

DEPARTMENT OF FORESTRY

M. Sc. Forestry

(Semester System)

CBCS

SYLLABUS

To be applicable from 2020-21

KUMAUN UNIVERSITY

NAINITAL

M. SC. FORESTRY
Choice Based Credit System (CBCS)

I Semester

S. No.	Paper	Marks
1.	I-Forest Ecology	100 (ext.75+ int.25)
2.	II-Forest Mensuration and Biostatistics	100 (ext.75+ int.25)
3.	III-Advances in Silviculture	100 (ext.75+ int.25)
4.	IV-Agroforestry Principles and Systems	100 (ext.75+ int.25)
5.	V-Practical: Project report/field training /practical	100 (ext.75+ int.25)
Total Marks		500

II Semester

S. No.	Paper	Marks
1.	I-Forest Resources and Economics	100 (ext.75+ int.25)
2.	II-Forest Legislation and Policies	100 (ext.75+ int.25)
3.	III-Forest Biodiversity and Conservation	100 (ext.75+ int.25)
4.	IV-Advances in Forest Management	100 (ext.75+ int.25)
5.	V-Project report/field training /practical	100 (ext.75+ int.25)
Total Marks		500

III Semester

S. No.	Paper	Marks
1.	I-Nursery and Plantation Technology	100 (ext.75+ int.25)
2.	II-Management of Insect-Pest and Diseases	100 (ext.75+ int.25)
Elective course: Two elective papers will be opted from the following list of five given papers		
3.	III-IV-Research Methodology	100 (ext.75+ int.25)
4.	III-IV-Computer Application and Information Technology	100 (ext.75+ int.25)
5.	III-IV-Forest Genetics and Tree Improvement	100 (ext.75+ int.25)
6.	III-IV-Biotechnology Approaches in Forestry	100 (ext.75+ int.25)
7.	III-IV-Climate Change and Remote Sensing	100 (ext.75+ int.25)
8.	V-Project report/field training/practical (Compulsory)	100 (ext.75+ int.25)
Total Marks		500

IV Semester

S. No.	Paper	Marks
1.	I-Forest Products and Industries	100 (ext.75+ int.25)
Elective course: Two elective papers will be opted from the following given list.		
2.	II-III-Energy Plantation and Bio-Fuels	100 (ext.75+ int.25)
3.	II-III-Environmental Impact Assessment	100 (ext.75+ int.25)
4.	II-III-Ecotourism: Concept and Approaches	100 (ext.75+ int.25)
5.	II-III-Taxonomy of Woody Plants	100 (ext.75+ int.25)
6.	II-III-Medicinal and Aromatic Plants	100 (ext.75+ int.25)
Open elective course: One open elective paper/ dissertation will be opted from the following list (dissertation is optional it can be opted/given to those students who scored highest marks in all the previous semesters).		
7.	VI-Dissertation	100 (ext.75+ int.25)
8.	VI-Tree Seed Technology	100 (ext.75+ int.25)
9.	VI-Environmental Science	100 (ext.75+ int.25)
10.	V-Project report/field training/practical	100 (ext.75+ int.25)
(Compulsory)		
Total Marks		500

M. Sc. FORESTRY
Choice Based Credit System (CBCS) Syllabus

(w.e.f. 2020-21 onwards)

COURSE OUTLINE

(20 credits in each semester (total credits 80))

Semester	Paper	Title (Core and elective courses)	Total Credits (LTP)
Semester - I	4411	Forest Ecology	04(LTP)
	4412	Forest Mensuration and Biostatistics	04(LTP)
	4413	Advances in Silviculture	04(LTP)
	4414	Agroforestry Principles and Systems	04(LTP)
	4415	Project report/field training /practical	04(LTP)
Total credits			20(LTP)
Semester -II	4421	Forest Resources and Economics	04(LTP)
	4422	Forest Legislation and Policies	04(LTP)
	4423	Forest Biodiversity and Conservation	04(LTP)
	4424	Advances in Forest Management	04(LTP)
	4425	Project report/field training /practical	04(LTP)
Total credits			20(LTP)
Semester -III	4431	Nursery and Plantation Technology	04(LTP)
	4432	Management of Insect-Pest and Diseases	04 (LTP)
	Elective course: Two elective papers will be opted from the following list of five given papers.		
	4433	Research Methodology	04(LTP)
	4434	Computer Application and Information Technology	04(LTP)
	4435	Forest Genetics and Tree Improvement	04(LTP)
	4436	Biotechnology Approaches in Forestry	04(LTP)
	4437	Climate Change and Remote Sensing	04(LTP)
	4438	Project report/field training/practical (Compulsory)	04(LTP)
	Total credits		
4441	Forest Products and Industries	04(LTP)	
Elective course: Two elective papers will be opted from the following given list.			
4442	Energy Plantation and Bio-Fuels	04(LTP)	

Semester- IV	4443	Environmental Impact Assessment	04(LTP)
	4444	Ecotourism: Concept and Approaches	04(LTP)
	4445	Taxonomy of Woody Plants	04(LTP)
	4446	Medicinal and Aromatic Plants	04(LTP)
	4447	Project report/field training /practical (Compulsory)	04(LTP)

Open elective course: One open elective p a p e r / dissertation will be opted from the following list (dissertation is optional it can be opted/given to those students who scored highest marks in all the previous semesters).

