

**COURSE SYLLABUS  
FOR**

**M.Sc. FORESTRY & ENVIRONMENTAL SCIENCES**

**Choice Based Credit System (CBCS)**

(w.e.f. Academic session:2021-22)



**“SCHOOL OF NATURAL RESOURCES”**

**DEPARTMENT OF FORESTRY, WILDLIFE & ENVIRONMENTAL  
SCIENCES**

**GURU GHASIDAS VISHWAVIDYALAYA  
BILASPUR-495009, CHHATTISGARH**

(A Central University established by the Central University Act, 2009 No. 25 of 2009)

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**Course Structure**  
M.Sc. Forestry (2 -Year / 4- Semester) CBCS Program

Semester	Course Opted	Course Code	Name of the Course	Credit	Hour/week	Marks
I <sup>st</sup> SEM	Core-01	FOPATT1	Silviculture	3	3	100
	Core-01 Practical	FOPALT1		1	3	100
	Core-02	FOPATT2	Forest Biometry, Surveying & Engineering	3	3	100
	Core-02 Practical	FOPALT2		1	3	100
	Core-03	FOPATT3	Forest Management, Remote Sensing & GIS	3	3	100
	Core-03 Practical	FOPALT3		1	3	100
	Core-04	FOPATT4	Forest Protection	3	3	100
	Core-04 Practical	FOPALT4		1	3	100
	Core-05	FOPATT5	Forest Ecology and Biodiversity Conservation	3	3	100
	Core-05 Practical	FOPALT5		1	3	100
	Core -06	FOPATT6	Forest Policy, Law and Environmental Legislation	3	3	100
	Core -06 Practical	FOPALT6		1	3	100
	<b>TOTAL</b>				<b>24</b>	<b>36</b>

II <sup>nd</sup> SEM	Core -07	FOPBTT1	Forest Tree improvement and Biotechnology	3	3	100
	Core -07 Practical	FOPBLT1		1	3	100
	Core -08	FOPBTT2	Forest Industries and Wood Technology	3	3	100
	Core -08 Practical	FOPBLT2		1	3	100
	Core -09	FOPBTT3	Wildlife Biology and Conservation	3	3	100
	Core -09 Practical	FOPBLT3		1	3	100
	Core -10	FOPBTT4	Forest Soil and Watershed Management	3	3	100

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Core -10 Practical	FOPBLT4		1	3	100
Core -11	FOPBTT5	Global Environment and Climate Change	3	3	100
Core -11 Practical	FOPBLT5		1	3	100
RM -01	FOPBTM1	Forest Statistics and Research Methodology	3	3	100
RM-01 Practical	FOPBLM1		1	3	100
<b>TOTAL</b>			<b>24</b>	<b>36</b>	<b>1200</b>

<b>III<sup>rd</sup> SEM Forest Management (FM)</b>	Core -01	FOPCTJ1	Forest Resource Analysis	3	3	100	
	Core-01Practical	FOPCLJ1		1	3	100	
	Core -02	FOPCTJ2	Production Management in Nursery and Plantation Forestry	3	3	100	
	Core -02 Practical	FOPCLJ2		1	3	100	
	Core -03	FOPCTJ3	Finance and Marketing Management of Forest Resources	3	3	100	
	Core -03 Practical	FOPCLJ3		1	3	100	
	Core -04	FOPCTJ4	Tree Business Management	3	3	100	
	Core -04 Practical	FOPCLJ4		1	3	100	
	Core -05	FOPCLJ5	Sustainable Forest Management in Changing World	3	3	100	
	Core -05 Practical	FOPCLJ5		1	3	100	
	OE-01	FOPCTO1	Urban Forestry	2	2	100	
	<b>Total</b>				<b>22</b>	<b>32</b>	<b>1100</b>

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IV <sup>th</sup> SEM Forest Management (FM)					
Dissertation/Field work/ Internship/Project/Industry Visit/ Field Visit	FOPDDJ1	Field Training (Attachment with State Forest Department for understanding of Operations and Management / Practices currently used in Forest Management.	10	30	150
	FOPDEJ1	Forest Based Industrial Training	10	30	150
	FOPDPJ1	ICT Tools and Techniques Applications in Forestry.	03	09	50
	FOPDPJ2	Student Project Dissertations.	02	06	50
	<b>Total</b>		<b>25</b>	<b>75</b>	<b>400</b>
<b>GRAND TOTAL</b>			<b>95</b>	<b>179</b>	<b>3900</b>

III <sup>rd</sup> SEM Forest Genetic Resources (FGR)	Core -01	FOPCTR1	Breeding Methods in Forest Trees	3	3	100
	Core -01 Practical	FOPCLR1		1	3	100
	Core-02	FOPCTR2	Forest Tree Reproductive Biology and Seed Orchards	3	3	100
	Core -02 Practical	FOPCLR2		1	3	100
	Core-03	FOPCTR3	Molecular Genetics of Forest Trees	3	3	100
	Core -03 Practical	FOPCLR3		1	3	100
	Core-04	FOPCTR4	Quantitative Genetics of Forest Trees	3	3	100
	Core -04 Practical	FOPCLR4		1	3	100
	Core -05	FOPCLR5	Forest Genetic Diversity, Conservation and Environmental Impact	3	3	100
	Core -05 Practical	FOPCLR5		1	3	100

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	OE-01	FOPCTO1	Urban Forestry	2	2	100
	<b>Total</b>			<b>22</b>	<b>32</b>	<b>1100</b>

<b>IV<sup>th</sup> SEM Forest Genetic Resources (FGR)</b>					
<b>Dissertation/Field work/Internship/Project/Industry Visit/ Field Visit</b>	FOPDDR1	Field Training (Attachment with State Forest Department for understanding of analysis of FGR, Forest Operations and Management of Forest Genetic Resources)	10	30	150
	FOPDER1	Forest Based Industrial Training	10	30	150
	FOPDPR1	ICT Tools and Techniques Applications in Forestry	03	09	50
	FOPDPR2	Student Projects Dissertations.	02	06	50
		<b>Total</b>	<b>25</b>	<b>75</b>	<b>400</b>
<b>GRAND TOTAL</b>			<b>95</b>	<b>179</b>	<b>3900</b>

### Grand Total of Credits: 95

- The student project will be allotted in III Semester and will be evaluated at the end of IV Semester. Students will be given a topic for the project related to the curriculum by the supervisor allotted for the project.
- **Visits:** Visits to forest operation sites, forest nursery, wildlife habitats and plantation sites will be conducted as per the requirement of the curriculum.

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## Program Specific Objectives:

- To develop student strong competencies in the field of Forestry and Environmental Sciences and its application in a technology-rich, interactive environment.
- To develop strong student skills in silvicultural activities, Forest genetics and tree breeding, forest survey & mapping, forest management planning, forest based industries development and value addition, IPR applications, natural resource management, environmental sustainability, socio economic stability, data collection and analysis by using new techniques and tools.
- To prepare the students to compete successfully for employment in Forestry and Environmental Sciences and its allied disciplines and to meet the requirements of government and industrial sectors.

## Outcome of the programme:

- The M.Sc. Forestry and Environmental sciences programme will equip the students with knowledge, general competence, and analytical skills on an advanced level, needed in forest and forest based industries as well as in environmental sector consultancy, education, research, and forest administration.
- The hands on field training through one full semester will give special expertise within specializations of Forest Genetic Resources and Forest Management offered by the department.

