**Ph. D. FORESTRY**

*Course Structure – at a Glance*

### A. CORE COURSES (MAJOR)

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

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

1. **Silviculture**

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

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<tr>
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<tr>
<td>FGR 621</td>
<td>ADVANCES IN TREE BREEDING</td>
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<tr>
<td>FGR 622</td>
<td>ADVANCES IN QUANTITATIVE FOREST GENETICS</td>
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<tr>
<td>FGR 623</td>
<td>FOREST REPRODUCTIVE BIOLOGY</td>
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<tr>
<td>FGR 624</td>
<td>MOLECULAR GENETICS OF FOREST TREES</td>
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<tr>
<td>FGR 625</td>
<td>GENETICS OF FOREST ECOSYSTEMS</td>
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3. **Wood Science & Technology**

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<tr>
<td>WST 621</td>
<td>ADVANCES IN WOOD TECHNOLOGY</td>
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<tr>
<td>WST 622</td>
<td>ENERGY AND CHEMICALS FROM WOOD</td>
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<tr>
<td>WST 623</td>
<td>INSTRUMENTATION IN WOOD SCIENCES</td>
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<tr>
<td>WST 624</td>
<td>ADVANCES IN WOOD MODIFICATION</td>
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4. **Agroforestry**

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


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<td>APPLICATION OF TRADITIONAL KNOWLEDGE</td>
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<tr>
<td>MAP 622</td>
<td>PRODUCTION OF QUALITY PLANTING MATERIAL</td>
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<tr>
<td>MAP 623</td>
<td>TECHNOLOGY AND PROCESSING OF MEDICINAL AND AROMATIC PLANTS</td>
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<tr>
<td>MAP 624</td>
<td>BIOSYNTHETIC ANALYSIS OF SECONDARY METABOLITES</td>
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<tr>
<td>MAP 625</td>
<td>VALUE ADDITION AND MARKETING OF MEDICINAL AND AROMATICS PLANTS</td>
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<tr>
<td>FB 621</td>
<td>ADVANCES IN FOREST BIOTECHNOLOGY</td>
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<tr>
<td>FB 622</td>
<td>MOLECULAR GENETICS AND GENE MAPPING IN FOREST TREES</td>
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<tr>
<td>FB 624</td>
<td>TREE PHYSIOLOGY AND FOREST PRODUCTIVITY</td>
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<tr>
<td>FB 625</td>
<td>GENETIC ENGINEERING AND BIOINFORMATICS</td>
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<td>NRC 624</td>
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<tr>
<td>NRC 625</td>
<td>PROJECT PLANNING AND EVALUATION</td>
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### Specialization Areas

<table>
<thead>
<tr>
<th>Specialization Areas</th>
<th>Possible Discipline of Specialization in M. Sc. Forestry as Feeder</th>
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</thead>
<tbody>
<tr>
<td>1. Silviculture</td>
<td>Plantation Technology, Agroforestry, Environment Management</td>
</tr>
<tr>
<td>2. Forest Genetic Resources</td>
<td>Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry, Environment Management.</td>
</tr>
<tr>
<td>3. Wood Science &amp; Technology</td>
<td>Wood Science &amp; Technology</td>
</tr>
<tr>
<td>5. Medicinal and Aromatic Plants</td>
<td>Medicinal and Aromatic Plants, Agroforestry</td>
</tr>
<tr>
<td>6. Forest Biotechnology</td>
<td>Forest Genetic Resources, Medicinal Plants, Biotechnology, Agroforestry</td>
</tr>
<tr>
<td>7. Natural Resource Economics</td>
<td>Environment Management, Forest Business Management, Eco Tourism, Agroforestry</td>
</tr>
</tbody>
</table>
Ph.D. FORESTRY
Course Contents

A. CORE COURSES

FOR 601 QUANTITATIVE SILVICULTURE 2+1

Objective
To assess growth functions, dynamics of even aged and uneven aged forest. Thinning and growth, self thinning rule or 3/2 power law of self thinning.

Theory
UNIT I
Growth functions-empirical, exponential, allometry and Backman’s growth function. Growth pattern and growth increment curve. Growth cycle and phases.

UNIT II
Correlation between size and plant population. Probability of individual tree mortality. Models of mortality and yield for unthinned forest stands.

UNIT III
Dynamics of even aged and uneven aged forests. Competition for space, light and nutrients in forest stands and their effect on population. Effect of thinning and growth. Plant geometry and self thinning. Stand structure and allometry of trees during self thinning of pure stand. Interpretation of self thinning rule. Detailed concept 3/2 power law of self thinning and its revaluation and modifications.

Practical
Growth characteristics and effect of temperature, nutrients and water stress on growth behaviour of nursery plants. Preparation of growth and increment curves.

Suggested Readings

FOR 602 ADVANCES IN TREE IMPROVEMENT 2+1

Objective
To develop understanding of students in application of mendelian, principles to forest trees and integration of physiological and molecular techniques for tree improvement programmes.

Theory
UNIT I
Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchicloid and mutation breeding for forest trees.
UNIT II
Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees.

UNIT III
Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Inheritance of monoterpenic composition in conifers.