4448	Dissertation	04(LTP)
4449	Tree Seed Technology	04(LTP)
4450	Environmental Science	04(LTP)

Total credits	20(LTP)
----------------------	----------------

Total credits for the course (core course=52 credits, elective course=24 credits and open elective course=04 credit) 80 (LTP)

M. SC. FORESTRY

I – SEMESTER

CORE COURSE

PAPER-I: FOREST ECOLOGY

Course No.: 4411

Total Credit: 4(LTP)

Objective: To provide knowledge about concept of forest ecosystem in relation to the forestry and major environment issues, forest management and ecosystem and challenges, origin of earth, composition of atmosphere, lithosphere, hydrosphere and biosphere, Environmental parameters and their impact on biota. Forest ecosystem concept, stand dynamics, forest succession, productivity and vegetation forms and natural regeneration of tree species.

Course Outline: Theory/Lecture

1. Concept of ecology and environmental sciences, major issues and challenges, origin of earth, composition of atmosphere, lithosphere, hydrosphere and biosphere.
 2. Classification of world vegetation, and vegetation forms of India, Biogeographic regions of world and India.
 3. Forest ecosystem – major ecosystems of the world, structure, biotic and abiotic components of ecosystem.
 4. Biomass, productivity, litter fall and litter decomposition.
 5. Forest nutrient and cycling –input, accumulation (storage) and output (ecosystem loss) and nutrient use efficiency.
 6. Disturbance in forest ecosystem: nature of disturbance, fire, wind, flood and invasive species and restoration of degraded ecosystems.
 7. Ecological succession – mechanism and ecosystem change during succession, succession models and concept of climax.
 8. Methods of sampling of community- quadrat, line transect, point frame method and vegetational analysis (qualitative and quantitative characters).
 9. Ecosystem services.
-

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. Visit to nearby forests and study different stages of succession.
5. Estimation of biomass and net primary productivity in different forest types.
6. Estimation of litter production and decomposition rate of different forest types.
7. Study of vegetation of different region of India.
8. Impact assessment of invasive plant species on biodiversity.
9. Ecosystem service estimation.

PAPER-II: FOREST MENSURATION AND BIostatISTICS

Course No.: 4412

Total Credits: 4(LTP)

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

Course Outline: Theory/Lecture

1. Basics of forest mensuration- diameter, height, form of tree.
2. Determination of volume of standing and felled trees, uses and application of volume tables.
3. Determination of age of standing and felled trees.
4. Determination of growth of tree (stem and stump analysis) classification of increment and increment percentage.
5. Forest inventory and sampling design, random, multistage and non-random sampling.
6. Stand structure, density and site quality measures and modern tools, GPS etc. for measurements.
7. Statistical mean, mean deviation, standard deviation and standard error.
8. Simple correlation and linear regression.
9. Elementary idea on probability – normal, binomial and poisson distribution.
10. Test of significance based on normal, t and Chi square test.
11. Experimental design CRD, RBD, LSD, Split plot designing and strip plot.

Practical

1. Measurement of diameter and height at different situations, develop relationship between

diameter and girth for given species.

2. Determination of volume of logs and wood pieces by quarter girth and xylometric formula.
3. Estimation of volume of timber using various volume equation(s).
4. Age determination of standing tree by Pressler's increment borer and felled trees by ring count.
5. To develop CAI and MAI relationship for the given species.
6. Use of GPS in forest inventory.

PAPER-III: ADVANCES IN SILVICULTURE

Course No.: 4413

Total credits 4(LTP)

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

Course Outline: Theory/Lecture

1. Definition of forest and forestry, silviculture systems as a plan for management, timber harvesting and silviculture.
 2. Champion and Seth's classification of Forest Types of India and its limitations, influence of forests on environment.
 3. Site factors – climate, edaphic, physiographic and biotic factors.
 4. Interaction of site factors- Leibig's law of minimum, Shelford's law of tolerance, hardness and tolerance.
 5. Concept and objectives of regeneration, advantages and disadvantages of different regeneration methods, preparation, maintenance and management of site and factors affecting regeneration.
 6. Natural regeneration under clear felling, uniform shelter wood, irregular shelter wood, group and selection systems and methods obtaining assisted natural regeneration.
 7. Artificial regeneration, objectives and methods of artificial regeneration, selection of species-kinds of mixture, pattern of mixture, choice between natural and artificial regeneration.
 8. Tending operation- weeding, cleaning, thinning (objectives and types) and improvement, salvage and sanitation cuttings.
-

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.

