KUMAUN UNIVERSITY NAINITAL

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

National Education Policy – 2020

Subject: Forestry

FINAL DRAFT SYLLABUS:

Effective from academic year 2022-23

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

National Education Policy–2020

Subject: Forestry

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SEMESTER-WISE TITLES OF THE PAPERS
FOR FORESTRY COURSE

YEAR	SEMESTER	PAPER CODE	PAPER TITLE	CREDITS TH+PR
Certificate Course in Elementary Forestry				
1	I	MAJOR-1	Introduction to Forestry	4+2
		Vocational/Skill Development	Nursery Technology	03
	II	MAJOR-1	Forest Ecology	4+2
		Vocational/Skill Development	Watershed Management	03
	I & II	Minor Elective	Ecotourism in Himalayan Region	4+2
Diploma in Plantation Forestry				
2	III	MAJOR-1	Plantation Forestry	4+2
		Vocational/Skill Development	Medicinal and Aromatic Plants	03
	IV	MAJOR-1	Principles of Silviculture	4+2
		Vocational/Skill Development	Non-Timber Forest Products	03
	III & IV	Minor Elective	Remote Sensing and GIS	4+2

Bachelor in Science (Forestry)				
3	V	MAJOR-1	Forest Mensuration	4+1
		MAJOR-2	Principles of Agroforestry	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-V	Qualifying
	VI	MAJOR-1	Forest Protection	4+1
		MAJOR-2	Forest Utilization and Economics	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-VI	Qualifying
Bachelor (Research) in Forestry				
	VII	MAJOR-1	Biostatistics	4+1
		MAJOR-2	Forest Management, Policies and Laws	4+1
		MAJOR-3	Nursery Technology	4+1
		MAJOR-4	Environmental Science	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-VII	04

4	VIII	MAJOR-1	Forest Products and Industries	4+1
		MAJOR-2	Energy Plantation and Bio-Fuel	4+1
		MAJOR-3	Medicinal and Aromatic Plants	4+1
		MAJOR-4	Ecotourism and EIA	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-VIII	04
	VII OR VIII	Minor Elective or Minor Elective	Biotechnology Application in Forestry or Forest Dendrology	4+1 4+1
Master in Forestry				
5	IX	MAJOR-1	Forest Ecology and Biodiversity Conservation	4+1
		MAJOR-2	Advances in Silviculture	4+1
		MAJOR-3	Agroforestry: Systems and Management	4+1
		MAJOR-4	Forest Genetics and Tree Improvement	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-IX	04

	X	MAJOR-1	Tree Seed Technology	4+1
		MAJOR-2	Forest Entomology and Pathology	4+1
		MAJOR-3	Forest Economics and Marketing	4+1
		MAJOR-4	Natural Resources and Climate Change	4+1
		Industrial Training/Survey/Research Project	It is based on Major Papers of Semester-X	04
PGDR in Forestry				
6	XI	MAJOR-1	Statistical Methods and Experimental Designs	06
		MAJOR-2	Recent Advances in Forestry	06
		Industrial Training/Survey/Research Project	It is based on research scholar thesis proposal	Qualifying
Ph. D. in Forestry				
6,7,8	XII-XVI	Ph. D. Thesis		--

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Purpose of the programme

- ✓ Forestry is one of the professional subjects which was introduced in the country and elsewhere due to various reasons of forest depletion, deforestation and climate change as well as increased needs of plant product in nation and community development.

- ✓ Forests are the second major land resources of the country and it should be one third of the land cover as per the National Forest Policy but the areas of forest is less. Thus it is an urgent need to produce competent professional by imparting quality education to meet the industrial requirements and for serving the societal needs.

- ✓ Conservation and Scientific Management of the natural resources of the state/country by trained forestry graduates.

- ✓ To contribute to the advancement of forestry knowledge through teaching, research, publications and dissemination.

- ✓ To strengthen the interface of academia with the government and industry and prepare the next generations of skilled and ethical professionals.

- ✓ Efforts to galvanize the academic fervor and creative instincts of the youth coming from socially and economically backward areas.

Programme outcomes (POs):

PO 1	It will impart basic knowledge and skills of forestry among the students.
PO 2	It will inculcate forestry knowledge and practical skills among the students for diagnosis and analysis of existing problems in the fields of forestry and environment.
PO 3	It will be helpful to produce trained forestry graduates to fill the requirements of different sectors, i.e., private, public, NGOs, and other organizations.
PO 4	Assessment of various forestry problems and develop methods for their solutions.
PO 5	Students will become forestry professionals and use knowledge in research and technology.

Programme Specific Objective (PSO):

CERTIFICATE COURSE IN ELEMENTARY FORESTRY	
YEAR 1	The students will have a basic understanding of forestry and will be able to take up employment in government, private sector or self-employment.
DIPLOMA IN PLANTATION FORESTRY	
YEAR 2	The student will be able to use forestry knowledge in the management of forest and natural resources through their practical skills development.
BACHELOR OF SCIENCE (FORESTRY)	
YEAR 3	Students having knowledge, education and practical skill of forestry will be eligible for competitive examinations and can seek employment in different Sectors, i.e., Government, Private, Public, NGOs and Research Institute/Organization. Students will also eligible for getting higher degree (PG).
BACHELOR (RESEARCH) IN FORESTRY	
YEAR 4	Student having research knowledge in different environmental and social aspect of forestry which will be beneficial for human as well as other. Create and apply appropriate techniques and modern technology in the assessment of various environmental problems and also enrich the various professional practices.

Master in Forestry	
YEAR 5	Students in comprehending the numerous functions of forests, how to regenerate and conserve them, and how to prevent their destruction. Students at an advanced level of knowledge in specific fields of forestry to continue graduate studies or to meet professional in a variety of roles in public and private sectors.
PGDR & Ph. D. in Forestry	
YEAR 6	To develop scholars for undertaking research of the future challenges for the benefit of the society. To develop scholars for teaching, research and services including interdisciplinary activities that contributes to the advancement of the forestry fields. Developed the professional, philosophy, principles for legal and ethical responsibilities of the forestry fields.

Internal Assessment & External Assessment

Internal Assessment	**Marks**: **25**	**External Assessment**	**Marks**:**75**
Attendance of student	05	Written examination conducted by University	75
Assessment of subject papers	05		
Objective/short/long answer type questions of subject papers	15		

YEAR - 1

CERTIFICATE COURSE IN ELEMENTARY FORESTRY

Forestry Course Syllabus

SEMESTER-I

INTRODUCTION TO FORESTRY

MAJOR-1 **Total Credits: 6 (Th04+Pr02)**

Course Objective (CO): The student will impart Fundamental knowledge and skills of forest and forestry and its branches, forest acts and policies, forest and their branches, forest ecosystem, climate and environment, forest types and composition, tree morphology, tree measurement and skill of plant management and protection.

Theory	Topics	Lectures
Unit I	Introduction and definition of forestry; Forest and plantation; Concept of forestry education; Brief history of forestry; Branches of forestry; Legal classification of forests: Reserved forest, protected forest, un-classified forest, village forest and community forest (Van Panchayat); Forest area and forest cover in the state, country and world; Category of forest on the basis of origin: Primary forest and secondary forest; Forest acts and policies; Importance of forests for community, environment, climate change and sustainable development.	**15**
Unit II	Basic principles of silviculture: Introduction, definitions, objects, scope and importance; Regeneration of forests; Afforestation and reforestation; Methods of regeneration; Tree morphology, different forms and growth of trees, stem, root and other parts; Mycorrhiza, lignotubers and root nodules; High forest, coppice forest, closed forest, open forest, normal forest and abnormal forest.	**15**
Unit III	Introduction and definitions of forest mensuration; Principles of tree measurement: Height, diameter, circumference, basal area and volume; Measuring instruments in forestry: Christian's hypsometer, tree calliper, Ravi multimeter, Abney's level, Haga altimeter, meter tape, wedge prism, weighing machine and Pressler's increment borer.	**15**
Unit IV	Basic principles of forest management; Introduction, definition and scope of forest management; Participatory forest management and joint forest management (JFM); Forest products: Important timber and non-timber products; Forest protection; Introduction and definition; Important insect: Pests and diseases; Shifting cultivation; Encroachment; Illegal felling; Grazing and Forest fire.	**15**

Practical

1. Field visit in different forest sites.
2. Identification of tree species and their local and botanical name.
3. Introduction about instruments used in forestry (Christian's Hypsometer, tree calliper, Ravi multimeter, Abney's level, Haga altimeter, meter tape, Gunter chain, wedge prism, weighing machine, Pressler's increment borer, soil pH meter, soil thermometer, Swedish bark gauge, seed germinator, oven, balance etc.).
4. Measurement of tree height, diameter, basal area, circumference.
5. Nursery development, preparation of nursery layout, nursery beds, uses of different container, planting material seeds and vegetative parts, raising of plants of different tree species.

Suggested Readings:

1. *Ecology and Environment by P.D. Sharma*
2. *Principles and Practices of Silviculture by L.S. Khanna*
3. *A text Book of Silviculture by A.P. Dwivedi*
4. *Forest Management by Ram Prakash*
5. *Forest Mensuration, A.N. Chaturvedi*
6. *Theory and Practices of Silviculture by L.S. Khanna*
7. *Forest of Himalaya by J.S. Singh and S.P. Singh*
8. *Plantation Forestry in India by R.K. Luna*
9. *Nursery and Plantation Practices by Vinod Kumar*

SEMESTER-I

NURSERY TECHNOLOGY

VOCATIONAL/ SKILL DEVELOPMENT **Total Credit: 03**

Course Objective (CO): Students will learn about the different techniques of nursery raising of different forest tree species and their management.

Theory	Topics
Unit I	Introduction, importance and objectives of nursery; Classifications, nursery sites, area and seedbed; Methods of sowing, quality of seeds, time of sowing, shading, watering, Damping off and their control measures.
Unit II	Weeding and their controlled measures; Soil working and transplanting; Nursery Material and tools; Plant containers; Potting media; Timing-out and culling.
Unit III	Green manuring; Organic compost/manure; Farm yard manure (FYM); Bio-fertilizers; Mycorrhiza and fertilizer application; Plant propagation: Macro-propagation and micro-propagation techniques.
Unit IV	Greenhouse/mist chamber; Hormones and stimulants for rooting.

SEMESTER-II

FOREST ECOLOGY

MAJOR-1 **Total Credit: 6 (Th04+Pr02)**

Course Objective (CO): Students will learn about the basic structure of forest and their function for future management.