## Course Objectives

### SEMESTER-I

#### Paper I. SILVICULTURE

**Objective:** To provide knowledge about Forest ecosystem concept, forest stand dynamics forest succession, forest productivity and regeneration of forest.

**Outcome:** The course will enable the students to know the components and dynamics of forest, its regeneration and production.

#### Paper II. FOREST BIOMETRY, SURVEYING & ENGINEERING

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

**Outcome:** The students will be able to record the biometric measurements of trees, survey of the forest area and yield assessment of the forest stock.

#### Paper III: FOREST MANAGEMENT, REMOTE SENSING & GIS

**Objective:** To provide knowledge to students about the use of Remote Sensing and GIS technique in the mapping and management of forest resources.

**Outcome:** The course enables the students to be well-versed in forest mapping with latest use of ICT techniques, Remote Sensing & GIS.

#### Paper IV. FOREST PROTECTION

**Objective:** To provide knowledge to students about forest pests and diseases with their control measures through IPM.

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**Outcome:** Enables the students to maintain healthy growth of the trees with protection from pest and pathogens and other damaging agents of forest.

#### **Paper V. FOREST ECOLOGY AND BIODIVERSITY CONSERVATION**

**Objective:** To develop understanding of students about ecological aspects of forest and its biodiversity conservation strategies.

**Outcome:** The course will enable the students to understand the entire ecosystem of the forest with special emphasis on conservation of its biodiversity.

#### **Paper VI. FOREST POLICY, LAWS AND ENVIRONMENTAL LEGISLATION**

**Objective:** To develop understanding of students about forest policies, laws and Environmental Legislation for forest and wildlife management.

**Outcome:** Enables the students to manage the forest wealth with legal knowledge and expertise.

### **SEMESTER-II**

#### **Paper I. FOREST TREE IMPROVEMENT AND BIOTECHNOLOGY**

**Objective:** To acquaint the students about general principles of tree breeding with examples of important tree species.

**Outcome:** Enables the students to develop improved progeny of the forest trees to undertake tree improvement.

#### **Paper II. FOREST INDUSTRIES AND WOOD TECHNOLOGY**

**Objective:** To acquaint the students with the physical and mechanical characteristics of wood.

**Outcome:** The course enables the students to identify the wood and its uses for timber and other industries.

#### **Paper III. WILDLIFE BIOLOGY AND CONSERVATION**

**Objective:** To develop the understanding of conservation strategies of wildlife in forest areas.

**Outcome:** The students will spread the message among society for conservation and protection of wildlife.

#### **Paper IV. FOREST SOIL AND WATERSHED MANAGEMENT**

**Objective:** The basic objective of the course is to expose the students about the soil properties of world forests, its production function and capability of storing carbon in forest soils and opportunity/challenges in the management of forest soils. Apart from this student will be exposed about the watershed management projects for improving the forest health.

**Outcome:** The student will acquire sound knowledge on world forest soils and its role in carbon storage and CO<sub>2</sub> greenhouse gas mitigation. This will also enable students to have training for implementation of watershed projects.

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## PAPER V: GLOBAL ENVIRONMENT AND CLIMATIC CHANGE

**Objective:** To develop understanding of students about environment, global climatic changes and their effect on forest ecosystems.

**Outcome:** Enables the student about the regional, global environment and climate changes mitigation measures.

## PAPER VI: FOREST STATISTICS AND RESEARCH METHODOLOGY

**Objective:** To provide exposure about methods of statistical analysis, design and sampling techniques for data analysis and interpretation.

**Outcome:** Make the students well versed with statistical software, analysis of data and its interpretation.

## SPECIALIZATIONS FOREST MANAGEMENT

### PAPER I. FOREST RESOURCE ANALYSIS

**Objective:** To develop understanding of students about the nature and importance of forest resources, their availability and management strategies.

**Outcome:** To be well versed in the management of the forest resources and to develop strategies for their improved production with analytical approach.

### PAPER II. PRODUCTION MANAGEMENT IN NURSERY AND PLANTATION FORESTRY

**Objective:** To develop understanding and management skills of the students in respect of commercial nursery production and plantation forestry.

**Outcome:** Equipped the students with latest skills of forest produce production with commercial nursery production for plantation activities.

### PAPER III. FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES

**Objective:** To develop understanding of students about financial and marketing management tools applied for forest resources business and their marketing.

**Outcome:** Enable the students to make balance sheet and determine sustainability of business of forest based industries.

### PAPER IV. TREE BUSINESS MANAGEMENT

**Objective:** To develop understanding and management skills of the student with special reference to tree farm business management.

**Outcome:** Enables the students to manage the tree planting business.

### PAPER V. SUSTAINABLE FOREST MANAGEMENT IN CHANGING WORLD

**Objective:** To develop understanding and management skills of the student with special reference to Environment conservation in the changing world.

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**Outcome:** Enables the students to manage the forest area with the emphasis on environmental conservation and greenhouse gases mitigation and global climatic changes.

#### **PAPER V. URBAN FORESTRY**

**Objectives:** Planning, establishment, protection, and management of individual trees and forest systems within an urban environment

**Outcomes:** This will enable students to gain knowledge of urban forestry, create urban forests, commercial arborists, city planners and consultants.

### **SEMESTER- III**

#### **FOREST GENETIC RESOURCES**

##### **Paper I. BREEDING METHODS IN FOREST TREES**

**Objective:** To acquaint the students about the concepts of sub- selection, population structure for breeding and production, genetic testing and making designs.

**Outcome:** This will enable students in the selection of superior trees for developing disease resistant and drought resistant quality planting material for future tree improvement programmes.

##### **Paper II. FOREST TREES REPRODUCTIVE BIOLOGY AND SEED ORCHARDS**

**Objective:** To impart the knowledge of reproduction of forest tree species and to understand the mechanism of breeding, sex expression, and seed orchard development.

**Outcome:** This will enable students to understand the reproductive biology of the tree species and seed orchard which can be helpful for the production of genetically improved seed for large scale afforestation programme.

##### **Paper III. MOLECULAR GENETICS OF FOREST TREES**

**Objective:** To impart the knowledge of DNA and genomic structure of forest trees for quantification of superior traits for breeding programmes.

**Outcome:** The use of molecular marker will enable students to greatly enhance the understanding of genomic structure of forest trees.

##### **PAPER IV: QUANTITATIVE GENETICS OF FOREST TREES**

**Objective:** To develop vision of students in the qualitative analysis of genetic & phenotypic characteristics, heritability and fitness of population with inbreeding coefficient.

**Outcome:** This will enable students about the estimation of similarity and dissimilarity in the tree population and give the suitability of individuals in the environment. The students will also be able to understand the fitness of individual, relation with ancestry and genetic variance which can help in tree improvement and tree breeding techniques.

##### **PAPER V: FOREST GENETIC DIVERSITY, CONSERVATION AND ENVIRONMENTAL IMPACT**

**Objective:** To provide the student knowledge about the genetic diversity of forest tree species, their distribution, assessment and analysis, law and methodology of *in-situ* and *ex-situ*

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conservation.

**Outcome:** Students will be able to know the genetic diversity and evolve conservation strategies of flora and fauna.

## PAPER V. URBAN FORESTRY

**Objectives:** Planning, establishment, protection, and management of individual trees and forest systems within an urban environment

**Outcomes:** This will enable students to gain knowledge of urban forest, create urban forests, commercial arborist, city planners and consultants.