PAPER-IV: AGROFORESTRY: PRINCIPLES AND SYSTEMS**Course No.: 4414****Total credits: 4(LTP)**

Objective: To impart knowledge on the concept of agroforestry land use, diagnosis and design methodologies, soil and water management nutrient, cycling of nutrients and to acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems.

Course Outline: Theory/Lecture

1. Agroforestry- concept, scope (overview of global agroforestry), objectives, importance and research needs.
2. Agroforestry potentials and constraints, land capability classification and land use pattern.
3. Agroforestry systems – shifting, taungya, alley cropping, shelter belts, wind breaks, home gardens, agriculture-based systems, forest-based systems, pasture based and horticulture-based systems.
4. Selection of tree species and crop/inter crop in different agro-climatic zones of India.
5. Conservation and management of soil and water; soil organisms, nitrogen fixing tree species, nutrient cycling and budgeting; production and productivity in different agroforestry systems.
6. Tree crop interaction – exotic tree based, indigenous tree based, allelopathy.
7. Principles of harvesting, post-harvest handling, marketing of agroforestry products.
8. Economic of agroforestry, net present value, internal rate of return, cost benefit analysis.
9. Recent trends in research, diagnosis and design in agroforestry.

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.

PAPER-V: PROJECT REPORT/FIELD TRAINING /PRACTICAL

Course No.: 4415

Total credits: 4(LTP)

Objective: In this paper, 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.

II – SEMESTER

CORE COURSE

PAPER-I: FOREST RESOURCES AND ECONOMICS

Course No.: 4421

Credit Hours: 4(LTP)

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

Course Outline Theory/Lecture

1. Application of microeconomics in solving forest resource problems.
 2. Emphasis on forest products, demand and supply, production theory, forest products marketing, forest capital theory, and concept of cost.
 3. Regional and international trade of non-timber forest products (NTFP's), logs and lumber.
 4. Valuation of NTFPs and non-market goods and economics of multiple-use. Ecosystem services and market-based mechanism and capital at global level, forest valuation.
 5. Forest certification, sustainability Analysis and SWOT Analysis.
 6. Application of operations research tools in evaluating forest management alternatives in public and private forest planning and role of forestry sector in economic upliftment of communities.
-

Practical

1. Exercises on estimation of demand and supply functions.
2. Valuation of marketed forestry products.
3. Valuation of biodiversity and non-marketed forestry products.
4. Exercises on financial and economic appraisal of forestry projects.
5. EIA study of a given site.
6. Exercises on marketing of forest products and international trade competitiveness.
7. SWOT analysis of a given project.

PAPER-II: FOREST LEGISLATION AND POLICIES**Course No.: 4422****Total Credits: 4(LTP)**

Objective: To develop understanding of students about laws, forest policies and international conventions.

Course Outline Theory/Lecture

1. Constitutional and legislative provisions – fundamental norms, divisions of legislative authority, environmental legislation and article 253.
2. Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988.
3. General principles of criminal law; Indian Penal Code, criminal procedure code. Indian evidence act applied to forestry matters.
4. Forest laws; Indian Forest Act –1927, Forest Conservation Act1980, general provision and silent features, Forest (Conservation) rules and amendments.
5. 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.
6. Environmental (Protection) Act, 1986, National Environmental Policy, 2006, Forest Right Act, 2006.

Tutorials

1. Comments and assignment of above topics.

PAPER – III: FOREST BIODIVERSITY AND CONSERVATION**Course No.: 4423****Total Credits 4(LTP)**

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

Course Outline Theory/Lecture

1. Concept of biodiversity, magnitude of biodiversity, levels of biodiversity.

2. Importance, use and threats to biodiversity. Causes of biodiversity loss and the IUCN red list.
3. Assessment of biodiversity –inventory, monitoring, REDD, REDD+.
4. 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.
5. Evaluation of forest genetic resources (FGR), handling and storage of FGR conservation, vulnerability of FGR, quarantine laws, and FGR exchange, germplasm bank, Intellectual property rights and biodiversity.
6. Role of community in biodiversity conservation, indigenous knowledge of biodiversity, biodiversity conservation and community development, biodiversity and ecosystem services.
7. International efforts for conservation of biodiversity – International union for conservation of nature and natural resources, united nations environmental program, convention on biodiversity, world heritage convention, conference on parties, convention on international trade of endangered species, world wide fund for nature and natural resources.