Theory	Topics	Lectures
Unit I	Introduction and definition of ecology; Forest ecology: Definition and its importance in forest ecosystem management; Introduction, structure and components of ecosystem; Types of ecosystem: Forest, grassland, desert and aquatic ecosystem; Tropic structure, ecological pyramids, food chain, food web, and energy flow; Succession: Introduction, definition, causes and mechanism of succession; Types of succession and concept of climax.	**15**
Unit II	Introduction, definition, scope and importance of biodiversity; Threats and conservation of biodiversity; Species composition, species diversity and forest community; Niche; Methods of forest vegetation analysis, biomass, productivity, litter fall, forest floor biomass (standing tree biomass); Biomass and litter decomposition.	**15**
Unit III	Climatic factors: Light, temperature, moisture, wind and their effects; Topographic factors: Altitude, slope, aspects and exposure and their effects; Edaphic factors: Soil, its formation, soil profile, physico-chemical properties of soil and their effects; Soil organic matter; C:N ratio; Mycorrhiza and its types; Soil microorganism; Biotic factors: Mutualism, commensalism, parasitism, predation, competition, amensalism, neutralism, cannibalism, symbiotic association, epiphytes, climbers and weeds and their effects; Major nutrients (C,N,P,K) in forest ecosystem and nutrient cycle.	**15**
Unit IV	Forest composition, distribution and major forest type in India and world; Classification of forests (Champion and Seth, 1968); Growing stock and carbon stock of forests in India (as per forest survey of India); Biogeographical zones of India; Hotspot; Major biomes of the world.	**15**

Practical:

1. To determine the minimum size of quadrates.
2. To determine density of tree species in forest.
3. To determine frequency of tree species in forest.
4. To determine abundance and A/F ratio of tree species in forest.
5. To determine relative density, relative frequency and relative dominance and Important Value Index (IVI) of tree species in forest.
6. To determine basal area of tree species in forest.
7. To draw the population structure of tree species in forest.
8. To determine species diversity in forest by Shannon-Weiner Index.

Suggested Readings:

1. *Ecology, Environmental Science and Conservation by J.S. Singh, S.P. Singh and S.R. Gupta*
2. *Ecology and Environment by P.D. Sharma*
3. *Fundamental of Ecology by E.P. Odum*
4. *Concept of Ecology by E.J. Kormondy*
5. *Ecology by M.P. Arora*
6. *Ecology by S.N. Jha*
7. *Concept of Modern Ecology by P.C. Tewari*

SEMESTER-II

WATERSHED MANAGEMENT

VOCATIONAL/ SKILL DEVELOPMENT **Total Credit: 3**

Course Objective (CO): Students will learn about the watershed, its types their uses and how to manage a watershed in a particular region.

Theory	Topics
Unit I	Introduction, objectives and importance of watershed; Watershed characteristics; Degradation of watershed; Soil and water erosion and their conservation measures.
Unit II	Hazards in watershed: Flood, drought, sedimentation and their management; Monitoring and evaluation of watershed projects.
Unit III	Role of forests in watershed management; Role of community in watershed Management and PRA tools and techniques used for watershed development.
Unit IV	Holistic approach of integrated watershed management; Deforestation and its impacts on watershed; Hydrological cycle; Application of remote sensing and GIS tools in Watershed management.

SEMESTER- I & II

ECOTOURISM IN HIMALAYAN REGION

MINOREL ECTIVE: **Total Credit:5 (Th04+Pr 01)**

Course Objective (CO): Students will learn about the basic aspect of tourism, ecotourism its role in present scenario and employment generation through ecotourism in different forestry areas.

Theory	Topics	Lectures
Unit I	Major ecosystems of the world; Eco-tourism: History of tourism, identify various forms of tourism and evolution of ecotourism; Dimensions of tourism and essential conditions for tourism; Differences between tourism; Components mass tourism versus ecotourism.	**15**
Unit II	Understand dimensions of ecotourism and their criteria to qualify for ecotourism; Ecotourism indicators and conceptual differences between developing and developed countries; Organized tours and free in dependent travelers.	**15**
Unit III	Ecotourism in practices in and important protected area: Corbett National Park, Nanda Devi Biosphere Reserve, Kanha National Park, Kaziranga National Park, Gir National Park, Raja ji National Park.	**15**
Unit IV	Participation of local people in ecotourism; Limitations and problems; World tourism organization; Problems with definition of ecotourism and criticisms; International organizations and NGOs promoting ecotourism; Sociological implications of eco-tourism.	**15**

Practical

1. Make a list of nearby eco-tourism place.
2. Visit the nearby eco-tourism sites.
3. Visit Corbett National Park, Nanda Devi Biosphere Reserve, Kanha National Park, Kaziranga National Park, Gir National Park, Rajaji National Park.
4. Visit nearby wildlife Sanctuaries.
5. Visit nearby birds' sanctuaries.

Suggested Readings:

1. Indian forestry by K. Manikandan

2. Eco-tourism and livelihood by A. K Bhattacharya

3. Tourism, Environment and Man: Sustainable Tourism by Brigadier, B.P.S. Khati

4. Tourism in india Challenges and Opportunities by Ruchi Ramesh and Sudhir Kumar Singh

YEAR – 2

DIPLOMA IN PLANTATION FORESTRY

SEMESTER-III

PLANTATION FORESTRY

MAJOR-1 **Total Credit:5 (Th04+Pr01)**

Course Objective (CO): Students will learn the practical aspects and knowledge about raising, care, development and use of tree species in a specific site and specific objectives.

Theory	Topics	Lectures
Unit I	Introduction and definitions of forest and plantation, objectives, concept, scope and importance; Types of forest plantations: Commercial, industrial, production, protection, social forestry and agroforestry; Introduction, definition, importance of nursery; Types of nursery; Nursery bed preparation; Containers and its types; Seedling development; Planting stock (seedlings with naked roots, and seedling with ball of earth); Planting and pattern of planting; Stump planting; Beating up; Singling; Season of planting (monsoon, pre monsoon, winter and spring).	**15**
Unit II	Plantation organization and structure; Nursery and plantation site development; Nursery and plantation layout; Planting materials; Seeds and vegetative parts and their collections from different provenances/sites/agencies/forest research institutes/centers; Seed source and seed orchards; Storage techniques of seeds.	**15**
Unit III	Preparation of land in plantation sites; Pit digging and its types; Plantation techniques of tree species from seeds, seedlings, ETPs and other vegetative parts i.e. cuttings/stumps/roots; Uses of FYM; Organic manure; Vermi-Compost and inorganic fertilizers; Insecticides and fungicides; Tending operations (weeding, cleaning, thinning, girdling, pruning, bud pruning and climber cutting); Nurse crop, cover crop and mulching; Fencing and types of fencing; Soil and water conservation measures; Bio-fuels and energy plantations.	**15**
Unit IV	Important forest tree species- Indigenous tree species: Sal (*Sborea robusia*), Oak (*Quercus leucotrichophora*), Shesham (*Dalbergia sissoo*), Pine (*Pinus roxburghii*), Teak (*Tectona grandis*), Mulberry (*Morus alba*), Bhimal (*Grewia optiva*), Surai (*Cupressus torulosa*) and Van Peepal (*Populus ciliata*), its distribution, regeneration, silvicultural characteristics, uses and importance; Exotics tree species: Eucalyptus (*Eucalyptus tereticornis*), Poplar (*Populus deltoides*), European nettle tree (*Celtis australis*), and exotic pine species, its	**15**

	distribution, regeneration, silvicultural characteristics, uses and importance; Afforestation techniques of tree species in problematic sites: Saline, alkaline, drought prone, waterlogged, sandy soil, marshy land and mining sites/areas; Success of tree plantations; Reasons of failure of plantations and their remedial techniques.	

Practical

1. Selection of important fast growing, short rotational and multipurpose tree species: Indigenous (Conifers and broad leaved- Chir-pine, Deodar, Cupress and Quercus species) and exotic species (Poplar and Eucalypt).
2. Collection and storage techniques of tree seeds/vegetative parts.
3. Preparation techniques of seedlings for above tree species.
4. Spacing and number of plants in a unit area.
5. Pit digging techniques and mulching methods.
6. Tree species used for energy/fuel wood.
7. Tree species in paper, ply wood and match industries.
8. Selection of trees species planted in different problematic sites.

Suggested Readings:

1. *Plantation Forestry by R.K Luna*
2. *Plantation Trees by R.K. Luna*
3. *Principles and practices of Silviculture by L.S. Khanna*
4. *Propagation Practice of Tree Improvement Indian Trees By Ram Prakash, D.C. Chaudhary and S.S. Negi*
5. *Plantation Forestry In tropics by J. Evans*
6. *Forestry in India by A.P. Dwivedi*
7. *A textbook of Silviculture by A.P. Dwivedi*

SEMESTER-III

MEDICINAL AND AROMATIC PLANTS

VOCATIONAL/ SKILL DEVELOPMENT **(Total Credit: 3)**

Course Outcomes: Students will learn the practical aspects and knowledge about different medicinal and aromatic plants, their distribution, habitat, importance and use specially those growing in the Himalayan region.

Theory	Topics
Unit I	Ecology and biology of plant resources of medicinal value; Medicinal and aromatic, Plant diversity; Plant exploration, introduction and exchange.
Unit II	Conservation of medicinal and aromatic plants, its techniques: In situ, ex- situ and biotechnological; Cultivation and propagation of medicinal and aromatic plants: *Picrorhiza kurroo, Valeriana jatamasi, Viola species, Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum sanctum, Withania somnifera, Stevia rebaudiana, Phyllanthus emblica,* Terminalia species, Bacopa monniera, *Centella asiatica, Berberis species, Asparagus officinalis, Tinospora cordifolia, Parthenocissus quinquefolia.*
Unit III	Distribution, habitat and ecology of important medicinal and aromatic plant; Distinctiveness, uniformity and stability testing; Drug descriptors for medicinal and aromatic plants; Production, storage and marketing of medicinal and aromatic plants.

SEMESTER-IV

PRINCIPLES OF SILVICULTURE

MAJOR-1 **Total Credit: 6 (Th04+Pr02)**

Course Outcomes: In this course student will learn about the regeneration, cultivation and establishment, development of tree species in natural and man-made forest for better stand development.

Theory	Topics	Lectures
Unit I	Introduction, definition, and scope of silviculture; Objects of silviculture; Form and growth of trees; Tree morphology: Stem, root system, form of roots, adaptability, mycorrhiza, lingo tubers and root nodules; Tree growth: Stages of growth, phenology, germination and establishment; Seasonal progress of growth; Height and diameter growth.	**15**
Unit II	Forest Regeneration: Introduction, definition and types of regeneration; Natural regeneration: Definition, methods of natural regeneration (from seeds and vegetative parts); Seed production; Seed dispersal; Seed germination; Seedling establishment; Assisted Natural Regeneration (ANR); Artificial regeneration: Definition and objectives; Essential preliminary considerations (choice of species, site selection, composition of plantation, choice of sowing, planting staff and labour); Mechanization operations (soil preparation, ploughing, harrowing, ridging, pit digging, transport of items, protection from fire and irrigation); Regeneration through vegetative parts.	**15**
Unit III	Classification of silviculture systems; Clear felling system, shelter wood system: Uniform system, group system, irregular shelter wood system, strip system, selection system, group selection system, accessory system, coppice system, coppice selection System and coppice with standard system.	**15**
Unit IV	Silviculture of importance tree species; Silvicultural characteristics; Phenology and regeneration; Growth, management and economic of Conifers: *Abies pindrow, Picea smithiana, Cedrus deodara, Pinus* species and Broadleaf species: *Quercus* species*, Acacia catechu, Acacia nilotica, Dalbergia sissoo, Shorea robusta, Eucalyptus* species*, Populus* species*, Tectona grandis, Casuarina equisetifolia* and Bamboo species.	**15**

Practical

1. Identification of Forest (Local/regional) Tree Species
2. Study of tree morphology for forms growth and root systems.
3. Phenology and silviculture characteristics of selected tree species.
4. Germination of plants from seeds/vegetative parts.
5. Identification of mycorrhizal association of tree species.
6. Silviculture Systems.
7. Tending Operations.