## SEMESTER- IV

### FOREST MANAGEMENT

#### 1. FIELD TRAINING (ATTACHMENT WITH STATE FOREST DEPARTMENT FOR UNDERSTANDING OF FOREST OPERATIONS AND MANAGEMENT PRACTICES CURRENTLY USED IN FOREST MANAGEMENT)

**Objective:** To apprise the students with the field practices which are needed for the sustainable utilization and management of forest resources.

**Outcome:** The student will be equipped with latest techniques of sustainable forest management practices.

#### 2. FOREST BASED INDUSTRIAL TRAINING

**Objective:** To make the students acquainted with the procurement of raw materials, its processing techniques and its best industrial utilization and financial and marketing management of the products needed for the forest based industries.

**Outcome:** The students will be trained with latest techniques for the sustainable utilization and management of forest products in forest based industries.

#### 3. ICT TOOLS AND TECHNIQUES APPLICATION IN FORESTRY.

**Objective:** To develop skill and training of ICT tools and techniques for mapping and measurements of forest.

**Outcome:** this course will enable the students to measure various parameter of forest and its resources through ICT tools and techniques.

#### 4. STUDENT PROJECT DISSERTATION

**Objective:** To provide the students research based skills for the planning, mapping and management of the forest and its resources.

**Outcome:** This will enable the students to carry out independent field/laboratory based research work on different aspects of forestry, wildlife and environmental sciences

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## SEMESTER- IV

### SPECIALIZATION: FOREST GENETIC RESOURCES

#### 1. FIELD TRAINING (ATTACHMENT WITH STATE FOREST DEPARTMENT FOR ANALYSIS OF FGR, FOREST OPERATIONS AND MANAGEMENT OF FOREST GENETIC RESOURCES)

**Objective:** To apprise the students with the field practices which are needed for the analysis of genetic resources, forest operations and sustainable utilization of forest genetic resources.

**Outcome:** The student will be equipped with the tools and techniques for analysis of genetic resources of forest, selection of superior trees for the tree improvement programmes.

#### 2. FOREST BASED INDUSTRIAL TRAINING

**Objective:** To make the students acquainted with the procurement of raw materials, its processing techniques and its best industrial utilization and financial and marketing management of the products needed for the forest based industries.

**Outcome:** The students will be trained with latest techniques of the sustainable utilization and management of forest products in forest based industries.

#### 3. ICT TOOLS AND TECHNIQUES APPLICATIONS IN FORESTRY.

**Objective:** To develop understanding and management skills in the students regarding use of ICT tools in mapping and measurement of the forest genetic resources.

**Outcome:** Enables the students to measure and map various forest genetics resources through ICT tools and techniques for forest genetic resources management.

#### 4. STUDENT PROJECT DISSERTATION

**Objective:** To provide the students research based skills for the planning, mapping and management of the forest and its resources.

**Outcome:** Enable the students to carry out independent field/laboratory based research work on different aspects of forestry, wildlife and environmental sciences.

## SEMESTER-I

### PAPER I. SILVICULTURE

CR.4 (3+1)

#### Theory

Principles of Silviculture, objective and scope, relationship with the other branch, forest structure and its components, tree and the forest, Ecophysiology of tree growth, factors of the locality, Bioclimatic and microclimate effect, Forest ecosystem concept, stand dynamics-forest succession, classification of world's forest vegetation, forest types and their distribution, Advanced and modern

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nursery tools & techniques, natural and artificial regeneration, Tending operation. Regeneration of important forest tree species (*Shorea robusta*, *Tectona grandis*, *Gmelina arborea*, *Eucalyptus spp.*, *Dalbergia sissoo*, *Bamboo spp.*, *Cedrus deodara* and *Pinus roxburghii*), regeneration survey and techniques.

### Practical

Acquaintance with various technical terms of silviculture. Study the forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering, and fruiting in (*Shorea robusta*, *Tectona grandis*, *Gmelina arborea*, *Eucalyptus spp.*, *Bamboo Cedrus deodara*, *Dalbergia sissoo*), Study of site factors like climatic, edaphic, physiographic and biotic. Study of natural regeneration, Afforestation and Reforestation success. Layout of nursery bed for sowing Classification of world's forest vegetation.

### Suggested Readings

- Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.
- Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.
- Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.
- Smith DM, Larson Be, Ketty MJ & Ashton PMS. 1997.
- Jha, L. K. 2014. *Advances in Agroforestry*, Today & Tomorrow's Printers and Publishers New Delhi.
- Lal J.B. 2011. *Forest ecology*, Natraj Publisher Dehradun.
- Mishra, S R. 2010. *Textbook of Dendrology*, Today & Tomorrow's Printers and Publishers New Delhi
- Patra, A K. 2013. *Agroforestry: Principles and Practices*, Today & Tomorrow's Printers and Publishers New Delhi.
- Pradeep Krishan. 2013. *Jungle trees of Central India*. Penguin Books India.
- Smith DM, Larson BC, Ketty MJ, and Ashton PMS. 1997. *The Practices of Silviculture- Applied Forest Ecology*. John Wiley & Sons.
- Raj, Antony Joseph & S B Lal. 2014. *Agroforestry: Theory and Practices*, Today & Tomorrow's Printers and Publishers New Delhi

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## PAPER II. FOREST BIOMETRY, SURVEYING & ENGINEERING

Cr.4 (3+1)

### Theory

Measurement of tree parameters: girth, diameter, height and form factor. Estimation of log volume and volume of standing trees. Estimation of tree age, growth and yield of individual tree and forest stands. Stump analysis and stem analysis for determining past growth. Preparation of volume table, yield table, stand table & its application in forestry. Forest inventory, sampling methods adopted in forestry. Growth and yield prediction models and forecasting of future yield.

Forest surveying: Chain survey, plane table and compass survey. Forest Engineering: Building materials and its quality testing, Design and construction of forest roads and bridges.

### Practical

Measurement of girth and diameter of plantation and forest, Determination of tree height and form factor, volume calculation of felled and standing trees. Estimation of tree age, Volume table preparation, Application of sampling procedures, Handling of GPS, preparation of yield and stand table.

Survey of forest and plantations using chain, plane table, compass, total station, measurement of road camber and road profile, Identification of building materials and its field testing, visit of different types of bridges.

### Suggested Readings

- Chaturvedi A.N., and Khanna L.S. 1994. Forest Mensuration. International Book Distributor, Dehradun, India
- Masani, N.J. 1995. Forest Engineering without tears, Natraj Publisher, Dehradun
- Manikandan K and Prabhu S. 2012. Indian Forestry, Jain Brothers, New Delhi
- Ram Parkash 1983. Forest Surveying, Khanna Bandhu Book Publisher India.
- Sharpe GW, Hendee CW & Sharpe WE. 1986. Introduction to Forestry. McGraw-Hill.
- Simmons CE. 1980. A Manual of Forest Mensuration. Bishen Singh. Mahender Pal Singh, Dehradun.
- Ram Parkash 1983. Forest Engineering. International Book Distributor, Dehradun, India.