Practical

1. Field inventory for biological diversity and determination of minimum size of sampling unit for trees, shrubs and herbs.
2. Collection, identification and herbarium preparation of plant species.
3. Calculation of species richness index in different forests.
4. Calculation of different indices of biodiversity, evenness, concentration of dominance, similarity index.
5. Calculation of α , β and γ diversity of a landscape.
6. Visit to nearby community forest and analyses their role in conservation of biological diversity.
7. Visit to National Parks, wildlife sanctuaries, botanical gardens and arboretum.
8. Comment on various national and international agencies.
9. List of IUCN indexed plants of India.

PAPER – IV: ADVANCES IN FOREST MANAGEMENT**Course No.: 4424****Total Credits 4(LTP)**

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

Course Outline Theory/Lecture

1. Introduction, principles, concept, criteria, scope, objectives, elements and methods of forest management.
2. Forest organization, sustained yield, rotation and normal yield.
3. Types of yield, yield regulation in regular and irregular forests (area, volume, increment, volume and increment basis).
4. Yield table and stand table, yield prediction models, their preparation and applications.
5. Management of community forests- participatory forest management, joint forest management, forest development agencies, Compensatory Afforestation Fund Management and Planning Authority.
6. Forest Working Plan – preparation, working plan code, measurement of growing stock, case study of working plan division.

Tutorials

1. Calculation of growing stock and yield using different formula.
2. Calculation of yield data using yield table.
3. Visit to forest division in which working plan is under progress.
4. Preparation of different growth and yield models.
5. Case study of working plan of a forest division.

PAPER-V: PROJECT REPORT/FIELD TRAINING /PRACTICAL**Course No.: 4415****Total credits: 4(LTP)**

Objective: In this paper, 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.

III – SEMESTER

CORE COURSE

PAPER-I: NURSERY AND PLANTATION TECHNOLOGY

Course No.: 4431

Total Credit 04(LTP)

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

Course Outline: Theory/Lecture

1. Introduction and importance, type of nursery including the modern.
2. Quality seed collection (Seed stand, SPA, seed orchard), processing, storage, sowing, germination, pre-sowing treatments.
3. Vegetative propagated nursery- 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.
4. Containerized nursery- Type and size of container including root trainers, potting media.
5. Types of green house and mist chamber, mist propagation, shade houses.
6. Nursery irrigation- drip, sprinkler, spot and flood irrigation.
7. Growing medium, fertilizers (bio & chemical), manure and compost, sanitation, integrated nutrient management.
8. Nursery production and management- soil and water management – soil amendments, pricking, watering including drip irrigation, weeding and hoeing.
9. Plantation: Definition, concept, objectives and scope of plantation, types of plantation, pit digging techniques, fencing, raising techniques of plantation, biomass and productivity and nutrient cycling of plantations, role of plantation in industries and climate change and success and failure of plantations.

Practical

1. Comment on modern equipments and tools used in nursery.
2. Preparation of nursery beds and growing media for containerized plants.
3. Application of various pre-sowing seed treatments.

4. Testing of seeds mainly for purity, moisture, viability, germination and pathogens.
5. Use of vegetative propagation methods such as budding, grafting and layering.
6. Use of plant bio-regulators for rooting in different spacing.
7. Collection and identification of nursery and plantation insect-pests, diseases and application of their control measures.
8. Inoculation of different bio- fertilizers.
9. Visit to nearby nurseries and forest sites to observe propagation methods that are applied for different tree species.
10. Soil amendments in nursery and plantation sites.

PAPER-II: MANAGEMENT OF INSECT-PEST AND DISEASES

Course No.: 4432

Credit Hours: 04(LTP)

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

Course Outline: Theory/Lecture

1. Introduction of entomology and pathology including classification, identification and symptoms.
2. Importance insect-pests of seed, nursery and plantation.
3. Important defoliators, skeletonizers, shoot borers and wood borers of Sal, Shisham, Khair, Teak, Poplar, Eucalyptus, Oak, Pine and Deodar.
4. Physical, cultural, chemical and biological control methods of insects, use of attractions and repellants, male sterility techniques principles and methods of integrated pests managements.
5. Abiotic agents of tree diseases and their relationship with hosts.
6. Disease of forest nurseries and plantations- root, heart diseases, physiological disorders.
7. Major diseases of Sal, Sissoo, Khair, Teak, Acacia, Eucalyptus, Poplar, Deodar and Pine.
8. Method of disease control- cultural, biological and chemical.
9. Seed pathology and plant quarantine.