UNIT IV
Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT V
Geographic variation in trees, evolution and gene flow. Exploration and conservation of gene resources of trees. Dioecism and moneicism in trees. Practical
Cytology of pine root tips, karyotypic analysis, mutagenic treatments with colchicine and MH, tissue culture of organs, and transformation experiments, resin tapping and observation of trees for monoecium and dioecium.

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

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

Objective
To acquaint the students regarding updated and advance technology of timber mechanics, wood derivatives, import and export potential of non timber forest produce and latest computer application in forest produces.

Theory
UNIT I
Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing.
UNIT II
Principles of industrial wood processes, Products derived from wood by chemical processes and value added wood products, Properties of construction, Wood polymers and surface chemistry, Fundamentals of adhesion and fracture in adhesively bonded wood, Adhesive systems used for wood with emphasis in wood based composites.

UNIT III
Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT IV
Computer application system in forest products, Use of information technologies to integrate material, quality and market fluctuations.

Suggested Readings
Anonymous. 1981. Wealth of India. CSIR.
Anonymous. 2007. Year Book of Forest Products. FAO.
Krishnamurthy T. Minor Forest Products of India. Oxford & IBH.

FOR 604 ADVANCES IN ECONOMIC ANALYSIS IN FORESTRY 2+0

Objective
To acquaint the students about the latest analytical methods as applied in production forestry and the environment analysis.

Theory
UNIT I
Use of theoretical frameworks of consumer behaviour, market equilibrium, efficiency of perfect and imperfect competition, game theory, and social welfare functions in decision about optimal utilization of forest resources; Issues and dynamics of domestic and international demand & supply of forestry products;

UNIT II

UNIT III
Environmental pollution as a case of common property management. Policy initiatives for improving the management of common property resources and environmental conservation.

Suggested Readings
FOR 605 AGROFORESTRY SYSTEMS AND MANAGEMENT 1+1

Objective
To impart knowledge on recent development on agroforestry models and its economics.

Theory
UNIT I
Rationale for research proposals: live fences, boundary plantings, hedgerow intercropping, mixed intercropping, fodder banks, woodlots; Possible experimental designs

UNIT II
The use of economics in diagnosis and design of Agroforestry systems; Costs and benefits in Agroforestry; Valuation of inputs and outputs; Environmental outputs

UNIT III
Discounting rates for private and public economic analysis; Discounted measures of economic worth; Non-numerical economic analysis; Methodology for the exploration and assessment of multipurpose trees

UNIT IV
General considerations; Collection of MPTs; Assessment and choice of experimental sites; Assessment of methodologies; Changes in plant species; Tree/crop interface approach; Systematic designs; Bivariate analysis for intercropping experiments; Modelling in Agroforestry; Elements.

Practical
Developing formats for diagnosis and design investigations; Discussion on published cases of discounting in Agroforestry; Valuation of input and output; Case study on B C ratios for community forestry; Scoring for multiple use of different species; Listing a hundred species of tropical origin; Market trends in tree based products; Study of impact of agroforestry/social forestry on wildlife; Birds and small animals; General of ergonomic data from Agroforestry practitioners in farmlands; Farmers responses to Agroforestry/community forestry; Studies on light and shade effects of trees on understorey plants. A review; The role of voluntary agencies/industries in promoting afforestation programmes; The impact of training to farmers, agricultural officers and others in promoting Agroforestry; Experience of Birsa Agricultural University. Constraints in
adoption of Agroforestry; Farmers view point; Visit to agave & biofuel plantations and report on its management practices; Industry; Farmer nexus; Wasteland development; Fuel wood plantations, Biomass productivity assessment; Develop models for rehabilitation of saline and alkaline areas.

**Suggested Readings**


Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

**FOR 606 FORESTRY INTERVENTIONS FOR 1+1 ENVIRONMENT AMELIORATION**

**Objective**
To develop understanding of students about environmental sustainability and forestry interventions for environment amelioration

**Theory**

**UNIT I**
Environmental amelioration – concept and challenges. Integration of environmental conservation strategies and economic development.

**UNIT II**
Forestry interventions viz. Plantation forestry, industrial forestry, urban forestry, fuelwood/energy forestry including biofuels, short rotation forestry, Agroforestry, biodiversity parks, Sanctuaries and national parks and catchment plantations.

**UNIT III**
Impact of soil erosion, soil moisture regimes, fertility improvements, poverty alleviation, micro-environment native biodiversity and overall environmental sustainability.

**UNIT IV**
Environmental concerns, monitoring methods, health & safety, environmental training, environmental organization.

**Practical**
Study structure and functions of forestry interventions. Analysis of the micro-environmental attributes viz. temperature, humidity, solar radiations, soil erosion, in-situ measurement of sediment load in native water bodies, native fauna and flora, measurement of particulate air pollutants and other gases.

**Suggested Readings**


**B. SUPPORTING COURSES**

**FOR 611 OPERATIONAL RESEARCH IN FOREST MANAGEMENT 1+1**

**Objective**

To develop knowledge about operation research in forest management through inventory models and simulation technique also.

**Theory**

UNIT I

Case studies in relation of even and uneven aged stands. Project planning.

UNIT II

Operational research methods for Forest Management.

UNIT III

Application of programming-linear and dynamic, network analysis, PERT and CPM, inventory models and simulation technique.

**Practical**

Application of above techniques through a case analysis using forest inventories.