## PAPER III: FOREST MANAGEMENT, REMOTE SENSING & GIS Cr.4 (3+1)

### Theory

Principles of forest management and their applications. Development of forest management in India. Concept of Normality, Normal forest, causes of abnormality in forest management Sustainable

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Forest Management, Rotation: Meaning and types. Increment, Types of increment, Yield: Types of yield, Yield regulation in regular forest, Yield regulation in irregular forest Management. Working circles, felling series, cutting section, coupes, periodic blocks and felling cycles. Silviculture system: Definition and types, Bamboo forest management and Working plan prescriptions. Site quality, Stand density, Criteria and Indicators.

Remote Sensing definition, scope, source of energy and interaction with forest, EMR Spectrum concept, Orbit, Platform and Sensor, Multi-band concept, Satellite system and its use for forest mapping and management. GIS definition, Hardware and software used, methods used in forest management, database and modeling concept. Imagery concept its interpretation and map preparation, LiDAR and RADAR concept for forest. Application of RS & GIS for forest management and planning, forest covers type discrimination and change detection analysis.

### Practical

Study of various records and forms maintained in Forest division with regard to management of forests under their control. Study of working plans of the forests. Toposheet reading, determination of scale and height on toposheets, introduction to different GIS software, conversion of file formats, image registration / geocoding, digitization, geo-referencing, Projection, File sub setting, mosaicing, unsupervised and supervised classification of forest, map preparation for forest cover, type, slope, LULC, fire, field visit for ground truthing.

### Suggested Readings

Burrough PA.1990. *Principles of GIS for Land Resources Assessment*, Oxford & IBH Lilesand T.M.

Clarke, Keith. 2011. *Geographical Information System*, Prentice Hall.

Dwivedi A.P. 1993. *A Text Book of Silviculture*, International Book Distributors, Dehradun.

J.B. Lal. 2011. *Forest Management: Classical Approach and Current Imperatives*, Natraj Publishers, Dehradun.

Franklin, Steven. 2014. *Remote Sensing for Sustainable Forest management*, CRC Press.

John Wiley. *Remote Sensing and its application*. Universities Press

Kohl, Michael 2012. *Sampling Methods, Remote Sensing and GIS Multisource Forest Inventory*, Springer publication.

Lillesand and Kiefer 2009. *Remote Sensing and Image Interpretation*, VI edition of John Wiley & Sons.

Lecture notes. 2000. *Photogrammetry and Remote Sensing*, module I, IIRS

Sen, Raj Kumar.2012. *Forest Management and Sustainable Development*, Today & Tomorrow's Printers and Publishers, New Delhi.

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## PAPER IV. FOREST PROTECTION

Cr.4 (3+1)

### Theory

General concept of forest protection. Various abiotic and biotic forest damaging agencies. Forest fire and its impact on forest health. Adverse climatic factors, acid rains and air pollutants in relation to tree health. Tree disease concept and disease cycle. Biodegradation of wood - microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots - factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health. Important diseases of forest trees- Teak, Sal, Shisham, *Acacia*, *Dalbergia*, Deodar, Pines and Casuarina. Insect pest of Sal, Teak, Shisham, Babool, *Ailanthus*, Pines, Deodar, Casuarinas and *Albizia*. Biological control of insect pests and diseases of forest trees Nature of disease resistance. Molecular tools for developing disease resistance trees.

### Practical

Collection, identification and preservation of important insect pests and disease specimens of forest plants. Preparation of culture media and methods of inoculation. Vegetative and reproductive study of pathogens. Detection of insect infestation and seed borne mycoflora. Assessment of losses due to diseases, insect pests etc. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio- control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of Vascular arbuscular mycorrhizal (VAM), fungi from soil and assessment of mycorrhizal root infection,

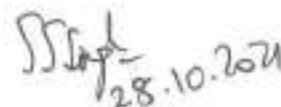
### Suggested Readings

- Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.  
Jha LK & Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.  
S S Negi, 2006. *Handbook of Forest Protection*. International Book Dist., Reprint  
Schmidt, Olaf. 2006. *Wood and Tree Fungi: Biology Damage Protection and Use*, Today & Tomorrow's Printers and Publishers, New Delhi.  
Paul. D. Mennan. 1991. *Tree Diseases Concept*. Prentice Hall.  
Stebbing EP. 1977. *Indian Forest Insects*. JKJain Bros.







  
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## Paper V. FOREST ECOLOGY AND BIODIVERSITY CONSERVATION

Cr.4 (3+1)

### Theory

Forest ecology, forest community dynamics, forest community structure and function, phyto-geography and zoo-geographic regions of India, Basic concept of biodiversity, history of biodiversity conservation, Conservation of natural resources (Hotspot areas, Wildlife Sanctuaries, National parks, Biosphere reserve-terrestrial and aquatic, Botanical Gardens, Zoological Parks), Important Plant and wildlife ecological indicator species, endangered species, Coral reefs, Mangrove forest. Climate change and biodiversity, Global warming and forests, Green House Effect, Ozone depletion and its consequences, Biodiversity Conservation laws and acts. International programmes for biodiversity conservation, convention on biological diversity CBD, CITES UNFCCC Kyoto protocol, TRIPS, Ramsar convention, Intellectual property rights.

### Practical

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Identification of ecological indicator species, Methods of vegetation analysis, Measurement of biomass and productivity, Visit to National parks, Wildlife sanctuaries, Botanical gardens and arboreta.

### Suggested Readings

- Anonymous. 2006. *Report of the National Forest Commission*. Govt. of India.
- Kumar Arvind. 2005. *Biodiversity and Conservation*, Today & Tomorrow's Printers and Publishers New Delhi.
- Dhyani SN. 1994. *Wildlife Management*, Rawat Publ.
- Malik, Ashok. 2008. *Dynamics of Forest Ecosystems*, Today & Tomorrow's Printers and Publishers New Delhi.
- Huxley P. 1999. *Tropical Agroforestry*, Blackwell.
- Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures*, Pointer Publ.
- Kimmins JP. 1976. *Forestry Ecology*, Macmillan.
- Nautiyal S & Koul AK. 1999. *Forest Biodiversity and its Conservation Practices in India*, Oriental Enterprises New Delhi.
- Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*. Man and

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Biosphere Series, The Parthenon Publ. Group.

Singh, M P et al. 2013. *Conservation of Biodiversity and Natural Resources*. Today & Tomorrow's Printers and Publishers New Delhi.

## PAPER VI. FOREST POLICY, LAWS AND ENVIRONMENTAL LEGISLATION

Cr.4 (3+1)

### Theory

Forest policy -Relevance and scope, National Forest Policy-1894, 1952 and 1988, criminal laws, Indian Penal Code, criminal procedure code; Indian Forest Act-1927, Forest Conservation Act 1980, Biodiversity Act 2002, Forest Right Act 2006-Privilege concession and Right of forest dwellers, Environment and their legal issues in India, Legal and policy frameworks related to forest conservation, Environment (protection) act 1986.

### Practical

Visit to High Court, Lower Court. Visit to forest depot. Visit and study about crime cell of forest department

### Suggested Readings

Chaturvedi A. N., 2011. *Forest Policy and law*, Khanna Bandhu.

*Indian Forest Acts* (with short notes) 1975. Allahabad Law Agency.

Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy*. Ashish Pub. House.

Poddar A.K. et al. 2011. *Forest Laws and Policies in India*, Today and Tomorrow Printers and Publishers New Delhi

Prabhakar V.K., 2001. *Laws on Forests*, Anmol Publication.

National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi.