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.

Electives course: Two elective papers will be opted from the following.

PAPER – III-IV: RESEARCH METHODOLOGY

Course No.: 4433

Credits Hours: 04(LTP)

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

Course Outline: Theory/Lecture

1. Nature and type of research, selection of research problem considering national forest policy.
2. Formulation of research problem, objectives, source of identifying a problems definition of the problem, hypothesis.
3. Estimation and testing of Hypotheses, concept of point and interval estimation, estimators and estimates, properties of good estimators- unbiasedness and minimum variance.
4. Germination of research questions, planning for literature survey, planning for field work, collection and recording of data and use of statistical tools.
5. Interpretation of data and deriving inferences and conclusion.
6. Writing of project proposal and preparation of research project report, thesis and dissertation.
7. Writing of scientific articles and technical bulletins, monitoring and evolution methods.
8. Sampling and designing: Random, stratified, cluster and systematic sampling. Principles of experimental designs, types of experimental design, CRD, RBD, LSD, row-column (alpha) designs, split plot and strip plot designs.

Practical

1. Fitting of probability distributions.
2. Computation of correlations and regression.
3. Exercise on tests of significance – t, F, Z and X^2 .
4. Layering out of designs in the field (i) Latin Square, (ii) Randomized block design, (iii) Split plot design, (iv) Row- column designs and (V) Scattered block.
5. Data analysis of the above designs.
6. Data entry operation and database design.
7. Exposure to statistical packages SPSS.

Paper- III-IV: COMPUTER APPLICATION AND INFORMATION TECHNOLOGY

Course No.: 4434**Credit Hours: 4(LTP)**

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

Course Outline: Theory/Lecture

1. Introduction to computer- characteristics of computer, basic computer organization (input/output unit, storage unit, ALU, CU, CPU).
2. Number system (binary, octal, hexadecimal number system and conversion).
3. Memory storage- flash drive, memory card (SD/MMC), CD/DVD/blue ray disk/HDD.
4. Operating system basic concepts, database management programme.
5. Computer software- system software, application software, free software and firmware. Application software package- word processing, creating documents, printing, formatting, header and footers, tables and importing graphics. Data analysis package- SPSS and statistica.
6. Basic use of statistical package, spread sheet, graphs and charts, mathematical functions, averages, correlation and regression.
7. Presentation- creating presentation, auto content wizards, templates and importing multimedia in presentation.

8. Introduction to Information Technology- Network and internet, elements of communication system, network topologies, network type, wireless network, internet, e-mail and internet protocol (http, ftp, telnet). Internet browser (web browser), searching, google maps, earth and other application. Scope of IT in forestry.

Practical

1. Working with database design and data entry operation.
2. Word processing: MS Office. Database management programme.
3. Use of electronic spread sheet and graphics.
4. Use of SPSS statistical application packages.
5. Assignments on the above topics.

PAPER- III-IV: FOREST GENETICS AND TREE IMPROVEMENT

Course No.: 4435

Credit Hours: 04(LTP)

Objective: To acquaint the students about general principles of tree breeding with examples of important trees growing in different regions.

Course Outline: Theory/Lecture

1. General concept of forest tree breeding, tree improvement and forest genetics.
2. Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distance, pollinators and their energetic. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms. Variation in trees importance and its causes.
3. Natural variation as a basis for tree improvement. Geographic variations- Ecotypes, clines, races and land races. Seed, seed formation, dispersal, storage, stratification and seed dormancy.
4. Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses. Progeny and clone testing.
5. Seed orchards- type, functions and importance. Estimating genetic parameters and genetic gain.

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization.

6. Indian examples- teak, sal, shisham, eucalyptus, acacias, pines and poplars. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy.
7. Marker assisted selection, Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance. Tree improvement case histories.
8. Hardy-weinberg law, null hypothesis, wohlund's principle, Mutation breeding.
9. Economics of tree breeding.

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.

PAPER- III-IV: BIOTECHNOLOGY APPROACHES IN FORESTRY

Course No.: 4436

Credit Hours: 4(LTP)

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

Course Outline: Theory/Lecture

1. Historical development of biotechnology, scope of biotechnology in forestry, different methods of biotechnology related to forestry.
2. Gene regulation, genetic engineering techniques.
3. In vitro selection and micro propagation in forestry for conservation.