Suggested Readings:

1. *Principle and practice of silviculture by L.S. Khanna*
2. *A textbook of silviculture by A.P. Dwivedi*
3. *Manual of silviculture by W.M. Sunlich*
4. *Silviculture by R.D. Nyland*
5. *The practices of silviculture by D.M. Smith*
6. *Theory and practice of Indian silvicultural systems by L.S. Khanna*
7. *Silviculture of important Indian trees by R.S. Troup*

SEMESTER- IV

NON-TIMBER FOREST PRODUCTS

VOCATIONAL/SKILL DEVELOPMENT **Total Credits: 03**

Course Outcomes: In this course student will learn about the different non-timber forest product, their use and techniques of extraction of such product from forest species.

Theory	Topics
Unit I	Non-timber forest produce, their definitions; General survey; Economic importance; Mode of collection and trade & marketing.
Unit II	Types of minor forest products: Fiber and flosses, grasses, bamboo, canes, essential oils, oil seed, tans & dye, gum, resins, drugs, spices, edible and wild plants.
Unit III	Forest based industries: Pulp and paper industry, turpentine, katha & cutch, sports goods.
Unit IV	Regulation of international timber trade; World Trade Organization; GATT and International Timber Trade Organization (ITTO).

SEMESTER-III & IV

REMOTE SENSING AND GIS

MINOR ELECTIVE **Total Credit: 6 (Th04+Pr02)**

Course Outcomes: In this course student will learn about the different remote sensing techniques used in forest surveying.

Theory	Topics	Lectures
Unit I	Introduction, definition and importance of remote sensing; Basic of remote sensing; Platform and sensor remote sensing (active and passive system); Aerial remote sensing.	**15**
Unit II	Remote sensing satellite, image and ground truth; Systems for data collection and analysis.	**15**
Unit III	GIS: Basic concept, tools and components; GIS application in forestry; GPS and its uses; Advantages of RS and GIS in future prospect.	**15**
Unit IV	Collection, storage, analysis, data and information of forest resources through remote sensing; Software used in remote sensing and GIS.	**15**

Practical

1. Uses of various photo-grammetry instruments.
2. Ground truthing and satellite images.
3. GPS data collection.
4. Hands on practice on remote sensing and GIS software.
5. Visual and digital interpretation of satellite image.
6. Recognition and identification of objects on photography, compilation of map sand their interpretation.

Suggested Readings:

1. *Textbook of Remote Sensing and Geographical Information Systems byM. Reddy*
2. *GIS Fundamentals Applications and Implementations by K. Elangovan*
3. *Fundamentals of Remote Sensing by George Joseph.*
4. *Remote Sensing of the Environment: An Earth Resource Perspective by J. R. Jensen*
5. *Remote Sensing and Image Interpretation by T. Lilles and, R.W. Kiefer and J. Chipman*
6. *Remote Sensing: Principles and Interpretation by F.F. Sabins*
7. *TextBook of Remote Sensing and Geographic Information Systems by K.C. Sahu*

YEAR – 3

BACHELOR IN SCIENCE (FORESTRY)

SEMESTER-V

FOREST MENSURATION

MAJOR-1 **Total Credit:6 (Th04+Pr02)**

Course Outcomes: In this course student will get knowledge about the measurement of different standing and felled forest tree species, their use in different forest-based industries and how to manage of different forest and their category.

Theory	Topics	Lectures
Unit I	Forest mensuration; Definition and objectives; Scales of measurement; Units of measurements; Precision, bias and accuracy.	**15**
Unit II	Diameter and girth measurements; Breast height measurements; Instruments used; Measurement of height; Definitions; Methods of measurement of height ocular; Non instrumental and instrumental methods; Sources of error in height measurements of leaning trees.	**15**
Unit III	Tree stem form; Metzgr's theory; Form factor; Types of form factor; Form height; Form quotient; Form class; Volume measurements of standing trees, fell tree and volume tables.	**15**
Unit IV	Determination of growth of trees; Stump and stem analysis; Increment; Types of increment; CAI and MAI; Increment percent and instrument used; Stem density; Canopy density; Crown; Competition factor; Site quality.	**15**

Practical

1. Determination of length, measurements of diameter, girth and basal area of trees using calipers, tape, ruler, pentaprism, and tree caliper etc.
2. Measurement of height using non instrumental method.
3. Preparation and use of simple height measuring instruments: Christens hypsometer, Smithies hypsometer.
4. Measurement of tree height using instrumental methods: Ravi Altimeter, Abney's level, Haga altimeter, relaskop, clinometer, blumeleiss, hypsometer, laser hypsometer.
5. Volume determination of standing and felled trees.
6. Exercise on stump analysis.
7. Exercise on stem analysis, annual ring counting using ring borer.
8. Preparation of volume tables and local volume table.

Suggested Readings:

1. *Forest Mensuration and Biometry by A.N. Chaturvedi and L.S. Khanna*
2. *Forest mensuration: A Handbook for Practitioners by Forestry Commission Publications*
3. *Forest Mensuration by B. Husch, T.W. Beers and Kershaw*
4. *Forest Mensuration by V.A. Laar and A. Akca*
5. *Indian Forestry by K. Manikandan and S. Prabhu*
6. *Tree and Forest Measurement by P.W. West*
7. *Forest Mensuration by C. Husch, C.I. Miller and T.W. Beers*

SEMESTER-V

PRINCIPLES OF AGROFORESTRY

MAJOR-2 **Total Credit: 6 (Th04+Pr02)**

Course Outcomes: In this course students will learn about different agroforestry practices, systems and their implementation in different areas.

Theory	Topics	Lectures
Unit I	Introduction, definition, objectives, scope and importance of agroforestry and social forestry; History of agroforestry, traditional practices of agroforestry; Choice and characteristics of species for agroforestry; Multipurpose tree (MPTs) in Agroforestry; Potential and constrains of Agroforestry systems.	**15**
Unit II	Agroforestry systems: Forest based agroforestry systems, agriculture-based agroforestry systems and pasture-based agroforestry systems; Shifting cultivation; Taungya system; Alley cropping; Home gardens; Agri-silvicultural system; Agri-silvipastoral system; Agri-horticultural system; Agri-horti- pastoral system; Tree-crop interaction.	**15**
Unit III	Diagnosis and design techniques; Socio-economic and ecological aspect of agroforestry; Economic aspects of agroforestry; Cost, benefit, benefit-cost ratio; Land equivalent ratio (LER); Protein banks; Fodder species; Lopping cycle; Fodder values of trees; Alley cropping/hedge cropping; Ecological aspects of agroforestry; Species diversity of plant components; Soil fertility and productivity aspect; Soil and water conservation aspects in agroforestry.	**15**
Unit IV	Management of trees in agroforestry; Important tree species of agroforestry systems: Eucalyptus, poplar, Gmelina, Bamboo etc; Legume trees species: Subabul, Causaurina, Sesbenia, Grewia, Kachnar, Celtis, Ficus etc and important fruit plants; Farm crops; Cereals: Wheat, maize, rice, millets etc; Pulses: Gram, pea, soyabean, urad, moong, arhar, lentil etc; Medicinal and aromatic plants; Spices; Vegetables and grasses: Barseem (*Trifolium alexandrinum)*, Paragrass (*Bracheria mutica)*, Napier (*Penecitum perpureaum*,), Sorghum (*Sorghum vulgare*) and other farm crops used as grasses.	**15**

Practical

1. Introduction of various Agroforestry systems prevailing in the region.
2. Identification of major tree species used in Agroforestry practises.
3. Characteristics of multipurpose tree species used in agroforestry.
4. Various D&D techniques of agroforestry

Suggested Readings:

1. *Agroforestry by A.P. Dwivedi*
2. *An introduction of Agroforestry by P.K.R. Nair*
3. *Textbook of Agroforestry by D.S. Chundawat and S.K. Gautam*
4. *Agroforestry hand book by S.S. Negi*
5. *Agroforestry: theory and practices by A.J. Raj and S.B. Lal*
6. *Manual by Agroforestry and social forestry by M.L. Sen, R.C. Dadheech and L.K. Deshora*
7. *Perspective of social forestry by B.L. Sharma and R.L. Vishnoi*
8. *Principles and practices of social cum community forests by V.N. Prasad*

SEMESTER-V

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: Qualifying

Course Outcomes: In this course students will learn about forest-based industries or attached in these industries, survey of different forest and livelihood-based topic and also research various topics.

Course Outline:

It is based on the major papers

- Measurement of various height, diameter and volume parameters.
- Study of forest organizations and classification.
- Tree and crop components combination and intercropping.
- Study of agroforestry systems, cost, benefit and benefit: cost ratio.
- Assessment of important tree species used in agroforestry.
- Study of fodder, fuel, small timber, medicinal plants.
- Uses of exotic tree species in different industries.
- Field survey in forest and agriculture systems.
- Collection of important data for research project.

SEMESTER- VI

FOREST PROTECTION

MAJOR-1 **Total Credit: 6 (Th04+Pr02)**

Course Outcomes: In this course student will get aware about different forest tree diseases and different methods to control them for better productivity and management of forest.

Theory	Topics	Lectures
Unit I	Introduction of forest pathology and forest entomology; Introduction of various plants pathogens: Fungi, bacteria, viruses etc; Symptomatology and identification of plant diseases.	**15**
Unit II	Classification of forest tree diseases and their control; Common diseases in forest trees: Root rot, heart rot, wilt, stem canker, stem rust, die-back, galls, leaf spots, leaf blight, powdery mildew and leaf rust; Nursery diseases; Protection against injuries by plants-defoliating, skeletonizers, shoot borers, wood borers, twig and root insects, seed and cone insects, and gall markers; Methods of control against insects and pests: Silvicultural, biological and chemical.	**15**
Unit III	Protection against injuries by insects; Important pests of Sal, Khair, Teak, Pine and Deodar; Prevention and control: Cultural, chemical and biological control.	**15**
Unit IV	Forest fire; Encroachment; Shifting cultivation; Illicit felling; Grazing/ browsing.	**15**

Practical

1. Identification and symptoms of different forest tree diseases.
2. Various pathogenic and non-pathogenic diseases of forest tree species.
3. Forest fire and their types.
4. Various disease of Sal, Shisham,Teak, Chir, Deodar, Eucalyptus and Khair.