**Suggested Readings**


FOR 612 LAND USE PLANNING AND WATERSHED MANAGEMENT

Objective
To develop understanding of students about land use planning and watershed management

Theory
UNIT I
Land use Planning: Concepts and techniques; Agro-ecological regions/sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.

UNIT II
Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

UNIT III
Watershed management concept - objectives, characterization, planning, execution, community participation and evaluation.

UNIT IV
Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions.

UNIT V
Watershed management cases studies.

Suggested Readings

FOR 613 FOREST ECOLOGICAL MODELING

Objective:
To develop understanding of students in the concepts of modeling techniques in ecology and analysis of different models for population structure.

Theory
UNIT I
Systems and Models - Descriptive and explanatory models - Dynamic systems and models - Deterministic and Stochastic models - Usefulness of ecological research using models.

UNIT II
UNIT III
Optimization of resources under constraints - Linear and non-linear programming - Formulation and their applications in ecological modeling. Simulation - Elements and basic concepts - Deterministic simulation - state variables, rate variables and drying variables - Feedback models and their solutions - analytic integration and system behaviour in time-dynamic simulation using numerical integration.

Practical

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

FOR 614 ADVANCES IN FOREST BIOMETRICS 1+1

Objective
To acquire advance knowledge on estimation of growth of the forest and also study prediction models.

Theory
UNIT I
Measurement of tree parameters. Estimation of volume, growth and yield of forest and plantations
UNIT II
UNIT III
Different growth and yield prediction models – logistic model, etc. and application

Practical
Calculations of volume of felled as well as standing trees, Vol, Application of sampling procedures, Handling of GPS, calculation of data for prediction of growth models.

Suggested Readings
FOR 615 CLIMATE CHANGE AND FORESTRY 2+0

Objective
To acquaint the students about processes causing climate change and ecological and economic impacts and also strategies to combat climate change.

Theory
UNIT I
Introduction to changes in the earth's climate. Definition of climate change – Scientific evidence, process and consequences for society and ecosystems – Interpretation of past climatic conditions from proxy records – Patterns of climate variability – Trends recorded instrumentally – Synopsis of observations
UNIT II
Processes that cause climate change. An overview of mechanisms – Atmosphere – Climate change and thermohaline circulation – Global warming as a possible trigger for climate change – Limited predictability close to an instability – Changes in natural modes of the atmosphere-ocean system – Possible future changes in the hydrological cycle – Ice sheet changes
UNIT III
Economic and Ecological impacts of climate change. Recent scientific studies in the ecological and social sciences – sectoral approaches – Modeling the impacts of climate change – Impacts on the Indian agricultural sector – Sea-level rise and its effect on coastal resources – Potential impact on Indian water resources
UNIT IV
Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India
UNIT V
Global and regional strategies to combat climate change. Action around the world – European Union: A review of five national programme – US climate policy: Factors and constraints – Climate change mitigation in Japan – Climate change mitigation programs in India – Electric power futures in five developing countries.

Suggested Readings

FOR 616 INFORMATION TECHNOLOGY IN FORESTRY  1+1

Objective
To explore students to use information technology in forest research, management of information systems and database in forestry.

Theory
UNIT I
Information and communication technology and the forest sector: History; ecommerce in forestry sector. Remote Sensing and Image Interpretation: Basic concepts, elements of photographic system, principles of photogrammetry, introduction to visual image interpretation.

UNIT II

UNIT III

Practical
Applications of GPS: Data retrieval and Database development.

Suggested Readings

C. SPECIALIZATIONS

1. Silviculture
SILVI 621 ADVANCES IN SILVICULTURE  1+1

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

Theory
UNIT I
Philosophy of silviculture – Advance reproduction methods and their role in silviculture – Judging successful establishment; Analysis of active and passive site preparation – Silviculture with an ecosystem approach
UNIT II
Advance silvicultural practices in rain forest; Tropical forest; Subtropical forest, Temperate forest; Mechanization and role in Silviculture

UNIT III
Analysis of different techniques of silviculture in forest stand management, Technique for early stand development; Analysis of thinning methods and its impact on wood yield and quality; Stand protection and health management

UNIT IV
Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India and abroad; Advances in coppice Silviculture

UNIT V
Adjusting silviculture to meet industrial demands – Silviculture in perspective – Problem solving procedure for silviculture – Silviculture in retrospect.

Practical
Study of components of silvicultural system for sustained yield; Management strategies for even aged and uneven aged stands; Regeneration methods for specific sites; Choice of site preparation methods, Plantation map, Quality planting stock, Planning for tree planting, Release cutting operation, Selection of thinning methods, Intensity of thinning, Analysis of site quality and biomass production for timber, pulp wood and fuel wood species, Problems in silviculture in tropical, subtropical plantation and their solutions.

Suggested Readings

SILVI 622 PLANTATION FOREST PRODUCTIVITY 1+1

Objective
To develop understanding of students about plantation forest productivity. Dynamics of plantation growth, thinning and fertilization of plantation.
Theory

UNIT I
Plantation forests - Scope and perspective, International and national scenario

UNIT II
Dynamics of plantation growth – Site quality, Stand density, Dynamics of nutrient cycling, Thinning, Spacing and crown efficiency, Fertilization, Nutrient pools and dynamics, Biological factors in nutrient supply, Fertilization of plantation.

