, Rhizophoraceae, Rubiaceae, Lauraceae, Fagaceae, Verbenaceae, Euphorbiaceae, Coniferae, Poaceae (Bamboo)

MODULE IV ETHNOBOTANY
- Ethnobotany and its importance.
- Ethnobotany of important forest species

4th SEMESTER

FSY 441   SYNOPSIS

FMT 442   MASTER THESIS

LEARNING OBJECTIVES: In final semester students have full six month to conduct their own experiments and conclude the findings as thesis reports. Students work on research problem and hypotheses under the supervision of a concerned faculty. It equips the students to pursue the goal in academic area or R and D section. They learn methods, techniques of research writing. This provides them an opportunity about identifying challenges and opportunities and helps them in solving problems through research and experimentation

FTS 443   MASTER THESIS SEMINAR