Suggested Readings:

1. *Forest protection by L.S. Khanna*
2. *Handbook of forest protection by S.S. Negi*
3. *Forest Entomology by K.C. Joshi*
4. *Forest fire by S.S. Negi*
5. *Forest fire control by R.K Luna*

SEMESTER- VI

FOREST UTILIZATION AND ECONOMICS

MAJOR-2 **Total Credit: 6 (Th04+Pr02)**

Course Outcomes: In this course students will get knowledge about importance of various timbers and non-timber forest product, their uses and the concept of cost and benefits for better use.

Theory	Topics	Lectures
Unit I	Introduction, definition, scope and importance of forest utilization; Logging practices: Felling, extraction, season of felling, method of felling and conversion and tools used in forest logging; Transportation: Major and minor transportation; Storage and depots; Management and disposal of timber.	**15**
Unit II	Physical properties of wood: Weight, density, reaction of heat, sound, light and electricity on wood, thermal; Other wood qualities: Expansion, moisture contain, porosity, colour, and wood working qualities; Mechanical properties of wood: Standard test, special testing on wood store and timber products, non destructive testing of wood, factor influencing strength, hardiness, flexibility, elasticity, fissility and combustibility.	**15**
Unit III	Defects and abnormalities of wood- Natural defects: Knots, shakes, cross grain, reaction wood, defects due to climber; Other defects; Seasoning defects: Warping, checks, splits and shake, case-hardening, reverse case- hardening and honey- combing, collapse; Defects due to conversion and wood working: Boxed-heart, imperfect grains, machine burn, machine notches, machine gauge, miscut timber, mis-matching, skip and wane.	**15**
Unit IV	Seasoning of wood: Principles and methods; Classification and types of seasoning; Composite and improved woods.	**15**

Practical

1. Identification and uses of various (local) NTFP's.
2. Extraction of grass oil, distillation unit.
3. Extraction method of lac cultivation.
4. Extraction method of resin and rosin.
5. To visit the cutch and katha industries.
6. To visit the pulp and paper industries.
7. To visit the different timber depot.
8. To determine the SWOT analysis.
9. To determine the demand and supply curve
10. Law of equilibrium.

Suggested Readings:

1. *Forest Utilization FRI Publication*
2. *A handbook of forest utilization by T. Mehta*
3. *Forest product and their utilization by S.S. Negi*
4. *Forest: the non-wood resources by A.P. Dwivedi*
5. *Forestry for Economic development by M.M. Pant*
6. *Forest Economics: Principle and Application by J.C. Nautiyal*

SEMESTER-VI

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: Qualifying

Course Outcomes: In this course students will learn about forest-based industries or attached in these industries, survey of different forest and livelihood-based topic and also research various topics.

Course Outline:

It is based on the major papers

- Identification and collection of important insect-pests.
- Identification and collection of diseased plants.
- Forest fire control techniques.
- Training for protection of forest from biotic factors.
- Silvicultural, biological and chemical methods of forest protection.
- Survey for identification of forest products (major and minor).
- Tree products assessment used by industries and communities.
- Assessment of demand and supply of forest products.

YEAR – 4

BACHELOR

(RESEARCH)

IN

FORESTRY

SEMESTER- VII

BIOSTATISTICS

MAJOR-1 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: In this course students will learn about basic concept of statistics, biostatistics and its use in forestry.

Theory	Topics	Lectures
Unit I	Biostatistics: An introduction, collection, classification and tabulation of data; Graphical representation of data; Measures of central tendency: Arithmetic mean, mode, median.	**15**
Unit II	Measures of dispersion: Range, mean deviation, standard deviation, quartile deviation and coefficient of variability.	**15**
Unit III	Research hypothesis testing and significance; Correlation; Linear models; Correlation coefficients; Regressions and multiple regressions.	**15**
Unit IV	Probability: Normal, poisson and binomial distribution; t and chi-square test; Skewness and kurtosis; f-test; One-way ANOVA and two ways ANOVA; Sampling design; Experimental design: CRD, RBD, LSD, split plot designing and strip plot.	**15**

Practical

1. To determine the mean by different methods.
2. To determine the median by different methods.
3. To determine the mode by different methods.
4. To determine the standard deviation.
5. To calculate the t-test and chi-square test.
6. To calculate the one-way ANOVA and two ways ANOVA.

Suggested Readings:

1. *Statistical Theory in Research by R.L. Anderson and Bancroft*
2. *Experimental designs by W.G. Cochran and G.M. Cox*
3. *Design and Analysis of Experiments by M.N. Das and N.C. Giri*
4. *Experimental Design by W.T Federer and Macmillan*
5. *Statistical Procedures for Agricultural Research by K.A. Gomez and A.A. Gomez*
6. *The design and analysis of experiments by O. Kempthorne*
7. *Statistical methods by Snedecor, G.W. and Cochran, W.G. (1967) 6th Edition, The Iowa State University Press, Ames.*
8. *Principles and Procedures of Statistics: A Biometrical Approach (MCGRAW HILL SERIES IN PROBABILITY AND STATISTICS) by Steel, R. G. D. ; Torrie, J. H. (1981)*
9. *Statistical Methods for Biologists. Published by Palani Paramount Publications, by Manoharan M. Palanichamy S. (1990)*

SEMESTER- VII

FOREST MANAGEMENT, POLICIES AND LAWS

MAJOR-2 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: In this course students will learn about forest, its types, classification based of classification, their different management strategies, and also different legislation and policies related to forest and wildlife.

Theory	Topics	Lectures
Unit I	Definition, scope, objective and principles of forest management; Classification of forests: Administrative, territorial, silviculture; Sustained yield: Definition, principles and limitations; Sustainable forest management: Criteria and indicators; Increasing and progressive yields; Rotation: Definitions, various types of rotations, length of rotations, choice of type and kind of rotation; Normal forest: Definitions, basic factors of normality.	**15**
Unit II	Distribution of age classes and age gradation in even and uneven aged forest and growing stock; Normal forest: Basic factors of normality, kinds of abnormality in regular and irregular forest; CAI and MAI curves and increment percent; Yield regulation: Definition, principle and method of yield, area method, von mental method for yield regulation.	**15**
Unit III	Constitutional and legislative provisions: Fundamental norms, divisions of legislative authority; Forest policy: Relevance and scope; National Forest Policy-1894, 1952 and 1988; Forest laws; Indian Forest Act-1927; Forest Conservation Act-1980; General provision and silent features; Forest (Conservation) rules and amendments.	**15**
Unit IV	Wildlife Protect Act-1972 and amendments; The Biological Diversity Act-2002; National Green Tribunal Act-2010; Important forest rules and guidelines; Silent features and national biodiversity authority; Forest Right Act-2006.	**15**

Practical

1. Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber.
2. Study forest organizational setup and forest range administration including booking of offences.
3. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume.
4. Field visit to JFM operational areas.
5. Study the different field exercises for data collection for working plan.

Suggested Readings:

1. *Essentials of Forest Management by S. Balakathiresan*
2. *Joint Forest Management in India by P. Bhattacharya, A.K. Kandya and Krishna Kumar*
3. *Forest Management in India-Issues and Problems by V. Desai*
4. *Timber Management: A Quantitative Approach by Jerome. L. Cutteretal*
5. *National Working Plan Code by MoEFCC, New Delhi.*
6. *Forest Management, IBD, Dehradun.*
7. *Forest Management by P.R. Trivedi and K.N. Sudarshan*
8. *Forest Policy and Law by A.N. Chautervedi*
9. *Forest Policy and Laws by S.S. Negi*
10. *Forest Laws and Policies in India by A.K. Poddar*
11. *Compilation of Forest Policy and Laws by C.A. Rahman*
12. *Indian Forest Act 1972 by Vinod Rishi*
13. *Legal forestry by S. Mehra.*

SEMESTER–VII

NURSERY TECHNOLOGY

MAJOR-3 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: In this course students impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use.

Theory	Topics	Lectures
Unit I	Introduction and importance: Type of nursery including the modern quality seed collection (Seed stand, seed production area (SPA), seed orchard), processing, storage, sowing, germination and pre-sowing treatments.	**15**
Unit II	Selection of superior phenotype; Methods of propagation (Cutting, budding, grafting and layering); Hormones used for rooting; Factors affecting rooting of cuttings; Methods of micro-propagation.	**15**
Unit III	Containerized nursery: Type and size of container including root trainers; Potting media; Types of green house and mist chamber; Mist propagation; Shade houses; Nursery irrigation: Drip, sprinkler, spot and flood irrigation.	**15**
Unit IV	Growing medium; Fertilizers (bio & chemical); Manure and compost; Sanitation; Integrated nutrient management; Nursery production and management; Soil and water management; Soil amendments; Pricking; Watering including drip irrigation, weeding and hoeing.	**15**

Practical

1. Layout of forest nursery.
2. Tools used in forest nursery.
3. A visit of forest nursery in their region.
4. To prepare the potting mixture.
5. To prepare the stump cuttings.

Suggested Readings:

1. *Nursery and plantation practices by V. Kumar*
2. *Plant nursery management by P.K. Ray*
3. *Nursery management by J. Mason*
4. *Nursery and landscaping by L.C. Dey*
5. *Principles and practices of silviculture by L.S. Khanna*
6. *Plantation forestry in India by R.K. Lun*

SEMESTER-VII

ENVIRONMENTAL SCIENCE

MAJOR-4 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: In this course students will learn about the different aspect of environmental science, current status of environment, global warming and sustainable development.

Theory	Topics	Lectures
Unit I	Introduction and definition of Environment Science; Factors affecting the environment; Interactions of organisms in ecosystem; Various strategies for sustainable environment; History of environment: Past and present status.	**15**
Unit II	Different types of pollutions and pollutants: Air, water, soil and noise pollution; Causes, source and control measures; Acid rain; Global warming; Ozone layer depletion; Sewage and waste water management; Impact of different pollutions on humans and other organisms; Biological magnification; Toxins and Eutrophication.	**15**
Unit III	Indian and global efforts; Case studies; Analysis on environmental disasters and their remedial measures; International and voluntary agencies for environmental conservation; Mandates and activities; Environmental ethics.	**15**
Unit IV	Causes of environmental degradation: Deforestation and anthropogenic pressure; Explosion of human population, ecological and economic issues; National and International conventions and summits and their major achievements; Environmental policy and legislation in Indian perspective; The Environment (Protection) Act 1986, The Water (Prevention and Control of Pollution) Act 1974, The Air (Prevention and Control of Pollution) Act 1981; Role of forest for sustainable environment.	**15**

Practical

1. To identify the environmental problems in local region.
2. To estimate the water and air quality.
3. Comments on pollution and their control measures.