UNIT III
Irrigation – Tending operation and plantation productivity.

Practical

Plantation productivity analysis – Nutrient cycling, Stand density estimation, Fertilizers and fertilizer application in plantation, Stability analysis of forest ecosystem, Response of plantation to irrigation, Productivity of clonal forestry, modern tools in site preparation, Weed management methods, Management strategies for enhancing plantation productivity, Methods of estimating plantation.

Suggested Readings

SILVI 623 FOREST REGENERATION 1+1

Objective
To develop understanding of students about the concepts, underlying principles and soil nutrient relationships in forest regeneration. Regeneration in relation to silvicultural systems. Problems of regeneration in important conifers and broadleaved species.

Theory

UNIT I
Principles and methodologies of Forest regeneration, Ecological basis of natural regeneration techniques, Tree regeneration and its evolutionary trend; Ecological status of woody plants, Choice of species for various sites, Regeneration sampling pattern and intensity.

UNIT II
Factors affecting natural and artificial regeneration - Kinds, extent and quality of sites, Relationship of soil characteristics like nutrient, moisture, structure and physiography with tree growth and site productivity; Site manipulation by physical chemical and biological methods.

UNIT III
Regeneration in relation to silvicultural systems, Problems of regeneration in respect of important conifers (Fir, Spruce, Deodar, Chir) and broad leaved species (Sandal, Sal, Teak, Terminalias, Alnus etc.).
Practical
Monitoring of forest regeneration, Choosing a regeneration method, Preparation of regeneration plans, Factors promoting natural regeneration, Sampling method and accessing success or failure of regeneration, Preparation of regeneration map, Case study of natural regeneration in India; Modern approaches in container seedling production, INM and irrigation in quality seedling production, Studies on the regeneration techniques of timber and pulpwood species, Cost benefit analysis of regeneration methods.

Suggested Readings
Boyd RJ. 1991. The Biology of Planting. USDA.

SILVI 624 ECOLOGY OF FOREST FARMING 2+0
Objective
To develop understanding of students about designs, concepts and potential of species and their forest farming.

Theory
UNIT I
Introduction, objectives and background of forest farming

UNIT II

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

Suggested Readings

SILVI 625 ADVANCES IN FOREST SOIL MANAGEMENT 2+1
Objective:
To acquire knowledge on advances in forest soil management. Hydrology of forest plantation; Stand development and productivity. Fruit management & long term soil productivity.

Theory
UNIT I
Tropical soils and their management for plantation forestry: Soils of the tropics, Soil requirements for plantation forestry, physical properties of major soils of tropics, soil erosion and erodibility, Erosion control
UNIT II

UNIT III
Hydrology of forest plantations : Forest hydrological cycle; Hydrology of forest plantations - Plantation management and hydrology; The role of hydrological modelling in plantation management.

UNIT IV
Organic matter: Decomposition and mineralization; Litter accumulation, litter decomposition, effect of litter on soil, Interpretation of accumulation, decay and mineralisation processes, management of litter and soil organic matter in tropical plantations. Soil and stand management for short rotation plantations; Water availability, Nutrient supply, uptake and tree growth, constraints on production, nutrient amendments and correction of nutrient deficiency.

UNIT V
Stand development and productivity: Definition and measurement of productivity, patterns of stand growth, Nutritional factors controlling stand growth. Reforestation of salt affected and Acid soils, reforestation of salt affected soils, acid soils, coastal soils. Effects of fire on soils: Types of fires, effects of fire on soil properties, effects of fire on air and water quality.

UNIT VI

Practical
Nutrient budgeting for different plantation systems, Quantification of physical and chemical soil constraints in plantation and Agroforestry systems, Evolving new strategies for development.

Suggested Readings

SILVI 626 LAND USE PLANNING AND WATERSHED MANAGEMENT

Objective
To develop understanding of students about land use planning and watershed management. Developing sustainable Agroforestry system techniques in watershed.
Theory

UNIT I
Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.

UNIT II
Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

UNIT III
Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.

UNIT IV
Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions.

UNIT V: Watershed management cases studies.

Suggested Readings

SILVI 627 FOREST SEED MANAGEMENT 1+1
Objective
To develop understanding of students in the concepts of seed maturity, dormancy, stratification, seed storage and forest seed management.

Theory

UNIT I
Concepts, classification, seed fortification, use of adjuvants, diluents, stickers, encapsulation materials, dyes, chemicals, pesticides, fungicides, animal repellents, biological materials, antibiotic and growth regulators, biofertilizers, minerals salts, bioactive substances.

UNIT II
Seed infusion and involvement in synergistic factors dormancy and stratification, Physical treatment with abrasives, hot and cold temperature, radio - frequency waves, UV rays, X-rays and gamma rays.

UNIT III
Methods of application and their effects on germination, seed hardening, osmotic priming in relation to stress management.

UNIT IV
Seed pelleting, use of bio-fertilizers, mineral salts, growth regulators, hydrophilic substances, seed-coat polymers in stress management, sequences in seed inoculation.