4. Plant tissue culture and response pattern; application of plant tissue culture in tree improvement.
5. Basis of operation in DNA manipulation, molecular markers and its application in forestry.
6. Importance type bio-pesticides and control of pests.
7. Inoculation, advantages and types of bio-fertilizers and mycorrhiza.
8. Genetically modified crops and ethical issues.
9. Bioinformatics- definition, tools in analysis and approaches.
10. Modification of plant species to practically desired products; biodegradation of forestry wastes through genetically engineered microbes.

Practical

1. Micro propagation technique, Preparation of MS media, collection of explants.
2. Acquaintance of different instruments use in biotechnology.
3. Visit to nearby tissue culture laboratories and beverage industry.
4. Isolation of Rhizobium bacteria from root nodules and its culture.
5. Nursery inoculation of different mycorrhizae and bio-fertilizers.

PAPER- III-IV: CLIMATE CHANGE AND REMOTE SENSING

Course 4437

Credits Hours: 04(LTP)

Objective: To develop understanding of students about global climatic changes and to acquaint with the use of imageries, GIS and simulation in forest survey and management.

Course Outline: Theory/Lecture

1. Earth's climate systems- origin and structure of atmosphere.
2. Impact of global warming and climate change- major green house gases, green house effect, ultra- violet radiation, ozone depletion, acid rain and future climate predictions.
3. Tool to study the global climate change.
4. Adaptation to climate change- national and international initiative for mitigating climate change.
5. Basic of remote sensing- platforms, sensors (active and passive systems).
6. Satellite systems and images- uses and limitation, elements of data collection and data analysis.
7. Visual and digital image processing, ground truth, geo-referencing, acquisition and interpretation

of satellite data for forestry purpose.

8. Elements of geographic information system- GIS tools, components, applications.
9. Data and information on forest resources- collection, storage and analysis. Software used in remote sensing and geographical information system. GPS and uses advance of remote sensing and GIS and future prospects.

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 maps and their interpretation.
7. Carbon foot print calculation of a given area.
8. Estimation of carbon sequestration rate of different Himalayan trees.
9. Comments on different tools used in climate change study.

PAPER-V: PROJECT REPORT/FIELD TRAINING /PRACTICAL (Compulsory)

Course No.: 4438

Total credits: 4(LTP)

Objective: In this paper, 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.

IV – SEMESTER

CORE COURSE

PAPER – I: FOREST PRODUCTS AND INDUSTRIES

Course No.: 4441

Credit Hours: 04(LTP)

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

Course Outline: Theory/lecture

1. Introduction, Scope and importance of forest based industries in relation to Indian economy.
2. Brief description of types of forest based industries in India.
3. Pulp and paper industry- types of paper, raw material, pulping (mechanical, chemical and semi-chemical), beating, bleaching, sizing and sheet formation.
4. Description about rayon and other cellulose derived products.
5. Composite wood, plywood, laminated wood, core board, sandwich board, particle board and their manufacturing processes, properties and uses.
6. 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.
7. Manufacture of katha and cutch, Rhododendron flower and its importance and use berberis plant.
8. NTFP based industries drugs and essential oils (medicine), 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.

Practical

1. Comments on various NTFPs.

2. Extraction of essential oil by distillation and solvent extraction process.
3. Field inventory for medicinal plants.
4. Visit to nearby wood based industries e.g. paper mill, kattha mil, packing case, plywood industries and other industries present in the area.

Elective course: Two elective papers will be opted from the following:

PAPER – II-III: ENERGY PLANTATION AND BIO-FUELS

Course No.: 4442

Credit Hours: 04(LTP)

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

Course Outline: Theory/lecture

1. Selection of site for planting operations, arrangement of staff, organization of plantation work, planting activities and maintenance of plantations.
2. Choice of species adopted, characteristics of fodder fuel-wood, optimizing energy fixation.
3. Problems, techniques and suitable species for afforestation in desert, water logged area, saline and alkaline soils, degraded hills, mine spoil.
4. Energy and biomass consumption pattern in India. Environment impact of biomass energy.
5. 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.
6. Petro- crops: Criteria for evaluation of different species for energy plantation.
7. Impact of energy efficiency in power sector, need for research and development on environment friendly and socio-economically relevant technologies.
8. Network of NGOs in renewable energy use. Energy from plants- problems and prospects. Recent energy technologies in the production of bio-fuels.

Practical

1. Identification of important fuel woods and petro-crops.
2. Determination of calorific value, moisture and ash content in biomass.

3. Study on different bio-fuels used in India.
4. Study of energy consumption pattern in rural and urban areas through survey.
5. Visit to nearby energy plantation(s) and energy unit(s).
6. Plantation layout in different patterns.
7. Preparation of energy budget for the given area/village/household.

PAPER – II-III: ENVIRONMENTAL IMPACT ASSESSMENT**Course No.: 4443****Credit Hours: 04(LTP)**

Objective: To train the students in planning and evaluation projects in the country.