Suggested Readings:

1. *Ecology and environmental by P.D. Sharma*
2. *Ecology, environmental science and conservation by J.S. Singh, S.P. Singh and S.R. Gupta*
3. *Environmental laws and policies in Indian by S. Devan*
4. *Essential of environmental studies by S.P. Mishra and S.N. Pandey*
5. *Environment Impact Assessment by A.K. Srivastava*
6. *A textbook of environmental studies by D.K. Asthana and M. Asthana.*
7. *Report of the National Forest Commission. Govt. of India, NewDehli*
8. *Global Environmental Crisis by K.L. Barik*
9. *Natural resource conservation and Management by S.C Tewari, P.P. Dabral*
10. *Environmental Impact Assessment by A.K. Srivastava*
11. *Environmental Impact Assessment by P.R. Trivedi*

SEMESTER-VII

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: 4

Course Outcomes: In this course students will learn about forest-based industries or attached in these industries, survey of different forest and livelihood-based topic and also take research on various topics.

Course Outline:

It is based on major papers

- Methods of height and diameter measurements
- Estimation of Volume of logs.
- Identification of Nursery Plants.
- Methods of tree raising in Plantation.
- Study of Pollution and Pollutants.
- Assessment of JFM, CAMPA and FDA programmes.
- Survey in Forest, Nurseries, Plantation site and Industries.

SEMESTER-VIII

FOREST PRODUCTS AND INDUSTRIES

MAJOR-1 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: The course will be equipped the students regarding wood-based industries. How it is affecting the economy of the country such as paper and pulp, match and splint, sports and pencil making, besides this wood extracts resins and gum, katha, tannin and various types of non-timber products. Practical will make them aware regarding extracting method of different products of wood.

Theory	Topics	Lectures
Unit I	Introduction, scope and importance of forest-based industries in relation to Indian economy; Brief description of types of forest-based industries in India.	**15**
Unit II	Pulp and paper industry: Types of paper, raw material, pulping (mechanical, chemical and semi-chemical), beating, bleaching, sizing and sheet formation; Description about rayon and other cellulose derived products.	**15**
Unit III	Composite wood, plywood, laminated wood, core board, sandwich 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; Scarification of wood chemistry and processes; Production of wood molasses, alcohol yeast and other by products from wood hydrolysis and wood substitution.	**15**
Unit IV	Manufacture of katha and cutch; NTFP based industries drugs and essential oils, bidi, resin, turpentine, rosin, oleoresin, gum-resin, lac and shellac, tans, dyes, leaves and fodder of various tree species, honey, wax, silk, soap, fibers, nuts, fruits, flowers, oil yielding plants and grasses, minerals, medicinal and aromatic plants and spices.	**15**

Practical

1. Identification and uses of various (local) NTFP's.
2. Extraction of grass oil, distillation unit.
3. Extraction method of lac cultivation.
4. Extraction method of resin and rosin.
5. To visit the cutch and katha in dustries.
6. To visit the pulp and paper industries.
7. Identification of different types of wood.

Suggested Readings:

1. *Wealth of India by CSIR*
2. *Year book of forest products by FAO*
3. *Forest: the non-wood resources by A.P. Dwivedi*
4. *Forest products and their utilization by S.S. Negi*
5. *A handbook of forest utilization by T. Mehta*
6. *Handbook of paper and pulp technology by W.Britt and Kenneth*
7. *The chemistry of solid wood by R. Rowell*

SEMESTER-VIII

ENERGY PLANTATION AND BIOFUEL

MAJOR-2 **Total Credit: 5 (Th04+Pr01)**

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

Theory	Topics	Lectures
Unit I	Selection of site for planting operations, arrangement of staff, organization of plantation work, method of planting techniques, planting activities and maintenance of plantations; Choice of species adopted; Characteristics of fodder and fuel-wood.	**15**
Unit II	Problems, techniques and suitable species for afforestration in desert, waterlogged area, saline and alkaline soils, degraded hills, mine spoil; Energy and biomass consumption pattern in India; Environment impact of biomass energy.	**15**
Unit III	Assessment of bio-energy programs in India; Power generation from energy plantation; High Density Energy Plantation (HDEP); Land and biomass availability for sustainable bio energy; Petro- crops; Criteria for evaluation of different species for energy plantation.	**15**
Unit IV	Impact of energy efficiency in power sector; Need for research and development on environment friendly and socio-economically relevant technologies; Network of NGOs in renewable energy use; Energy from Plants, it's Problems and prospects; Recent energy technologies in the production of bio-fuels.	**15**

Practical

1. Comment and assignments on the above topics.
2. To study the techniques of plantation.
3. Visit to nearby energy plantation area.

Suggested Readings:

1. *Plantation forestry in India by R.K. Luna*
2. *Nursery and plantation practices by Vinod Kumar*
3. *Plantation and nursery techniques of forest trees by Ram Prakash*
4. *Jatropha carcus for biodiesel, organic farming and health by Shyam Sunder*

SEMESTER-VIII

MEDICINAL AND AROMATIC PLANTS

MAJOR-3 **Total Credit: 5 (Th04+Pr01)**

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

Theory	Topics	Lectures
Unit I	Definition; Role of medicinal and aromatic plants in Indian economy; Important essential oil yielding plants in India; Detailed study on botany, climate, soil of the important plants: Shatavari (*Asparagus racemosus*), Rasaut (*Berberis aristata*), Chirayita (*Swertia chirayita*), Kutki (*Picrorhiza kurroa*), Guggul (*Commiphora wightii*), Geranium (*Pelargonium graveolens*), Sarpagandha (*Rauvolfia serpentina*), Kuth (*Saussurea costus*), Jatamansi (*Nardostachys jatamansi*), Giloy (*Tinospora cordifolia*), Vanyakarkati (*Podophyllum hexandrum*), Ashwagandha (*Withania somnifera*), Lemongrass (*Cymbopogon citratus*), Palmarosa (*Cymbopogon martinii*), Vetiver (*Chrysopogon zizanioides*), Japanese mint (*Mentha canadensis*), Eucalyptus (*Eucalyptus globulus*), Jasmine (*Jasminum officinale*) and Patchouli (*Pogostemon cablin*); Planting cultural and manorial practices; Harvesting, curing and extraction of essential oils.	**15**
Unit II	Medicinal plants in India and Uttarakhand; History, origin, area and distribution; Production, botany and varieties; Cultivation, extraction of active principles and their uses.	**15**
Unit III	Plant genetic resources; General perspectives; Ecology and biology of plant resources of medicinal value; Plant exploration, introduction & exchange.	**15**
Unit IV	Evaluation and breeding techniques of important medicinal and aromatic plants: *Picrorhiza kurrooa, Swertia chirayita, Valeriana jatamasi, Viola* species*, Gloriosa superba, Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum sanctum, Withania somnifera*; Distinctiveness, uniformity and stability testing.	**15**

Practical

1. Identification of different medicinal and aromatic plants.
2. To visit the nearby medicinal and aromatic plant nurseries.
3. To study the different regeneration techniques.
4. Field visit to different regions to gain ethnobotanical knowledge and the inter-relation between plant and people.
5. Survey and identification of plants used by the local people for medicine, food and other social purposes.
6. Collection and preparation of herbarium specimens of the above plants.
7. Harvesting and oil extraction of aromatic plants.

Suggested Readings:

1. *Endangered Medicinal plants by A.B. Chaudhari*
2. *Medicinal plants of Uttarakhand by K.P. Singh, Anuj Kumar and Upendra Kumar (VolumeI)*
3. *Medicinal plants of Uttarakhand by K.P. Singh, Anuj Kumar and Upendra Kumar (VolumeII)*
4. *Medicinal plants of Uttarakhand by K.P. Singh, Anuj Kumar and Upendra Kumar (VolumeIII)*
5. *Cultivation and utilization of medicinal plants by C.K. Atul and B.K. Kapur*
6. *Glossary of Indian medicinal plants by R.N.Chopra, S.L. Nayar and I.C. Chopra*
7. *Applied Ethnobotany: People, Wild Plant Use and Conservation by A.Cunningham*
8. *Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction by EIRI Board*
9. *Ethnobotany. Principles and applications by C.M. Cotton*

SEMESTER-VIII

ECOTOURISM AND EIA

MAJOR-4 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To acquaint about various forms of tourism and evolution of ecotourism and its impact on ecology. To train the students in planning and evaluation projects in the country.

Theory	Topics	Lectures
Unit I	Ecotourism: Study history of tourism; identify various forms of tourism and evolution of ecotourism; Dimensions of tourism and essential conditions for tourism to occur; Differences between tourism components; Mass tourism versus ecotourism; Understand dimensions of ecotourism and the criteria to qualify for ecotourism; Ecotourism indicators and conceptual differences between developing and developed countries.	**15**
Unit II	Organized tours and free independent travelers; Ecotourism in practices in important protected areas: Corbett National Park, Nanda Devi Biosphere Reserve, Kanha National Park, Kaziranga National Park, Gir National Park, Rajaji National Park; Participation of local people in ecotourism limitations and problems; World Tourism Organization; Problems with definition of ecotourism and criticisms; International organizations and NGOs promoting ecotourism; Sociological implications of eco-tourism; Major ecosystems of the world.	**15**
Unit III	Introduction, principle and purpose of EIA and its significance for the society; Environmental components of EIA: Air, water, land, noise and ecological environment; Cost and benefits of EIA.	**15**
Unit IV	EIA involvement during project life cycle; EIA management; Principles and management of EIA; Main stages in EIA processes: Screening, scooping, prediction, mitigation and alternatives auditing; EIA techniques, checklists, matrices, network method.	**15**

Practical

1. Comment and assignment on the above topics.
2. Visit the nearby eco-tourism sites.
3. Comment upon EIA procedures.

Suggested Readings:

1. *Indian forestry by K. Manikandan*
2. *Eco-tourism and livelihood by A.K Bhattacharya*
3. *Tourism, Environment and Man: Sustainable Tourism by Brigadier and B.P. SKhati*
4. *Tourism in India Challenges and Opportunities by Ruchi Ramesh and Sudhir Kumar Singh*

SEMESTER-VIII

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: 4

Course Outcomes: In this course, the assignments related to project report/field training including practical works will be given to the students so that the skill, entrepreneurship and value addition related task could be developed.

Course Outline:

It is based on major papers

- Identification of tree products and uses in industries and other areas.
- Assessment of tree species used in fuel, fodder and other uses.
- Study of medicinal and aromatic plants of the region.
- Role of ecotourism in socio–economic and ecological development.

SEMESTER-VII &VIII

FOREST DENDROLOGY

MINOR ELECTIVE **Total Credit: 5 (Th04+Pr01)**

Course Objective (CO): Students will learn about the basic aspect of dendrology and its application in forestry and its role in present scenario and employment generation through different forestry areas.