National Forest Policy 1988. Ministry of Environment and Forests, New Delhi.

Saharia, VB. 1989. *Wildlife Law in India*. Natraj Publ.

Sairam Bhat 2010. *Natural Resources Conservation Law*, Sage.

Negi SS. 1985. *Forest Law*. Natraj Publ.

## SEMESTER-II

### PAPER I. FOREST TREE IMPROVEMENT AND BIOTECHNOLOGY

CR.4 (3+1)

### Theory

General concept of forest tree breeding, tree improvement, forest genetics. Reproduction in forest trees, dimorphism Pollination mechanisms. Pollen dispersal, pollinators and their energetics.

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Attractants for pollinators. Variations in tree phenotypes, its importance and causes. 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. Selective breeding methods- mass, family, within family, family plus within family. Plus, tree selection for wood quality. Progeny and clone testing. 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. Indian examples - Teak, Shisham, *Eucalypts*, *Acacias*, Pines and Poplars. Polyploidy, aneuploidy and haploidy in soft and hardwood species. Induction of polyploidy. Hardy-weinberg law, null hypothesis, Wohlund's Principle.

Biotechnology in tree improvement Mutation breeding. Micro-propagation, Genetic engineering, Transgenic trees, molecular marker assisted tree improvement, Molecular marker and its application in forestry.

### Practical

Floral biology, modes of reproduction and modes of pollination in forest trees. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Identification of ecotypes, races, and land-races in natural forest. Visit to provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids. Induction of polyploidy through colchicine treatment.

### Suggested Readings

Khan IM. 2014 Forest Biotechnology, Today and Tomorrow Printers and Publishers New Delhi.  
Mandai A.K., & Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.  
Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

P. Shanmughavel, 2004. *Tree Improvement and Biotechnology*, Pointer.

Russel Haines, 1996. *Biotechnology in Forest Tree Improvement with Special Reference to Developing Countries*, Reprint, Dehradun.

White J.W. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talber J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

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**Theory**

Wood formation, kinds of wood, wood properties: physical, mechanical, acoustic and electrical properties, Wood strength, Wood moisture, Wood seasoning, defects and wood preservation. Wood machining and wood working. Concept and principle of Smart furniture, application of nano-science in wood industries. Importance of forest based industries in Indian economy, resin, tannin, gums extraction, resources of essential oil, katha and catch, dyes and pigments.

Wood based industries: paper and pulp, match, sport goods, plywood, matchwood industries, improved wood, engineered wood, composite wood. Wood certification.

**Practical**

Determination of wood density, wood bulking, wood moisture, identification of wood samples, wood defects, determination of wood strength, Effectiveness of wood preservatives, Grading of wood, wood based industries, improved wood and composite wood. Extraction of essential oil, tannin, gums and natural dyes. Grading of plywood, visit of forest based industries, sawmill, timber marts.

**Suggested Reading:**

Chauhan Laxmi and Vijendra Rao. 2003. Wood anatomy of Legumes of India: their identification, properties and uses. Bisen Singh and Mahendra Pal Singh, Dehradun.

Eiri Board 2011. Modern Technology of wood, veneer, plywood, particle board, fiberboard, bamboo and forest products. Engineers India Research Institute, India

Mehta T. 1981. A hand book of forest utilization. Periodical expert book agency Printer and publisher, New Delhi.

Murthy T.K. 2010. Minor forest products of India. Oxford and IBH Publication, India.

Negi SS. 1997. Wood Science and Technology. International book distributor, Dehradun.

Rao KR and Juneja KBS, 1992. Field identification of 50 important timbers of India, ICFRE Publication, Dehradun, India

Sharma LC. 1977. Development of Forests and forest based industries. Bisen Singh and Mahendra Pal Singh Dehradun, India

Terry Porter 2006. Wood: Identification and use. Guilds of Master Craftsman Publication.

Tewari, D.N. 2008. Management of non-timber forest resource of India. International Book Distributor Company, Lucknow, India

Trotter H. 1992. Manual of Indian Forest Utilization. Forest Research Institute, Dehradun.

Tsoumis G. 2009. Science and Technology of Wood. Verlag Kessel

Troup RS. 2007. Manual of Indian forest utilization. Today and Tomorrow Printers and Publishers, New Delhi

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**Theory**

Introduction/Conservation ethics- Definitions, Values, Zoological classification, Sign and symptoms. Animals behavior & adaptations, Wild life Ecology, Basic concepts, Wildlife habits and habitat. Wildlife habitat and its component Wildlife conservation: Definition, Concept, significance. Wildlife conservation movement, Wildlife conservation in India, In-situ and Ex-situ wildlife conservation, Role of protected area in wildlife conservation, some rare and threatened wildlife species of world particularly India, special project for endangered species, Project tiger, Gir Lion Project, Crocodile Breeding Project, Wildlife Conservation organization- National and International. Role of zoos parks and sanctuaries for conservation of wildlife, Ramsar wetlands. Wild life management: Wild life management its scope as a natural resource, current status of wildlife management. Tiger, Bear, Elephant, Rhinoceros, deer. Biological basis of management- animal population, shelter, food, WL Policy Legislation and administration policies and programmes, Wild life protection act 1972, Scheduled animals, Age and Sex determination, Tiger census, Preservation of biological material, National Park and Sanctuaries of (C.G). Biotelemetry, Forensic Analysis, Wildlife pathology, wildlife crimes.

**Practical**

Study of mammals birds and animals in university premises, Identification of pugmark, evaluation of Roosting cover in university premises, Plotting of National Park and Sanctuaries on map. Visit and list the wildlife present in nearby zoo, sanctuaries, National Park.

**Suggested Readings**

- Agarwal, K.G., 2000. *Wildlife of India: Conservation and management*, Nidi Publishers India.
- Gopal Rajesh., 1993. *Fundamentals of wildlife management*, Justice Home Publication, Allahabad.
- Hosetti B.B, 1997. *Concept of Wildlife management*, Daya Publishing House, Delhi.
- James, A. 1984 *Principles of wildlife management*, Inc. Bailey, John Wiley & Sons, New York.
- Hunter, M.L. Jr., 1990. *Wildlife forest and forestry principals of managing forest for Biological diversity.*, Printice Hall.
- Singh, S K., 2009. *Textbook of Wildlife Management*, Today & Tomorrow's Printers and Publishers New Delhi.
- Stephen H, Berwick and V. B, Sharia, 1995. *Wildlife Research and management*, Oxford University Press, Oxford.

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**Theory**

Definition and importance of forest soils; Origin, classification and nomenclature of soils; forest soil physical, chemical and microbiological properties, Soils of major forest biomes, Difference between forest soil and other arable soils, understanding of soil dynamics and influence upon forest composition stand regeneration, tree vigor and tree growth, Silviculture practices and forest soils. Soil factors in forest productivity, Forest soil fertility determination, nutrient management in forest soil. nursery soil management. Soil degradation-problems and impact on forest ecosystems; Forest fire and soil resilience; Forest soil pollution, maintenance and improvement of forest soil with special reference to tropical conditions. Watershed basic concept, social aspects of watershed management, watershed management practices, sustainable watershed approach, integrated watershed management, use of modern techniques in watershed management,

**Practical**

Determination of soil moisture, texture, porosity, bulk density, particle density and water holding capacity; Determination of pH, EC, organic C & Study of forest soil profile in field: Studies on fertilizers, biofertilizers and FYM uses in forest nursery, studies on drainage maps, characterization and delineation of watersheds, visits to nearby forest nursery and watershed areas.