UNIT V
Planting value determination and storage potential evaluation, aerial seeding and its implication, use of IDS for separation of viable seed from non viable seeds mid-storage correction treatment
Practical

Influence of seed fortification with different treatments on germination and vigour of seeds. Studies on seed infusion effects on germination - Vigour and planting value; Use of physical treatment of seeds on seed germination and vigour - Seed hardening treatments and their influence on the planting value of seeds, Studies on osmotic priming on stress tolerance of seedlings - Seed pelleting studies in tree seeds. Evaluation of pelleted seeds for survival percentage both in laboratory and field. - Determination of storage potential of pelleted seeds. - Use of organic solvents for seed infusion and their influence on the seed quality - Standardisation of IDS method to separate viable seeds from non-viable seeds in tree species - Evaluation of effectiveness of separation by IDS method by germination test, cutting test radiographic analysis. - Studies on the evaluation of mid-storage correction treatments on the viability and vigour of seeds in storage by accelerated aging test.

Suggested Readings


2. Forest Genetic Resources

FGR 621 ADVANCES IN FOREST GENETICS AND TREE BREEDING 1+1

Objective

To develop understanding of students about methodologies involved in the study of gene flow of forests tree through pollen, seed and gene flow development of hybrids.

Theory

UNIT I

Assessment of genetic diversity, gene conservation, breeding populations, taxonomy and phylogenetic studies, pollen collection storage, extension, theories of pollen dispersal, mating designs.

UNIT II

Gene structure and expression, gene regulation, bioregulators, protein synthesis and polygenic inheritance, genetics of heterosis, overcoming incompatibility, hybrid embryo rescue and studies in hybrid development in forest trees.

Practical

Emasculation and pollination studies in conifers and broadleaved tree species (dioecious, monoecious and bisexual). Pollen vector analysis and traplining distances.

Suggested Readings


**FGR 622 ADVANCES IN QUANTITATIVE FOREST GENETICS 2+1**

**Objective**

To develop understanding of students about principles of biometry as applied to forest genetics to determine, genotypes phenotypic and gene flow values along with discriminate function.

**Theory**

**UNIT I**

Quantitative genetics in forestry, sampling, planning and layout, design analysis, variance allocations (components, genotypic and environmental concepts), heritability, correlations.

**UNIT II**

Incomplete block design, trend-free block design and generalized lattice designs and their analysis.

**UNIT III**

Discriminate function, D2 analysis, correlation and path co-efficient analysis Software’s in forest genetic analysis and their interpretations.

**UNIT IV**

Models of gene action (one locus, multiple locus), theories of selection, inbreeding, migration, mutation and population drift.

**Practical**


**Suggested Readings**


FGR 623

**ADVANCES IN FOREST REPRODUCTIVE BIOLOGY 2+1**

**Objective**
To develop understanding of students about phenology, phenodynamics breeding behaviour pollination biology and breeding systems in forest trees.

**Theory**

**UNIT I**

**UNIT II**
Pollination, biology, pollination ecology of tropical and temperate forest tree species, plant-pollination interactions. Pollinator energetic and nectar production

**UNIT III**
Genetic consequences of variation in reproductive biology. Pollen biotechnology for improved production.

**UNIT IV**

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

**Suggested Readings**


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

**FGR 624 MOLECULAR GENETICS OF FOREST TREES 2+1**

**Objective**
To develop understanding of students about molecular markers, gene mapping, genotypic influences, protein and DNA markers.

**Theory**
UNIT I
Molecular markers, quantification of genetic diversity, characterization of cellular molecules and their variants, assessment of morphological and quantitative traits.

UNIT II
Genotype verification and delineation, influences of environmental factors on developmental stages.

UNIT III
Isozymes, RFLPs, RAPDs, microsatellites, and genetic finger-printing in forest trees, marker assisted selection, binary vectors, selectable and screenable markers, and transgenics, gene maps of selected forest trees.

**Practical**
Isolation of DNA, RNA from forest tree species, isozyme analysis, use of molecular markers and RAPD and RFLPs for clonal identification.

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

**FGR 625 GENETICS OF FOREST ECOSYSTEMS 2+0**

**Objective**
To make the students understand the mechanisms responsible for farm and structure in trees and how physiological and genetic concepts mingle to develop an ecosystem.

**Theory**
UNIT I
Introduction - tree forms in relation to environmental factors - mechanism responsible for differences in tree forms - stand structure and micro-climate.

UNIT II
Carbon fixation by tree canopies - leaf area, interception of solar adiation and tree growth - Leaf area index and dry matter production - Radiation
attenuation through canopies - strategies for maximising solar energy utilisation - stomatal conductance.

UNIT III
Carbon consumption and export - carbon balance in trees - canopy photosynthesis - Transport and partitioning - Factors influencing net photosynthesis in trees - Relationship between the CO2 compensation point and carbon fixation efficiency in trees - Physiology of formation of early and late woods-Resource sharing in mixed Agroforestry system.

UNIT IV

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

UNIT VI

Suggested Readings

3. Wood Science & Technology

WST 621 ADVANCES IN WOOD TECHNOLOGY 2+1

Objective
To develop understanding of students about advances in wood technology

Theory
UNIT I
Ultrastructure and composition of softwoods and hardwoods
UNIT II
Transverse, volumetric and longitudinal shrinkages in wood
UNIT III
Biopulping, enzyme pulp bleaching, biotechnological production of wood composites, bioremediation of wood treated with preservatives, bioactive wood polymer composites, non-conventional wood bonding, wood degradation by chemicals, treatment of pulp effluents.