Theory	Topics	Lectures
Unit I	Introduction, importance and scope of dendrology; Principles and systems of classification of plants; Bentham and Hooker's and Hutchinson's System; Modern classification.	**15**
Unit II	Plant Nomenclature: Objectives, principles and international code of botanical nomenclature; Role of vegetative morphology in identification of woody plants; Herbarium techniques, collection, processing and preservation of plant material; Arboretum and xylarium.	**15**
Unit III	Important families and their decriptions: Magnoliaceae, Dipterocarpaceae, Malvaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardaceae, Rhizophoraceae, Caesalpiniaceae, Mimosaceae, Combertaceae, Myrtaceae, Lythraceae, Ericaceae, Sapotaceae, Ebenaceae, Oleaceae, Verbenaceae, Lauraceae, Santalaceae, Euphorbiaceae, Ulmaceae, Moraceae, Betulaceae, Fagaceae, Salicaceae, Palmaceae, Pinaceae, Cupressaceae, Taxaceae, Cyperaceae.	**15**
Unit IV	Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.	**15**

Practical

1. Morphological description of plant parts
2. Methods of plant material collection and Techniques of preparing herbarium specimens.
3. Application of different preservatives used in herbarium.
4. Survey and descriptive study of flora of Magnoliaceae, Dipterocarpaceae, Malvaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardaceae, Rhizophoraceae, Fabaceae, Caesalpiniaceae, Mimosaceae, Combertaceae, Myrtaceae, Lythraceae, Ericaceae, Sapotaceae, Ebenaceae, Oleaceae, Verbenaceae, Lauraceae, Santalaceae, Euphorbiaceae, Ulmaceae, Moraceae, Betulaceae, Fagaceae, Salicaceae, Palmaceae, Poaceae, Pinaceae, Cupressaceae, Taxaceae families.

Suggested Readings:

1. Plant taxonomy V. Singh, P.C. Pande and D.K. Jain
2. Plant taxonology O. P. Sharma.

YEAR – 5

MASTER IN FORESTRY

SEMESTER-IX

FOREST ECOLOGY AND BIODIVERSITY CONSERVATION

MAJOR-1 **Total Credit: 5 (Th04+Pr01)**

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

Theory	Topics	Lectures
Unit I	Concept of ecology and forest ecology; Major issues and challenges; Origin of earth; Composition of atmosphere, lithosphere, hydrosphere and biosphere; Classification of world vegetation and vegetation forms of India; Biogeographic regions of world and India; Methods of sampling of communities.	**15**
Unit II	Forest ecosystem and structure; Biotic and abiotic components of ecosystem; Biomass, productivity, litter fall and litter decomposition; Forest nutrient and cycling-input, accumulation (storage) and output (ecosystem loss) and nutrient use efficiency; Disturbance in forest ecosystem, nature of disturbance, fire, wind, flood and invasive species and restoration of degraded ecosystems; Ecological succession; Mechanism and ecosystem change during succession; Succession models and concept of climax.	**15**
Unit III	Concept of biodiversity, importance, use and threats to biodiversity; Causes of biodiversity loss and the IUCN red list; Assessment of biodiversity: Inventory, monitoring, REDD, REDD+; Natural resources: Types, degradation and conservation, in-situ and ex-situ, hotspot areas, protected area network, wildlife sanctuaries, national parks, biosphere reserves, zoo, botanical gardens, arboretum etc. and conservation of sacred groves.	**15**
Unit IV	Role of community in biodiversity conservation; Indigenous knowledge of biodiversity; Biodiversity conservation and community development; Biodiversity and ecosystem services; International efforts for conservation of biodiversity; International union for conservation of nature and natural resources; United Nations Environmental Program; Convention on	**15**

	biodiversity; World heritage convention; Conference on parties; Convention on international trade of endangered species; World wide fund for nature and natural resources.	

Practical

1. Map preparation of world vegetation and mapping of different biogeographic regions of world and India.
2. Vegetational analysis of different plant communities.
3. Experiments on sapling methods used in ecological research.
4. Estimation of biomass and net primary productivity in different forest types.
5. Estimation of litter production and decomposition rate of different forest types.
6. Field inventory for biological diversity and determination of minimum size of sampling unit for trees, shrubs and herbs.
7. Collection, identification and herbarium preparation of plant species.
8. Calculation of different indices of biodiversity, evenness, concentration of dominance, similarity and α, β and γ diversity of a landscape index.
9. Visit to National Parks, wildlife sanctuaries, botanical gardens and arboretum.
10. List of IUCN indexed plants of India.

Suggested Readings:

1. *Basic Ecology by E.P. Odum*
2. *Manual of Plant Ecology by K.C. Misra*
3. *Ecological Methods for Field and Laboratory Investigations by P. Michael*
4. *Tropical Forest Ecology: The Basis for Conservation and Management by F. Montagnini and C.F. Jordan*
5. *The Conservation of Plant Biodiversity by O.H. Frankel, A.H.D Brown and J.J Burdon*
6. *Forest Ecology of India by S.S. Sagwal*

SEMESTER-IX

ADVANCES IN SILVICULTURE

MAJOR-2 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To develop understanding of students about advance in Silviculture and silvicultural practice. Effect of silvicultural practices on forest stand management and stand development. Advances in coppice silviculture.

Theory	Topics	Lectures
Unit I	Definition of forest and forestry; Silviculture: Definition and scope; Silviculture with an ecosystem approach; Silviculture systems; Timber harvesting and silviculture; Champion and Seth's classification of forest types of India and its limitations; Influence of forests on environment; Site factors: Climate, edaphic, physiographic and biotic factors; Interaction of site factors: Leibig's law of minimum, Shelford's law of tolerance, hardness and tolerance.	**15**
Unit II	Advance reproduction methods and their role in silviculture: Judging successful establishment; Concept and objectives of regeneration, advantages and disadvantages of different regeneration methods; Preparation, maintenance and management of site and factors affecting regeneration; Ecology of regeneration: Natural and artificial regeneration; Natural regeneration: Seed production, seed dispersal, germination and establishment, requirement for natural regeneration, advance growth, coppice, root sucker, regeneration survey; Natural regeneration supplemented by artificial regeneration.	**15**
Unit III	Natural regeneration under clear felling, uniform shelter wood, irregular shelter wood, group and selection systems and methods obtaining assisted natural regeneration; Artificial regeneration and its objectives and methods of artificial regeneration, selection of species-kinds of mixture, pattern of mixture, choice between natural and artificial regeneration; Factors governing the choice of regeneration techniques.	**15**
Unit IV	Tree planting; Sowing v/s planting different kinds of pits; Technique for early stand development; Tending and cultural operations; Release operations,	**15**

	singling, cleaning, liberation cutting weeding, cleaning, thinning and improvement, salvage and sanitation cuttings; Analysis of thinning methods and its impact on wood yield and quality; Stand protection and health management; Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India and abroad.	

Practical

1. Study of harvesting operations practiced in nearby forest area.
2. Inventory and assessment of natural regeneration of given species.
3. Mapping and comments on different forest types of India and Uttarakhand.
4. Collection, preservation and identification of plant specimens of different states of India.
5. Observe and analyze regeneration under different silvicultural systems.

Suggested Readings:

1. *Principles of Silviculture by F.S. Baker.*
2. *Handbook of Silviculture by H.G. Champion and G. Trevor.*
3. *Principles of Silviculture by T.W. Daniel, J.A. Helms and F.S. Baker.*
4. *Forest Nursery Manual: Production of bareroot seedlings by M.L. Duryea and T.D. Landis.*
5. *Text book of Silviculture by A.P. Dwivedi.*
6. *Plantation For estryinthe Tropics by J.E. Evans.*
7. *1986. Tropical Silviculture by I.T. Haig, M.A. Huberman and U. Aung Din.*
8. *Principles and Practice of Silviculture by L.S. Khanna.*
9. *Silviculture by J. Kostler.*
10. *The Practice of Silviculture by D.M. Smith.*

SEMESTER-IX

AGROFORESTRY: SYSTEMS AND MANAGEMENT

MAJOR-3 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To impart knowledge on recent development on agroforestry models and its economics.

Theory	Topics	Lectures
Unit I	Agroforestry: Concept, scope, objectives and importance; Social, ecological and economic reasons for agroforestry; Selection of tree species and crop/inter crop in different agro-climatic zones of India; Conservation and management of soil and water; Soil organisms, nitrogen fixing tree species, nutrient cycling and budgeting; Production and productivity in different agroforestry systems.	**15**
Unit II	Agroforestry potentials and constraints, land capability classification and land use pattern; Agroforestry systems: Shifting, taungya, alley cropping, shelter belts, wind breaks, home gardens, agriculture-based systems, forest-based systems, pasture based and horticulture-based systems; Rationale for research proposals: Live fences, boundary plantings, hedgerow intercropping, mixed intercropping, fodder banks, woodlots; Possible experimental designs.	**15**
Unit III	Principles of harvesting; Post-harvest handling; Marketing of agroforestry products; Economic of agroforestry, net present value, internal rate of return, cost benefit analysis; Valuation of inputs and outputs; Recent trends in research, diagnosis and design in agroforestry; Components of Agroforestry; Provisioning and regulator services of agroforestry; Nutrient cycling; Soil improvement; Increased production and productivity; Collection of MPTs; Methodology for the exploration and assessment of multipurpose trees.	**15**
Unit IV	Tree-crop interaction in agroforestry- Definition, types of interaction: compatibility, mutualism, commensalism, allelopathy and competition; Interaction management: Above and below ground interactions; Manipulation of density, space, crown and roots; Agroforestry practices to minimize negative interaction: Coppicing, thinning, pollarding and pruning; Crop planning and management: Selection of suitable crops, management of nutrients, water and weeds; Classification of agroforestry systems; National Agroforestry Policy 2014; National and International organizations in Agroforestry.	**15**

Practical

1. Survey and analysis of land use systems in the adjoining areas.
2. Design and plan of suitable models for improvement.
3. Mineral nutrient analysis of soil and plants.
4. Study of crop –weed association and fertilizer response in different crops. Preparation and application of herbicides.
5. Application of various methods in formulation and appraisal of agro-forestry projects.
6. Nutrient analysis of forages derived from fodder trees/shrubs. Digestibility of some agro-forestry forages.
7. Benefit-cost ratio estimation of agroforestry systems.
8. Case studies on harvesting, post-harvest management and marketing of agroforestry products.
9. Visit to nearby agroforestry practicing area and interaction with the practicing farmers.

Suggested Readings:

1. *Plant Research and Agroforestry by P.A. Huxley.*
2. *Tropical Agroforestry by P. Huxley.*
3. *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advance in Agro forestry by B.M. Kumar and P.K.R. Nair.*
4. *Ecological Methods for Field and Laboratory Investigations by P. Michael.*
5. *New Vistas in Agroforestry by P.K.R. Nair, M.R. Rao and L.E. Buck.*
6. *An Introduction to Agroforestry by P.K.R. Nair.*
7. *Agroforestry Systems in the Tropics P.K.R. Nair.*
8. *Agroforestry as a strategy for carbon sequestration by P.K.R. Nair, B.M. Kumar and D.N. Vimala.*
9. *Agroforestry: Potentials and Opportunities by P.S. Pathak and Newaj Ram.*

SEMESTER-IX

FOREST GENETICS AND TREE IMPROVEMENT

MAJOR-4 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To impart knowledge in the field of biometry as applied to breeding, population, gene flow of forests tree through pollen, seed and gene flow development of hybrids, provinces and making experiment in forest genetics and tree breeding with examples of important trees.