**Suggested Readings:**

- A K Mani; R Santhi and K M Sellamuthu. 2008. *Fundamentals of Forest Soils*, Satish Serial Pub.
- DhuruvaNarayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed management*. ICAR Publication, New Delhi.
- Matt Burshe Christian P. Giardina, Dave and Morris and Debora S. Page Dumroese 2019. *Global change ion forest soils*, Esiver Science Publisher.
- Murty, J.V.S.1995. *Watershed management in India*. Wiley Eastern, New Delhi.
- Singh, P.K, 2000. *Watershed management: Design and Practices*. E-media publications, Udaipur, India.
- N.C. Brady 1990. *The Nature and Properties of Soils*: Macmillan Publishing Company, New York (10th Edition).
- Negi S.S., 2000. *Forest Soils*, International Book Distributors.
- Osman, Khan Towhid, 2013. *Forest Soils: Properties and Management*, Springer Science publ.
- D. Binkley and R.F. Fischer (2000). *Ecology and Management of Forest Soils* (fifth addition

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Willey & Blackwell Publisher)

S. A: Wilde 1995. *Forest Soils and Forest Growth, Periodicals* Express Book Agency, New Delhi, International Book Distributors, Dehradun.

## PAPER V. GLOOBALE ENVIRONMENT & CLIMATE CHANGE

CR.4 (3+1)

### Objective

To develop understanding of students about environmental and climatic System. To develop understanding of students about global climatic changes and their effect on forest aquatic ecosystems.

### Theory

Environment: Definitions and concepts of environment components of atmosphere, hydrosphere, pedosphere, biosphere and their interactions. Biogeochemical cycle of greenhouse gases, source and sinks.

Environment Pollution: Types of pollutions, methods of measurement of pollution, classification of pollutants, national and international Environmental standards of important pollutants.

Air pollution: Major pollutants and their sources. Ionizing radiation, monitoring of gaseous pollutants and particulate matter, Vehicular pollution. Biological abatement of air pollution. Development of green belt.

Water Pollution: Important pollutants source, impact of heavy metals, halogen and radio nuclides on aquatic flora and fauna. Treatment technologies for industrial effluents/wastewater. Monitoring water pollution and water quality standards.

Soil pollution: Heavy metal toxicity in soil, Impact of pesticides, industrial waste and fertilizers on soil physicochemical properties. Microbiological degradation of xenobiotic in environment.

Climate changes: Earth's climate systems, adaptability and vulnerability. A global perspective of climate change, global warming, greenhouse gases, IPCC initiatives in climate change mitigation, various mitigation mechanism- Kyoto protocol- strategies. Impact of climate changes on Indian forest, adaptation of forest trees to climate change, case studies on the management of certain tree species in India.

Global Environmental Problems: acid rain, Eutrophication, Bio manipulation, Ozone depletion and UV radiation. Bioremediation of contaminated soils and waste lands. Environment Impact Assessment.

### Practical

Impact of particulate matter on environment, Impact of coal mining on environment Impact of cement pollution in environment. Effect of effluent from several industries on environment. Reclamation of mining wastes with microorganisms. Bio-accumulation studies on metals by

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microorganisms. Assessments of environmental impact on polluted sites. Assessing the awareness of environmental regulation and control methods, Impact of power stations on plant, microorganisms, animals and soils ecosystems, EIA of polluted river ecosystem, Environmental Impact Assessment.

### Suggested Readings

Anonymous, 2006, Report of the National Forest Commission, Govt. of India, New Delhi.

E. Claussen, V. A. Cochran, and D. P. Davis. 2001. *Climate Change: Science, Strategies, & Solutions*, University of Michigan.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International; Rome, Italy.

Streck, C et al, 2006 Climate Change and Forests Emerging Policy and Market Opportunities Today & Tomorrow's Printers and Publishers New Delhi.

## PAPER VI. FOREST STATISTICS & RESEARCH METHODOLOGY CR.4 (3+1)

### Theory

Basics of statistics: Scales of measurement, types of data: quantitative and qualitative data of forest tree species frequency arrangement, different series and its arrangement and representation methods, Central tendency: Mean, Median, Mode, Measures of Dispersion: Range, quartile deviation, Mean deviation and Standard deviation- variance, covariance, Basic concept of probability, Correlation: Concept, Karl Pearson's coefficient, Spearman rank correlation coefficient, Regression: Regression equations, linear and nonlinear regressions and regression coefficient. Tests of significance: t- test, paired t-test, Z- test and  $\chi^2$ -test

Analysis of Variance (ANOVA) - one way and two-way analysis of variance, Experiments designs: Basic concept, Principles of experimental designs, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Split Plot and Strip Plot Designs, Comparisons of all experimental designs

### Practical

Use of Excel sheet: To arrange forest based statistical data and represent in different diagram and graphical ways, Forest based measurements: arrangements and frequency distribution, Calculation

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of mean, median and mode of measured characteristics of different tree species, Finding out the relationship between the height and DBH of some forest tree species-correlations and regressions, Testing the hypothesis under t- test,z- test and  $\chi^2$ -test,

ANOVA under the different types of designs: Completely Randomized Block Design, Randomized Block Design, Latin Square Design

### **Suggested Readings**

Forestry Statistics India-1996: Indian Council of Forestry Research and Education, 1999

Mead R & Relay J. 1987. *Statistical Tools for Agro-Forestry Research - Bivariate Analysis for intercropping Experiments*. ICRAF, Nairobi.

Surendran C, Sehgal RN & Paramathma M. *Statistical Methods for Agricultural Workers*.ICAR.2003.

R. Rangaswamy: A Text Book of Agricultural Statistics, New Age International Pvt Ltd Publisher, ISBN-9788122425925, 9788122425925

Dr. S R S Chandel: A handbook of Agricultural Statistics, IMPECT PUBLISHER ISBN-9780012599754, 0012599751

## **SEMESTER- III SPECIALIZATIONS**

**A. FOREST MANAGEMENT**

**B. FOREST GENETIC RESOURCES**

### **A. FOREST MANAGEMNET**

**PAPER I. FOREST RESOURCE ANALYSIS**

**CR.4 (3+1)**

#### **Theory**

Forest resources: wood produce and non-wood produce. Raw materials of forest origin for industries viz: paper and pulp; plywood and board, saw mills, furniture making, packing case, match splints, toys etc.

Minor forest products: edible products, fodder trees, shrub and grasses, bamboo and cane, medicinal and aromatic plants, oil seeds, gum & resins, fiber and flosses, spices and miscellaneous products e.g. Katha, latex, insecticides, soap nuts, etc. Animal products from forest - lac, honey, silk, fur, skins, tusks etc. Dependency of villagers/ tribal on forest resources for different livelihood options. Nature, scope and importance of forest resources in regional & national economy, nature, role and functions of forest based industries, reasons for resource

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degradation. Causes of low productivity of forest resources, remedial strategies, Trends in the production of important forest resources (wood and non-wood products). Government policies on forest resources. Approaches to achievements under five year plans. Management strategies for improved production and consumption of forest resources.

### **Practical**

Identification, nature and properties of different wood and non-wood forest resources. Techniques & methods of value addition to forest resources for other upgradation. Exercise for forest resource mapping and analysis.