Course Outline: Theory/lecture

1. Introduction; principle and purpose of EIA and its significance for the society.
2. Environmental components of EIA- air, water, land, noise and ecological environment.
3. Cost and benefits of EIA; EIA involvement during project life cycle.
4. EIA management; principles and management of EIA, main stages in EIA processes; screening, scoping, prediction, mitigation and alternatives auditing.
5. EIA techniques, checklists, matrices, network method, remote sensing and GIS.
6. Main participants in EIA process, public consultation and participation in EIA process.
7. Environmental appraisal procedure in India.
8. EIS formulation. New approaches to EIA (environmental impact assessment) and SEA (strategic environmental assessment).

Practical

1. Preparation of EIA report of a given project.
2. Preparation of SEA report.

PAPER- II-III: ECOTOURISM – CONCEPT AND APPROACHES**Course No.: 4444****Credit Hours: 04 (LTP)**

Objective: To acquaint about various forms of tourism and evolution of ecotourism and its impact on ecology.

Course Outline: Theory/lecture

1. Major ecosystems of the world.
2. Eco tourism- study history of tourism, identify various forms of tourism and evolution of ecotourism.
3. Dimensions of tourism and essential conditions for tourism to occur.
4. Differences between tourism components Mass tourism versus ecotourism.
5. Understand dimensions of ecotourism and the criteria to qualify for ecotourism.
6. Ecotourism indicators and conceptual differences between developing and developed countries.
7. Organized tours and free Independent Travelers.
8. Ecotourism in practices in important protected areas- Corbett National park, Nanda Devi Biosphere reserve, Kanha National park, Kajaranga National park, Gir National park, Rajaji National park.
9. Participation of local people in ecotourism limitations and problems.
10. World Tourism Organization. Problems with definition of ecotourism and criticisms. International organizations and NGOs promoting ecotourism.
11. Sociological implications of eco-tourism.

Practical

1. Prepare a detailed reference on the various forms of Ecotourism in the world.
2. Visit to various ecotourism areas and identify the tourism components - suggest modifications.
3. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism.
4. Evaluation and monitoring of the various ecotourism activities of the region such as National Walk, The guided day trek, the Tiger Trill, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage. Jungle Inn, The Soared groves, Bamboo Grove, Green Mansions, the backwater cruise.
5. Study the carrying capacity and impact of ecotourism activity on the ecosystem.
6. Climate change and its influence on carbon economy.

PAPER- II-III: TAXONOMY OF WOODY PLANTS**Course No.: 4445****Credit Hours: 04(LTP)**

Objective: To provide knowledge of importance and scope of dendrology, principles and systems of classification of plants and general studies on herbarium, arboretum and xylarium.

Course Outline: Theory/lecture

1. Introduction- importance and scope of dendrology.
2. Principles and systems of classification of plants. Bentham and Hooker's and Hutchinson's System.
3. Plant Nomenclature.
4. Role of vegetative morphology in identification of woody forest flora; herbarium techniques, collection, processing and preservation of plant material, arboreum and xylarium.
5. Study of families, as survey of forest resources: Magnoliaceae, Dipterocarpaceae, Malvaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardaceae, Rhizophoraceae, Fabaceae, Caesalpiniaceae, Mimosaceae, Combretaceae, Myrtaceae, Lythraceae, Ericaceae, Sapotaceae, Ebenaceae, Oleaceae, Verbenaceae, Lauraceae, Santalaceae, Euphorbiaceae, Ulmaceae, Moraceae, Betulaceae, Fagaceae, Salicaceae, Palmaceae, Poaceae, Pinaceae, Cupressaceae, Taxaceae.
6. Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

Practical

1. Morphology 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 woody flora of Magnoliaceae, Dipterocarpaceae, Malvaceae, Tiliaceae, Rutaceae, Meliaceae, Celastraceae, Sapindaceae, Aceraceae, Anacardaceae, Fabaceae, Caesalpiniaceae, Mimosaceae, Rosaceae, Combretaceae, Myrtaceae, Punicaceae, Cornaceae, Ericaceae, Sapotaceae, Symplococaceae, Oleaceae, Verbenaceae, Lauraceae, Santalaceae, Euphorbiaceae, Ulmaceae, Moraceae, Betulaceae, Fagaceae, Salicaceae, Arecaceae, Poaceae, Taxaceae, Pinaceae and Cupressaceae families.