Practical
Suggested Readings

WST 622  
**ENERGY AND CHEMICALS FROM WOOD**  
**2+1**

**Objective**
To develop understanding of students about energy and chemicals from wood

**Theory**
**UNIT I**
Energy and its measurements. Wood as sources of energy and its comparisons with other sources. Criteria for evaluation of different fuel wood species for energy.

**UNIT II**

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

**Practical**

**Suggested readings**

WST 623  
**RESEARCH METHODS**  
**1+2**

**Objective**
To develop understanding of students about advances in research methods

**Theory**
**UNIT I**
Principles and utilization of research instruments-microtomes, gas liquid chromatography, HPLC, amino acid analyzer.
UNIT II
CHN analyzer, atomic absorption spectrophotometer, IR, UV, NMR and mass spectrophotometer.

UNIT III
Chemical analysis of pulp. Physical strength properties of paper, breaking length, stretch, tear index and burst index.

Practical

Suggested readings
Wadoo MS. 1992. *Utilization of Forest Resources.* IDRIS Publ..

WST 624 ADVANCES IN WOOD MODIFICATION 2+1
Objective
To develop understanding of students about advances in wood modification

Theory
UNIT I

UNIT II

UNIT III
Enviornmental issues related to wood modification.

Practical

Suggested readings
4. Agroforestry

AF 621  ADVANCES IN AGROFORESTRY RESEARCH AND MANAGEMENT  2+0

Objective
To teach how to refine the Agroforestry systems’ management practices and their integration for developing suitable Agroforestry systems.

Theory
UNIT I
Recent trends in Agroforestry research and development. Agroforestry land use systems and their salient features.

UNIT II
Study of systems specification, prioritizing potential interventions and technology specifications; space and time related considerations.

UNIT III
Introduction to on farm and on station research experiments. Factors affecting biomass production.

UNIT IV
Soil-site sustainability and environmental resource sharing. Site-Species compatibility. Competition predation, mutualism, commensalisms. Simulation modeling of Agroforestry systems.

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

AF 622  PRODUCTIVITY OF AGROFORESTRY SYSTEMS 2+1

Objective
To acquaint the students with concepts in tree-crop systems productivity, managing the factors of production and sustained yield levels.

Theory
UNIT I
Concept of crop productivity. Productivity potential in relation to light, water and nutrients.

UNIT II
System complementarity, supplementarity, competetiveness, sustainability and management techniques. Tree root architecture, reallocation of resources within the plant system.

UNIT III

UNIT IV
Allelopathic effects. Strategies to improve the efficiency and productivity of different land use systems.
Practical
Techniques for leaf area index, photosynthetically active radiation, soil moisture and leaf water potential and canopy density measurements.

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

AF 623 LAND USE PLANNING AND WATERSHED MANAGEMENT 2+0

Objective
To impart knowledge to the students on developing skills in the development of watershed plans leading to sustainable management of watershed resources.

Theory
UNIT I
Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing technique.
UNIT II
Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.
UNIT III
Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.
UNIT IV
Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/shrubs and grasses for watershed for different agroclimatic regions.
UNIT V
Watershed management cases studies.

Suggested Readings

AF 624 ADVANCED AGROFORESTRY MANAGEMENT 2+1

ANALYSES

Objective
To expose the students towards advanced tools of management with regard to Agroforestry systems.
Theory

UNIT I
Advances in Agroforestry management with emphasis on production, marketing and financial management.

UNIT II
Farm and other landuse principles and systems under perfect and imperfect knowledge situations. Simulation of Agroforestry situations. Evaluating relative profitability of different Agroforestry systems vis-à-vis other competitive agro-based systems.

UNIT III
Role of various financing agencies in Agroforestry and critical evaluation of different credit systems with emphasis on Agroforestry.

UNIT IV

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

Suggested Readings
Ong CK & Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
UNIT IV
Organic matter: Decomposition and mineralisation: Litter accumulation - litter decomposition, effect of litter on soil; Interpretation of accumulation - decay and mineralisation processes; management of litter and soil organic matter in Agroforestry systems; Soil and tree management for energy plantations and SRF plantations: Water availability; Nutrient supply, uptake and tree growth, constraints on production, nutrient amendments and correction of nutrient deficiency.

UNIT V
Management and long term soil productivity; soil compaction and erosion; Harvest removal and nutrient Budgeting; Harvest effect on water quality, strategies for future management

Practical
Nutrient budgeting for different plantation systems - Quantification of physical and chemical soil constraints in social and Agroforestry systems - Evolving new strategies for development

Suggested Readings

5. Medicinal and Aromatic Plants

MAP 621 APPLICATION OF TRADITIONAL KNOWLEDGE 2+0

Objective
To develop understanding of students about application of traditional knowledge

Theory
UNIT I
Traditional remedies for treating specific diseases like cardiovascular disease, mental disorders, rheumatic arthritis, diabetes, cough & asthma, fatigue, liver diseases, kidney and bladder stones, wounds stomach disorders etc. Traditional therapies vis-à-vis modern therapies.

UNIT II
Scientific validation of traditional therapies – case studies. Identity of important herbs used in traditional medicines. Integration of herbal remedies with allopathic system of medicine. Allopathic drugs based on traditional herbs.