Theory	Topics	Lectures
Unit I	General concept of forest genetics and tree breeding; Importance of forest genetics in tree breeding; Basic principles of genetics: Mendal's Law, gene interaction; Selective breeding methods: Mass, family, within family, family plus within family.	**15**
Unit II	Variations- Geographic variations: Ecotypes, clines, races and land races; Genetic variations: Environment variation, genetic into environmental variation; Breeding methods: Selective breeding methods, mass, family, within family; Plus tree; Selection strategies and choice of breeding methods; Breeding methods for wood quality, agro forestry, diseases and pest resistance, drought and salt resistance; Tree improvement case histories; Hardy-Weinberg law, null hypothesis, Wohlund's principle; Mutation breeding and Economics of tree breeding.	**15**
Unit III	Seed orchards: Types, functions and importance; Estimating genetic parameters and genetic gain; Heterosis breeding: Inbreeding and hybrid vigor; Manifestation and fixation of heterosis; Species and racial hybridization; Indian examples: Teak, sal, shisham, eucalyptus, acacias, pines and poplars; Polyploidy, aneuploidy and haploidy in soft and hard wood species; Induction of polyploidy.	**15**
Unit IV	Assessment of genetic diversity; Gene conservation; Breeding populations; Taxonomy and phylogenetic studies; Pollen collection, storage and extension; Theories of pollen dispersal, mating designs; Marker assisted selection.	**15**

Practical

1. Observation of modes pollination and reproduction in forest trees.
2. Estimation pollen viability and controlled pollination experiment.
3. Field practice in emasculation, crossing and selfing in local plants.
4. Manipulation of flowering through hormonal application.
5. Identification of ecotypes, races and land-races in natural forest.
6. Marking of candidate trees, plus trees and elite trees.
7. Induction of polyploidy through colchicines treatment.
8. Successful case studies of tree breeding.
9. Visit to seed orchard.

Suggested Readings:

1. *Forest Genetics by T.L. White, W.T. Adams and D.B. Neale.*
2. *Text book of Forest Tree Breeding by C. Surendran, R.N. Sehgal and M. Parmathma.*
3. *Introduction to Forest Genetics by Wright.*
4. *Applied Forest Tree Improvement by B. Zobel and J. Talbert.*
5. *Principles of Genetics by E.J. Garner, M.J. Simmons and P.D. Sunstad.*
6. *Cytogenetics by P.K. Gupta.*
7. *Genetics by M.W. Strickberger.*
8. *Principles of Genetic by R. Tamarin.*

SEMESTER-IX

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: 4

Course Outcomes: In this course, the assignments related to project report/field training including practical works will be given to the students so that the skill, entrepreneurship and value addition related task could be developed.

Course Outline:

It is based on major papers

- Vegetation analysis of different forest types.
- Physical and chemical analysis of different forest soil.
- Conservation of wild life strategy.
- Suitable agroforestry system.
- Agroforestry practices in different forest and land sites.
- Benefit-cost ratio estimation of agroforestry systems.
- Field practice in emasculation, crossing and selfing in local plants.
- Experiment of manipulation of flowering through hormonal application.
- Identification of candidate trees, plus trees and elite trees.
- Identification of ecotypes, races and land-races in natural forest.
- Successful case studies of tree breeding.
- Experiments on sapling methods used in ecological research.
- Estimation of biomass and net primary productivity in different forest types.
- Estimation of litter production and decomposition rate of different forest types
- Calculation of different indices of biodiversity, evenness, concentration of dominance, similarity and α, β and γ diversity of a landscape index.

SEMESTER-X

TREE SEED TECHNOLOGY

MAJOR-1 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: The course will equip the students regarding physical characters of seed, germination and treatment in seed, seed dormancy, seed viability test, seed quarantine, seed legislation, angiosperm and gymnosperm seed, and importance of seed for regeneration of forest.

Theory	Topics	Lectures
Unit I	Introduction and history of seed industry in India; Flowering and seed production in gymnosperms and angiosperms; Development and maturation of seed/ fruit; Definition of seed, classes-types of seed and its importance; Role of seed technology in nursery stock production; Production of quality seed; Identification of seed collection areas-seed orchards; Maintenance of genetic purity; Isolation and rouging; Seed source (provenance and stands).	**15**
Unit II	Selection of seed tree (genotypic and phenotypic selection); Plus tree (pure stands, elite seed tree, isolated tree and their location); Seed Collection: Planning and organization, collection methods, factors affecting seed collection and seed maturity; Seed processing: Seed extraction, drying, blending, cleaning, grading, treating, bagging, labeling and storage; Orthodox, intermediate and recalcitrant seeds, precautions of handling of recalcitrant seeds, natural longevity of tree seeds, factors affecting longevity.	**15**
Unit III	Eco-physiological role of seed storage; Classification of seed storage potential; Factors affecting seed longevity; Pre-storage treatment; Physiological change during ageing; Storage of orthodox, recalcitrant and pre-storage intermediate seeds; Fumigation and seed treatment; Seed testing (sampling, mixing and dividing, determination of genuineness, germination, moisture, purity, vigor, viability); Seed dormancy, classification and breaking of seed dormancy; Different viability and vigor tests, seed pelleting, seed health; Classes of tree seeds, certification and procedures of tree seeds certification.	**15**

Unit IV	Role of temperature, humidity and light in seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging and seed extraction; Seed dispersal mechanism; Field and seed standards and seed legislation; Importance of genetically improved seed in plantation forestry; Status of seed production among major plantation species; Short term supply of superior seed.	**15**

Practical

1. Identification of seeds of tree species, Seed maturity tests.
2. Physical purity analysis.
3. Determination of seed moisture.
4. Seed germination test.
5. Hydrogen peroxide test.
6. Tetrazolium test for viability.
7. Seed vigor and its measurements.
8. Study of seed structure, colour size, shape and texture.
9. Harvesting and seed extraction.
10. Methods of seed production.
11. Seed processing machines.
12. Visit to seed production units.

Suggested Readings:

1. *An introduction of seed technology by J.R. Thompson.*
2. *Techniques in seed science and technology by P.K. Agrawal and M. Dadlani.*
3. *Principles of seed technology by P.K. Agrawal.*
4. *Seed Technology by R.L Agrawal.*

SEMESTER-X

FOREST ENTOMOLOGY AND PATHOLOGY

MAJOR-2 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To impart knowledge in the field of Importance insect-pests of seed, categories of pests, physical, cultural, chemical and biological control methods of insects, Insect Ecology and major disease in forest tree species.

Theory	Topics	Lectures
Unit I	Introduction of entomology and plant pathology including classification, identification and symptoms; Importance insect-pests of seed, nursery and plantation; Theories of natural regulation of insect populations; Molecular tools for developing disease resistance trees; Seed pathology and plant quarantine; Insecticides Act 1968, Important provisions; Physical, cultural, chemical and biological control methods of insects.	**15**
Unit II	Categories of pests; Concept of IPM; Practices, scope and limitations of IPM; Classification of insecticides, toxicity of insecticides and formulations of insecticides; Chemical control importance, hazards and limitations; Recent methods of pest control, repellents, anti-feed ants, hormones, attractants, gamma radiation; Use of attractions and repellants, male sterility techniques principles and methods of integrated pests managements; Microbial control of forest insect pests; Genetic improvement of entomopathogens; Recombinant DNA; Genetic control of insects; Genetic improvement of parasitoids and predators.	**15**
Unit III	Insect Ecology: Introduction, environment and its components; Effect of abiotic factors: Temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents; Effect of biotic factors: Food competition, natural and environmental resistance; Abiotic agents of tree diseases and their relationship with hosts.	**15**

Unit IV	Important defoliators, skeletonizers, shoot borers and wood borers of Sal, Shisham, Khair, Teak, Poplar, Eucalyptus, Oak, Pine and Deodar and their management; Important disease of forest nurseries and plantations: Root, heart diseases, physiological disorders and their management; Major diseases of Sal, Sissoo, Khair, Teak, Acacia, Eucalyptus, Poplar, Deodar and Pine; Method of disease control: Cultural, biological and chemical; Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds.	**15**

Practical

1. Collection, preservation and identification of different insects.
2. Collection, preservation and identification of different fruiting bodies of pathogenic and non-pathogenic fungi.
3. Inspection and collection of insect damaged materials.
4. Identification and use of plant protection equipments.
5. Preparation of different concentration of pesticides.
6. Symptoms and identification key of important disease of natural forest and Plantations.
7. Preparation of fungicidal concentration and their application in forest and plantation.
8. Identification of nursery insects and disease and their control measures.
9. Collection and preservation of butterflies and moths.

Suggested Readings:

1. *Plant Pathology by G.N Agrios*
2. *Principles of Insect Pest Management by G.S. Dhaliwal and R. Arora*
3. *Plant Pathology by R.S. Mehrotra and A. Aggarwal*
4. *Plant Diseases by R.S. Singh*
5. *Introduction to Principles of Plant Pathology by R.S. Singh*
6. *Principles of Plant Pathology by E.C. Stakman and J.G. Harrar*
7. *Introduction to general and applied entomology by V.B. Awasthi*
8. *General entomology by M.S. Mani*
9. *Modern Entomology by D.B. Tembhare*

SEMESTER-X

FOREST ECONOMICS AND MARKETING

MAJOR-3 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To consolidate and develop understanding of students in respect of theory and applications of forest economics.

Theory	Topics	Lectures
Unit I	Forest Economics: Meaning and definition; Basic concepts: Goods, wealth, income, capital, cost particular of forest economics; Basics of micro and macro economics; Consumer and consumer behavior; Law of diminishing returns; Law of equimarginal utility; Consumer and utility; Influence of external factors on consumer behavioral; Consumer surplus, meaning, definition and importance.	**15**
Unit II	Demand: Meaning, definition, kinds of demand, demand schedule, demand curve, law of demand, extension and contraction v/s increase and decrease in demand; Elasticity of demand: Types of elasticity of demand, degrees of price elasticity of demand, methods of measuring elasticity, factors influencing demand, elasticity of demand and importance of elasticity of demand; Supply: Meaning and supply function; Law of supply: Factors influencing supply; Elasticity of supply.	**15**
Unit III	Economics of timber and non-timber forest products; Forest planning, forest policy and development; Production theory: Meaning, factors of production-land, labor, capital, organization; Production function: Average and marginal physical products; Production theory apply to forestry; National income: Cost and type of cost.	**15**
Unit IV	Marketing definition; Market dynamics; Market period; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Perfect competition; Monopolistic competition, duopoly, oligopoly, and monopoly; Price discrimination; Monopoly pricing; Forest valuation of ecosystem services; Forestry for economic development; Forestry for employment promotion; Forest industry; Marketing efficiency; Integration; Constraints in marketing of forest produce; SWOT analysis.	**15**

Practical

1. Techno-economic parameters for preparation of projects.
2. Preparation of Bankable projects for various agricultural products and its value-added products.
3. Identification of marketing channel.
4. Calculation of Price Spread.
5. Identification of Market Structure.
6. Visit to different Markets.
7. SWOT analysis.
8. Demand and Supply curve.