### **Suggested Readings**

*Agricultural Production and Resource Use*. Oxford Univ. Press.

Bamoul W J & Oates WE. 1975. *The Theory of Environmental Policy*.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO.1981. *Tropical Forest Resources Assessment Project* (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economics- Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management*. Cambridge Univ. Press. Nautiyal Jc. 1988. New Delhi 2007

Prentice Hall. Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commission Research Station, Surveys.

Rakshit, Swapan Kumar, *Forest Resource Management/ Today & Tomorrow's Printers and Publishers*

Sharma LC, 1980. *Forest Economics - Principles and Applications*. Natraj Publ.

Tewari, D D. 2008 *Management of Non Timber Forest Product Resources of India: An Analysis of Forest Development Corporations*

Upton M *Forest Economics - Principles and Applications*. Natraj Publ. 1976.

## **PAPER II. PRODUCTION MANAGEMENT IN NURSERY AND PLANTATION FORESTRY**

**CR.4 (3+1)**

### **Theory**

Introduction to production theory, Production basic concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of production analysis, theory of demand

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and supply, theory of production cost analysis, Managing risk and uncertainty in nursery and plantation forestry.

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis. Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period. Market structure, Functions, Channels, Marketing efficiency and marketing problems of nursery and plantation forestry.

### **Practical**

Exercises on production analysis, assessment of efficient production, Exercises on financial analysis of production, studies of marketing channels of different nursery and plantation crops and products, costs, margin and price spread for different nursery and plantation crops.

### **Suggested Readings.**

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commission Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (The Framework of Gems). *Forest Resources of Tropical Africa*. Part 1 & II. *Regional Synthesis*.

Makchau JP Makeham and L.R. Malcolm, *Economy of Tropical Farm Management*/ Cambridge University Press.

Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.

NPTL E content on managerial economics by Prof. Tripty Mishra IIT Bombay.

Rakshit Swapan Kumar. 2007. *Forest Resource Management*. Today's and Tomorrow's printers and publishers New, Delhi.

Sharma LC. 1980. *Forest Economics - Principles and Applications*. Natraj Publ.

*Natural Resource Economics- Theory and Application in India*. Oxford & IBH.

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management*. Cambridge Univ. Press.

## **PAPER III. FINANCE AND MARKETING MANAGEMENT OF FOREST**

### **RESOURCES**

**CR.4 (3+1)**

### **Theory:**

Finance and financial management: aims and objective with reference to forest based resources; Sources of long term finance, Major Sources of funding and financing to the forest sector,

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Organization of finance in forest based industries

Concept of Working capital: Gross and net working capital, sources of working capital, factors influencing working capital of forest based industries.

Financial statements: importance and preparation, Balance sheet preparation of forest based industries with reference to profit and loss accounts,

Budget: Purpose and essentials of budgeting, important components of budget, preparation of budgets.

Challenges in Forest finance, Collaborative Partnership on Forests

Market- Classification, price determination, Demand and supply and factors affecting the market.

Marketing efficiency-measurement methods, Marketing cost, margin and price spread-concepts and applications types of market integration, Marketing and trading of wood and non-wood forest products. IPRs and their implications in forestry.

### **Practical**

Working capital analysis of forest based industries. Balance sheet preparation of forest based product industries; field and local area visit and its classification under different types of market, Price determination of any forest products under the different market situation, Demand and supply elasticity measurements of forest produces, Measurement of marketing efficiency, Marketing and trade of national and international timber and non-timber forest products.

### **Suggested Readings**

Busby RJN. 1981. Investment Appraisal in Forestry. Forestry Commission Research Station, Surveys.

FAO 1986.Guidelines to Project Evaluation. NatrajPubl.

FAO, 1981.Tropical Forest Resources Assessment Project(In the Framework of Gems). Forest Resources of Tropical Africa.Part 1 & 2RegionalSynthesis.

Grebner D, Betting P. Siryj.,2013 Introduction to forestry and Natural Resource. Elsevier Publisher.

J.M. Kerr, 1997. Natural Resource Economics-Theory and Application in India, Oxford &IBH.

Joshi.SS. and T.R. Kapoor., 2001.Fundamental of farm business Management. Kalyani Publishers

MakehauJP&Malcolm LE.1986.Economics of Tropical Farm Management.Cambridge Univ. Press.

Nautiyal JC. 1988. Forest Economics, Principles and Applications; Natraj Publ.

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- Panda SC 2011. Farm management and Agricultural Marketing, Kalyani Publishers.
- Shanley Alan R P. 2001 Tapping the green Market: Management and Certification of Non- Timber Forest Products. Amazon.
- Sharma LC. 1980. Forest Economics -Principles and Applications; Natraj Publ.
- W.A. Lauscher, Introduction to forest Resource Economics.
- FAO.2019. Forest finance

#### **PAPER IV. TREE BUSINESS MANAGEMENT**

**CR.4 (3+1)**

##### **Theory**

Tree farm: definition, concept, components and potential in uplifting the farmer's economy. Current farm scenario in India, constraints and the impact of climate change, Farm types and system of tree farming. Tree business management principles, Law of diminishing return, decision making, cost and price principle, Depreciation, Compounding, Planning and budgeting of tree and plantation. Labour efficiency measures, Management of tree based farms: technical and financial components of forest Nursery, plantations, sericulture, agroforestry, lac culture and other commercial plantations.

##### **Practical**

Visit of tree plantation, agriculture farm, agroforestry fields, Calculation of fertilizer and compost mixture for different plantations, Farm budgeting, Calculation of depreciation of farm machinery, calculation of cost of production, Preparation of farm record and ledger file. Farm tools and working principles, Visit of sericulture plantation and processing center.

##### **Suggested reading:**

- FAO 1986. Guideline to project evaluation. Natraj Publication, India.
- Joshi SS and Kapoor TR. 2001. Fundamental of Farm Business Management, Kalyani Publication, India.
- Ken JM, Morothia DK, Singh K, Ramashwamy C and Bentley WR. 1997. Natural Resource Economics: theory and application in India. Oxford and IBH publication.
- Makchau JP and Malcolm LE. 1986. Economics of tropical farm management. Cambridge University Press.
- Nautiyal JC. 1988. Forest Economics: Principle and application. Natraj Publisher, India
- Panda SC. 2011. Farm Management and agricultural marketing. Kalyani Publishers.

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## PAPER V: SUSTAINABLE FOREST MANAGEMENT IN CHANGING WORLD

CR.4 (3+1)

### Theory

Sustainable Forest Management-concept, principles, origin and challenges, sustainable forest management principles. The Montreal Process, Criteria and Indicators of Sustainable Forest Management, Bhopal India Process.

Management of Common Property Resources (CPRs) and open access resources, The role of indigenous and local communities on forest management and sustainable livelihood strategies, Sustainable Fuel wood, Sustainable NTFP management, Forests in rural development, forest societies, social and cultural factors of forest management, Forest rights of people.

Micro-level planning and participatory rural appraisal, Techniques of PRA and RRA, role of NGOs and other community based organizations in forest management. Gender dimension of forest management. Ecotourism: sustainable tourism and people's participation.

Global environmental challenges and issues, Carbon credit, CIFOR, REDD, REDD+ Payments for environmental services. National strategies and action plans for SFM, CAMPA, JFM, ASSISTED NATURAL REGENERATION, National Green Tribunal.