UNIT III
National and international research and other institutions involved in scientific validation of traditional knowledge eg. CDRI, CIMAP, PRL’s, WHO etc., their role and major achievements.

UNIT IV
Composition of major herbal formulations eg. Chavanprash, Vasavaleha, Arjunarishta, Pachakchurna etc. Major herbal pharmaceutical companies and their products like Dabur, Zandhu, Baidyanath, Himalayan Drug Company, Charak Pharmaceuticals etc. Role of local health traditions in primary health care.
Suggested Readings


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

**Objective**
To develop understanding of students about production of quality planting material

**Theory**

UNIT I
Concept of quality in the context of medicinal and aromatic plants. Quality parameters of different medicinal and aromatic plants.

UNIT II
Role of genotype and environment in affecting quality. Selection and development of hybrids in medicinal and aromatic plants.

UNIT III
Breeders seed, foundation seed and certified seed. Marker assisted breeding. Authentication of nursery produce for quality parameters. Different approaches including biotechnological tools for production of quality planting material.

**Practical**
Production of inbreed seed of commercially important species. Selection of superior genotypes on the basis of agronomical characters from an existing population of medicinal and aromatic plants followed by their quality evaluation. Evaluation of germplasm for yield attributes.

**Suggested readings**

MAP 623 POST HARVEST AND PROCESSING OF MAP 2+1

Objective
To develop understanding of students about nutritional and post harvest aspects

Theory
UNIT I
Identification of harvesting period based on active content. Harvesting method of underground parts, leaves, stem, bark, fruits, flowers etc.

UNIT II
Processing of harvested crops of medicinal and aromatic plants. Storage and value addition. Deterioration degradation of active principles during storage and their control.

UNIT III
Isolation of major proactive contents from medicinal plants, preparation of active content enriched extracts.

UNIT IV
Latest methods of extraction of essential oil.

Practical
Harvesting, drying, garbling, grading and packaging of medicinal and aromatic plants. Assessment of deterioration of active principles during storage and their control. Preparation of active content enriched extracts of important medicinal plants.

Suggested readings
Alikhan I & Khanum A. 2008. Role of Biotechnology in Medicinal and Aromatic Plants. UKAZ Publ.
Gupta AK & Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.

MAP 624 BIOSYNTHETIC OF SECONDARY METABOLITES 3+0

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

Theory
UNIT I

UNIT II
Biosynthetic pathways of terpenoids (mono, sesqui, di, tri and tetraterpenoids) and sterooids.
UNIT III
Biosynthesis of alkaloids of phenylethylamine. Pyrrolidine piperidine, pyrrolidine – pyridine, tropane, quinoline, isoquinoline and phenanthrene groups.

UNIT IV
Biosynthesis of flavonoids, lignans (podophyllotoxin) and Vitamins E & K.

Suggested Readings
Alikhan I & Khanum A. 2008. Role of Biotechnology in Medicinal and Aromatic Plants. UKAZ Publ.
Gupta AK & Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.

MAP 625 PROCESSING AND Valise addition IN MAP 2+1
Objective
This course will educate students, methods of harvesting of yieldable plant/plant parts of herb shrub, trees, climber, lianas and ephipytes besides this to increase the value of product post harvest technology will be known to them, practical classes will make them awair about instruments/equipment used to extract essential oil and also operation of machine for tablets and mixture preparation.

Theory:
UNIT I
Value addition for higher economic returns. Concepts and procedures. Preparation of powders, aqueous and alcoholic extracts, essences etc. Preparation of tablets, mixtures, balms, ointments, etc. Bulk storage and packaging.

UNIT II
Basic and advanced concepts of trade and marketing, marketing under disorganized and organized sector. Village and regional markets, state, national and international market of herbs and herbal products. Internet marketing practices for latest market value and other pattern of fluctuations for high value medicinal and aromatic plants/plant parts and products.

Practical
Visit to nearby pharmaceutical concern for understanding value addition processes. Visit to local market and data collection of sale and sale procedure – organized and unorganized. Internet surfing for latest market value of high value of medicinal and aromatic plants.

Suggested Readings
Alikhan I & Khanum A. 2008. Role of Biotechnology in Medicinal and Aromatic Plants. UKAZ Publ.
UNIT III

7. Natural Resource Economics & Policy

NRE 621 ADVANCED ECONOMETRICS 2+1

**Objective**
To develop understanding and expose the students to advanced econometric techniques as applied in Natural Resource Management.

**Theory**

**UNIT I**
Ordinary least square method. Maximum likelihood estimation. Use of Linear and non-linear models in forestry/ agroforestry decision making.

**UNIT II**
Multiple regression analysis. Problems of multicollinearity, heteroscedasticity and autocorrelation – their tests and methods for their removal/mitigation.

**UNIT III**
Use of binary and dummy variables. Chow test, Theil test, Principal component, logit, probit analyses. Distributed lag models.

**UNIT IV**

**Practical**
Exercises on the use of OLS, maximum likelihood methods, homoscedasticity, heteroscedasticity, multicollinearity, autocorrelation etc.
Exercises on logit, probit and distributed lag models and forecasting models etc.
Suggested Readings


NRE 622  NATURAL RESOURCE ECONOMICS  2+0

Objective
To develop understanding of students about inter-relationship between natural resources and economics.