Suggested Readings:

1. *Modern Economic Theory by K.K. Dewett.*
2. *Dewett, K. K., Verma.2004 Elementary Economic Theory by K.K. Dewett and K. Verma.*
3. *Macro-Economic Theory by M.L. Jhingan.*
4. *Agricultural Economics by S.S Reddy, P. Raghu Ram, T.V. Neelakanta Sastry and D.I. Bhavani.*

SEMESTER-X

NATURAL RESOURCES AND CLIMATE CHANGE

MAJOR-4 **Total Credit: 5 (Th04+Pr01)**

Course Outcomes: To develop understanding of students about various energy resources, fossil fuels, global climatic changes and their effect on forest aquatic ecosystems, climatology and meteorology.

Theory	Topics	Lectures
Unit I	The energy resources, uses and crises; conventional and non-conventional sources of energy; Global change and sustainable issues; Concept of minimum viable population; Importance of energy; Per capita energy consumption; Energy conservation; Forest resources.	**15**
Unit II	Fossil fuels (coal, petroleum, LPG and natural gas); Types: Solar energy, wind energy, hydro energy, tidal energy, geothermal energy and OTEC; Nuclear energy; Biogas; Indian renewable energy development agency (IREDA); The role of energy manager; Environmental impact of energy; Energy Legislation-Energy Conservation Act, 2001.	**15**
Unit III	Climate change: An overview; climate and weather; Climate change mitigation; Tools to study the climate change; Impact of climate change in the mountain, glacial and coastal region; Global warming and possible effect of global warming; Greenhouse effect; Greenhouse gases; Approaches to deal with global warming.	**15**
Unit IV	Climatology: Tropical Cyclone, Hurricanes and Tsunami; Atmospheric stability and environmental lapse rate; Role of national and international organization in policy, Planning and sustainable development; Meteorology: Seasons, monsoon and monsoon circulation, isobars and wind speeds; Measurements of wind, cloud and humidity; Weather.	**15**

Practical

- To briefly study about the wind energy.
- To briefly study about the ocean energy.
- To briefly study about the geothermal energy
- To briefly study about the hydroelectric energy.
- To briefly study about the nuclear energy.
- To briefly study about the solar energy.
- To study the effect of Rainfall, Temperature, Latitude and Longitude, Aspect and Slope on given forest areas.
- To study the Environmental Lapse Rate.
- To Observe, Analysis and Prediction of local area.
- Measurements of Wind, Cloud and Humidity of local area.
- Study of tools to study climate change.
- To study organization for tracking climate and environment problems.
- Study of different instrument used to examine several environmental conditions.

Suggested Readings:

1. *Textbook of Renewable Energy Woodhead Publishing India in Energy Series by S. C. Bhatia, R. K. Gupta.*
2. *Renewable Energy in India. By Pramod Deo.*
3. *Energy Resources and Systems. by Tushar Ghosh, Mark Prelas.*
4. *Energy Crisis: The Future of Fossil Fuels by Daniel R. Faust 2007.*
5. *The Climate Solution: India's Climate-Change Crisis by Mridula Ramesh.*
6. *India in a Warming World: Integrating Climate Change by Navroz K. Dubash.*
7. *Ecological Climatology: Concepts and Applications by Gordon B. Bonan 2008.*

SEMESTER-X

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: 4

Course Outcomes: In this course, the assignments related to project report/field training including practical works will be given to the students so that the skill, entrepreneurship and value addition related task could be developed.

Course Outline:

It is based on major papers

- Maturity indices of different forest tree species.
- Physical purity analysis forest tree seeds.
- Determination of seed moisture and seed germination test.
- Tetrazolium test for viability.
- Collection, preservation and identification of different insects.
- Inspection and collection of insect damaged materials.
- Symptoms and identification key of important disease of natural forest and Plantations.
- Identification of nursery insects and disease and their control measures.
- Collection, preservation and identification of butterflies and moths.
- SWOT analysis.
- Analysis of timber market.
- Study of wind, ocean, geothermal, hydroelectric, nuclear and solar energy.
- Study the effect of Rainfall, Temperature, Latitude and Longitude, Aspect and Slope on given forest areas.
- Study the Environmental Lapse Rate and Observation, Analysis and Prediction of weather.
- Measurements of Wind, Cloud and Humidity of local area.

YEAR – 6

PGDR IN FORESTRY

SEMESTER-XI

STATISTICAL METHODS AND EXPERIMENTAL DESIGNS

MAJOR-1 **Total Credit: 06**

Course Outcomes: To provide exposure about methods of statistical analysis, designs and sampling techniques used in forestry research.

Theory	Topics	Lectures
Unit I	Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data; Construction of frequency distribution, tables – graphic presentation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles for raw and grouped data.	**15**
Unit II	Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data; Probability: Basic concept, additive and multiplicative laws; Theoretical distributions, binominal, poisson and normal distributions, sampling, basic concepts, sampling v/s complete enumeration parameter and static, sampling methods, simple random sampling and stratified and om sampling; Tests of significance: Basic concepts, tests for quality mean, chi-square tests.	**15**
Unit III	Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of sample linear regression, tests of significance of correlation and regressions-efficient; Introduction to design of experiment; Basic principles of experimental design-replication, randomization and local control.	**15**
Unit IV	Analysis of variance-assumptions-construction of ANOVA table– conclusions based on ANOVA; Comparisons based on means-critical difference, DMRT; Transformations of data square root, logarithmic and angulartrans formations; CRD, RBD, LSD design-Layout, analysis, advantages and limitations.	**15**

Suggested Readings:

1. *Statistical Theory in Research by R.L Anderson and Bancroft.*
2. *Experimental designs by W.G Cochran and G.M. Cox.*
3. *Design and Analysis of Experiments by M.N. Das and N.C Giri.*
4. *Experimental Design by W.T. Federer and Macmillan.*
5. *Statistical Procedures for Agricultural Research by K.A. Gomez and A.A Gomez.*
6. *The design and analysis of experiments by O. Kempthorne.*

SEMESTER-XI

RECENT ADVANCES IN FORESTRY

MAJOR-2 **Total Credit: 06**

Course Outcomes: To provide exposure about recent advances in forestry, forestry and its relation to industries and society, Uses of software and programmes, present day socio-economic needs dependent on forestry research.

Theory	Topics	Lectures
Unit I	Recent advances in forestry- an introduction; Various disciplines of forestry; Forest and impact of climate change; Research methods and sampling techniques for various disciplines of forestry viz. Agro-forestry, plantation forestry, watershed management, seed science & technology, regeneration and natural resource management (NRM); Important instruments used in forestry research.	**15**
Unit II	Forestry and its relation to industries and society; Use of GIS and Remote Sensing and computer application in forestry; Uses of software and programmes in forestry research; Basic statistics used in forestry, measures of central tendency, dispersion, co-relation, regression and analysis of variation and various software used in data analysis; Effect of climatic parameters: Rainfall, high and low temperature, humidity, topography, latitude and longitude, aspect, slope, snow and frost on vegetation; Microscopy, Chromatography, GC, IR, FTIR.	**15**
Unit III	Forestry research in the past; Present day socio-economic needs dependent on forestry research; Environmental demands on forestry research; Impact of other sciences on forestry research; Forest interface with humanities; Impact of global phenomena on forest; Emerging fields of forestry research; Modern technology for sustainable forest management in India; Key challenges in India's forests.	**15**
Unit IV	Ecology, silviculture, biodiversity & climate change; Species richness, evenness, diversity; New dimension in ecological research; Natural resources and their management; Biodiversity uses and conservation; Ecology and climatic change; Impact of climate change on biodiversity; Climate change	**15**

	process and mitigation approaches; Biomass, productivity, carbon sequestration; Tree morphology in brief; Physical characters of seed; Germination and treatment in seed; Seed dormancy; Seed legislation.	

Suggested Readings:

1. *Dwivedi AP. 1993. Forestry in India. Surya Publ.*
2. *Ram Prakash, Chaudhari DC & Negi SS. 1998. Plantation and Nursery Techniques of Forest Trees. International Book Distributors.*
3. *Dwivedi AP. 1992. Agroforestry – Principles and Practices. Oxford & IBH Experimental Design by W.T. Federer and Macmillan.*
4. *Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. Natural Resource Economies – Theory and Application in India. Oxford & IBH.*
5. *Claussen E, Cochran VA & Davis DP. 2001. Climate Change: Science, Strategies and Solutions. Pew Centre on Global Climate Change, USA.*
6. *Anonymous 2006. Report of the National Forest Commission. Govt. of India. Huxley P. 1999. Tropical Agroforestry. Blackwell.*
7. *Sadanandan Nambiar EK & Grown AG. (Eds.). 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. ACIAR, CSIR and CIFOR, Australia.*
8. *Kozlowski TT. 1971. Growth and Development of Trees. Vol. I. Academic Press. Kramer PJ & Kozlowshi TT. 1979. Physiology of Woody Plants. Academic Press. Larcher W. 1980.*
9. *Physiological Plant Ecology. Springer-Verlag. Raghavendra AS. 1991.*
10. *Physiology of Trees. John Wiley & Sons. Zimmerman RH. 1972.*
11. *Juvenility and Flowering in Woody Plants: A Review. Hort. Science 7(5): 447-455.*
12. *Zimmermann MH & Brown CL. 1971. Trees Structure and Function. Springer Verlag.*

SEMESTER-XI

INDUSTRIAL TRAINING/ SURVEY/ RESEARCH PROJECT

Total Credit: Qualifying

Course Outcomes: In this course, the assignments related to dissertation work will be given to the research scholar so that the thesis writing, research design, skill, entrepreneurship and value addition related task could be developed in his/her research.

Course Outline:

It is based on major thrust areas of research in the Department

- Forest ecology and eco-physiology,
- Valuation of ecosystem services,
- Seed science and technology,
- Biodiversity assessment and conservation and climate change,
- Agro-forestry and community forestry,
- Silviculture,
- Nursery management and regeneration of Himalayan species,
- Forest regeneration,
- Biological invasion,
- Biomass, productivity and carbon sequestration,
- Forest soils,
- Phenology,
- Wild-life,
- Medicinal plants,
- N.T.F.Ps and
- Eco-tourism.

YEAR – 6-8

PH. D. IN FORESTRY