PAPER- II-III: MEDICINAL AND AROMATIC PLANTS

Course No.: 4446**Credit Hours: 04(LTP)**

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

Course Outline: Theory/lecture

1. Plant genetic resources- General perspectives.
2. Ecology and biology of plant resources of medicinal value. Medicinal and aromatic plant diversity in the Indian gene center.
3. Plant exploration, introduction & exchange.
4. Conservation of medicinal and aromatic plants; its techniques- in situ, ex- situ & biotechnological.
5. Evaluation and breeding techniques of important medicinal and aromatic plants – *Picrorhiza kurrooa*, *Swertia chirayita*, *Valeriana jatamasi*, *Viola* spp., *Gloriosa superba*, *Rauwolfia serpentina*, *Plantago ovata*, *Cassia angustifolia*, *Ocimum sanctum*, *Withania somnifera*, Distinctiveness, uniformity and stability testing.
6. Drug descriptors for medicinal and aromatic plants.
7. Cultivation of commercially importance medicinal and aromatic plants *Picrorhiza kurrooa*, *Aconitum heterophyllum*, *Podophyllum hexandrum*, *Swertia chirayita*, *Valeriana jatamanshi*, *Asparagus recemosus*, *Phyllanthus emblica*, *Terminalia chebula*, *Terminalia bellirica* and *Rheum emodi*.

Practical

1. Identification and collection of medicinal plants growing on the locality.
2. Determination of mode of reproduction.
3. Seed germination testing of selected medicinal plants.
4. Rapid mapping exercise for mapping of medicinal plants.
5. Comments and constituents of different ayurvedic medicines.
6. Calculation of species richness and diversity of medicinal plants in different forest types of the state.

Open elective course: One of the following papers (dissertation and/or special paper) will be opted.

PAPER-IV: DISSERTATION

Course No.: 4448

Credit Hours: 04(LTP)

Objective: The objective of dissertation is to impart the field and research knowledge to the student in the following topics, so that student could be able to show his/her expertise in the given area.

- ❖ The dissertation topic will be given by the concern teacher to the student in the field of forest ecology, biodiversity, agroforestry, plantation forestry, ecotourism, seed technology, physiology, forest management (community and government owned forests), NTFP's,

PAPER – IV: TREE SEED TECHNOLOGY

Course No.: 4449

Credit Hours: 04(LTP)

Course Outline: Theory/lecture

1. Introduction – Seed and its importance.
2. Role of seed technology in nursery stock production.
3. Production of quality seed, identification of seed collection areas-seed orchards – maintenance of genetic purity- isolation and rouging, seed source (provenance and stands).
4. 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, Seed maturity and tests.
5. Seed processing - Seed extraction, drying, blending, cleaning, grading, treating, bagging, labeling and storage.
6. Storage - orthodox, intermediate and recalcitrant seeds, precautions of handling of recalcitrant seeds, natural longevity of tree seeds, factors affecting longevity.
7. Seed testing (sampling, mixing and dividing, determination of genuineness, germination, moisture, purity, vigor, viability). Seed dormancy, classification and breaking of seed dormancy.
8. Different viability and vigor tests, seed pelleting, seed health. Classes of tree seeds, certification and procedures of tree seeds certification.

Practical

1. Identification of seeds of tree species, Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigor and its measurements.
2. Identification of seed dormancy and methods of breaking dormancy in tree seeds Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed extraction.

PAPER- IV: ENVIRONMENTAL SCIENCE**Course No.: 4450****Credit Hours: 04(LTP)**

Course Outline: Theory/lecture

1. Environment Science scope and application.
2. Environment interactions with organisms, Methodological approaches in Environment Science.
3. Global and Indian environment – past and present status. Environmental pollution and pollutants. Air, water, food, soil, noise pollution – sources, causes, control measures and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazardous waste management.
4. Impact of different pollutions on humans and other organisms and on environmental quality. Biological magnification, of toxins in the environment. Deforestation – forms and causes relation to environment.
5. Prevention and control of pollution - technological and sociological measures and solutions – Indian and global efforts. Case studies, analysis on Environmental disasters and their remedial measures.
6. International and voluntary agencies for environmental conservation – mandates and activities. Environmental ethics.
7. Causes of environmental degradation - socio-economic factors. Human population growth and lifestyle. EMP, Environmental audit, ecological and economic issues in solving environmental problems.
8. International conventions and summits - major achievements. Environmental policy and legislation in India. Need for environmental impact assessment, various projects. Modern tools for better management of environment.

Practical

1. Visit to local areas - river/forest/Horticulture farm/ grassland/catchment etc.
2. To document components of ecosystem. Study of common plants, insects, birds and animals.
3. Visit to industries to study pollution abatement techniques.

PRACTICAL: V-PROJECT REPORT/FIELD TRAINING (compulsory)

Course No.: 4447

- ❖ In this paper, 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.