Theory

UNIT I
The theory of optimal use of non-renewable and renewable natural resources. Resource scarcity and environmental degradation. Natural resource accounting; measurement of sustainable income and issues relating to green accounting;

UNIT II
Economic efficiency in the context of inter-temporal resource use; Property rights and efficiency; Sources of inefficiency; optimum and actual resource use under different market situations; Economic theory of common property resources –forests, fishery, wildlife, etc.

UNIT III
Methods and decisions about un-priced values of forestry goods and services; Estimating recreation demand; Consideration of risk and uncertainty in natural resource planning and management. Welfare theory and pricing of natural resources.

Suggested Readings


**NRE 623 ENVIRONMENTAL ECONOMICS 2+1**

**Objective**

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

**Theory**

**UNIT I**


**UNIT II**

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

**UNIT III**

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

**Practical**

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

**Suggested Readings:**


NRE 624 FOREST ECONOMICS 1+1

Objective
To consolidate and develop understanding of students in respect of theory and applications of forest economics

Theory

UNIT I

UNIT II
Optimal rotation period. Externalities and property rights and forest resource conservation incentives. The linear and non-linear forests and supply of wood. The behaviour of self employed forest farmer.

UNIT III
The forest product market under perfect and imperfect conditions. Welfare theory and optimal pricing of natural resources.

UNIT IV
Forest valuation – introduction, interest on capital, models used in forest valuation. Cost benefit rules of forest resources.

Practical
Exercises on estimation of demand and supply functions; optimal rotation period and financial analysis. Exercises on biodiversity valuation, valuation of non marketed forest products.

Suggested readings
Objective
To develop understanding of students about the formulation of the forestry projects and its financial aspects.

Theory
UNIT I

UNIT II

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

Practical

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

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<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
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<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES</td>
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**Course Contents**

**PGS 501 LIBRARY AND INFORMATION SERVICES 0+1**

**Objective**
To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

**Practical**
Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

**PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1**

**Objective**
To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

**Practical**
*Technical Writing* - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction,
review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech; Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE 1+0

Objective
The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material
transfer agreements, Research collaboration Agreement,  License Agreement.

Suggested Readings


**PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1**

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings


PGS 505  AGRICULTURAL RESEARCH, RESEARCH ETHICS 1+0  
(e-Course)  AND RURAL DEVELOPMENT PROGRAMMES

Objective
To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory
UNIT I
History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.
UNIT II
Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
UNIT III
Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

PGS 506  DISASTER MANAGEMENT  1+0
(e-Course)

Objectives
To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory
UNIT I
Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches,
Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II
Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III
Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings
COMPULSORY NON-CREDIT DEFICIENCY COURSES
FOR B. Sc. Agri./ Hort. STREAM

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FOR 451  PRINCIPLE AND PRACTICES OF SILVICULTURE 3+1

Objective

To acquaint the students about general principles and practices of silviculture in India with examples of important trees.

Theory

UNIT I
Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

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

UNIT IV

UNIT V

UNIT VI
Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering.
and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

**Suggested Readings**


**FOR 452 FOREST MENSURATION 2+1**

**Objective**

To acquaint the students about measurements of growth, wood production, biomass production and forest inventory.

**Theory**

**UNIT I**

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression.

**UNIT II**

Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Finish Parabolic Calliper, Relaskop, Pentaprism.

**UNIT III**


**UNIT IV**


**UNIT V**

Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables.
UNIT IV
Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

Practical

Suggested Readings

FOR 453 PRINCIPLES OF TREE IMPROVEMENT 2+1

Objective
To acquaint the students about basic concepts and general principles of tree improvement.

Theory
UNIT I
Introduction, history and development of tree improvement, its relation to other disciplines for forest management. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding.

UNIT II
Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees.

UNIT III
Genetic basis of tree breeding and selection practices in forest trees. Patterns of environmental variation- species and provenance trials in forest trees. Seed stands (seed production areas) Plus tree selection, progeny trials and establishment of seed orchard.
UNIT IV
Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties.

UNIT V
Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement.

Practical

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

FOR 454 WILD LIFE MANAGEMENT 2 + 1

Objective
To acquaint the students about wild life status in India, need of biodiversity conservation and efforts in progress for wild life management in India.

Theory
UNIT I

UNIT II

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

UNIT V

Practical

Suggested Readings

FOR 455 WOOD PRODUCTS AND UTILIZATION 1+1
Objective
To acquaint the students about various wood products, availability of raw material and best utilization practices in India.

Theory
UNIT I
Pulp and paper industry. Introduction and raw material; pulping-mechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT II
Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT III

Practical
FOR 456 FOR 456 FOR 456 FOREST MANAGEMENT, POLICY AND LEGISLATION 2+1

Objective
To acquaint the students about general principles of forest management, working plan, forest policies and forest legislation in India.

Theory

UNIT I

UNIT II

UNIT III
Yield regulation – general principles of even aged and unevenaged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees.

UNIT IV

UNIT V

Practical
Visit to plantations of different age gradations, record the actual growing stock and workout increments. Visit to forests and enumerate the stock and test one of the method for yield regulation. Study the various units adopted in the forest management. Study of various records and forms maintained in the office of the RFO with regard to management of forests under their control. Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

Suggested Readings