SFM in protected forest area, Wildlife and human conflicts, Community participation in wildlife management; International programmes for biodiversity conservation, convention on biological diversity (CBD), CITES, ITTA, IUCN, WWF, UNFCCC, Kyoto Protocol, TRIPS, (IPR) Intellectual Property Right and bio resource patenting.

### Practical

Practice of Participatory Rural Appraisal technique. Preparation of micro plan for sustainable forest management. Resource survey and preparation of resource map. Exercise on designing training program for sustainable forest management. How to prepare leaflets and pamphlets ?.

### Suggested Readings

Anonymous. 2006. *Report of the National Forest Commission*. Govt. of India, New Delhi.

E. Claussen, V. A. Cochran, and D. P. Davis. 2001. *Climate Change: Science, Strategies, & Solutions*, University of Michigan.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International; Rome, Italy.

*Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Streck, C et al, 2006 *Climate Change and Forests Emerging Policy and Market Opportunities Today & Tomorrow's Printers and Publishers New Delhi.*







  
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**Theory:**

Introduction, objective and scope of urban forestry, History of Urban Forestry/Distribution and Ownership of the Urban. Forest Functions and Values of the Urban Forest, Urban Forest Environment, Tree Hazard Assessment and Management of Street, roads and parks, tree inventories and Valuation. The Urban Wildland Interface, Species selection for Street Tree and Park Management: Planting, Tree Maintenance, Removals. Urban Forestry Ordinances, biomass estimation for carbon stock assessment and mitigation. Carbon footprint calculation, Report writings on different aspects of urban forestry for the improvement of communication skills.

**Suggested Readings**

1. Urban forestry: planning and management by Malcolm Fisher, Syrawood publication house.
2. Forestry and forest resources edited by V.K. Prabhakar, Anmol Publication, New Delhi.
3. Urban and recreational forestry by S.S. Negi, International book distributors Dehradun.
4. Manual of forestry by S.S. Negi, Bishen singh, Mahendra pal singh, Dehradun.
5. Plantation Forestry by R.K. Luna.

**B. FOREST GENETIC RESOURCES****PAPER I. BREEDING METHODS IN FOREST TREES****Cr.4 (3+1)****Theory**

Introduction to plant breeding, Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy- Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes. Long-term and short-term breeding populations. Genetic variation and Heritability, Selective breeding methods- mass, family, within family, family plus within family, Grading system of plus trees in natural stands and \plantations regression systems, mother tree selection, Selection for different traits. Clonal selection and hybridization. Genetic testing programs - mating designs, complete designs - nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs - open pollinated mating and polycross mating.

Experimental designs in genetic testing. Selection for disease resistance, mutation and polyploidy in plant breeding, Marker assisted selection. Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance. Tree improvement case histories.

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Calculating gene and genotype frequencies. Flow chart for different breeding methods.

### Practical

Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete designs - nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs - open pollinated mating and polycross mating. Selection for biotic and biotic stresses.

### Suggested Readings

*Breeding*. ICAR.

FAO. 1985. *Forest Tree Improvement*, FAO Publ,

Faulkner R. 1975. *Seed Orchard* Forestry Commission Bull.No.34.

Fins L, Friedman ST & Brotschol JV.1992..*Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

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

Namkoong, Gene, Kang, Hyun C., Brouard, Jeans S. *Tree Breeding: Principles and strategies*, Academic Press.

Steve Lee and John Woolliams. 2013. *Novel Tree Breeding*. Publinia@inia.es

Wright JW. 1976. *Introduction to Forest Genetics*, Academic Press.

Yanchuk, A.K. 2009. *Forest and forest plants*- Vol. III. Techniques in forest tree breeding.

Zobel BJ Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

## PAPER II. FOREST TREES REPRODUCTIVE BIOLOGY AND SEED ORCHARDS CR.4 (3+1)

### Theory

Importance and application of reproductive biology in tree breeding. Modes of reproduction: vegetative, asexual, sexual reproduction their breeding systems and sex expression. Monoecy, dioecy and its evolution. Out-crossing mechanism in forest trees. Environmental effects on sex expression. Floral biology. Initiation and development- Microsporogenesis, Megasporogenesis, modes of pollination; Self and out-crossing. Fertilization in hardwood and softwood species. Embryo development, seed development, Seed dispersal and gene flow. Seed orchard need, establishment of seed orchard, hybrid and research seed orchard, selection and preparation of seed orchard site, isolation, orchard size, orchard design. Seed orchards – production and management,

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different types of seed orchards – SSO and CSO- merits and demerits. Progeny Pests and disease management. Seed production area- its production and management.

### Practical

Sex expression in forest trees. Out crossing mechanisms in forest trees. Measurement of pollen flow in wind-pollinated and insect-pollinated species. Pollen viability and fertility. Seed dispersal mechanism. Visit and study of seed orchard design. Plant growth regulator application for flower induction. Study the Intraclonal variation in floral and seed characters

### Suggested Readings

FAO.1985. *Forest Tree Improvement*, FAO Publ.

Faulkner R. 1975. *Seed Orchard* Forestry Commission Bull.No.34.

Fins L, Friedman ST & BrotschollV. 1992. *Handbook of Quantitative Forest Genetics*.

Joshi B.N. & P. S. Shrivastava.Reproductive Biology of plants. Springer verlog Berlin & Heidelberg Germany & Co ISBN – 9783642501357.

Khosla PK. 1981. *Advances in Forest Genetics*. Arnbika Publ., New Delhi.

Khrwer.

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

Manoj K. Sharma. 2012. Reproductive Biology of Angiosperm, Voyu Education in India. ISBN-9789382174684.

Shivana H. 2012. *Handbook of forest Biology*. Today's and Tomorrow printers and publisher, New Delhi.

Shrivastava K.R. Pollen Biology& Biotechnology. CRP Press. 2019.

Singh. V. Ponde& P.C. Jain. 2012. Embryology of Angiosperm, Rastogi Publication. ISBN 935078159x

Surendraran C, Sehgal RN & Parmathama M. 2003.*A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction toForest Genetics*. Academic Press.

Zobet BJ &Talbert J. 1984.*Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

### PAPER III. MOLECULAR GENETICS OF FOREST TREES

CR4 (3+1)

#### Theory

Genome: Nuclear Genome, Mitochondria Genome, Chloroplast Genome. Evolution of the three Plant Genomes. DNA replication, Transcription and Translation of forest tree Genes. Genetic code.

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Gene expression. Regulation of Gene Expression. DNA damage, repair and recombination. Genetic diversity/Genetic variation of forest trees: causes and advantages. Genetic characterization of forest tree species. Morphological, Biochemical and Genetic markers. Molecular markers: Dominant and codominant, Types of molecular markers: advantages and disadvantages. Techniques in molecular genetics of forest trees: DNA isolation, DNA quantification, DNA restriction; Primer, gel electrophoresis; southern, northern and western blotting, polymerase chain reaction, gene sequencing.

Polymorphism and its significance. Calculation of genetic diversity within and between forest tree populations. Molecular markers and genome mapping. Application of molecular markers in forest tree improvement. Genomics of wood formation. Molecular genetics of cellulose biosynthesis. Bioinformatics- its significance in forest tree genetics.

### Practical

Estimation of genetic diversity between/among forest tree populations through Morphological markers. Preparation of solutions for DNA isolation, Electrophoresis and PCR Standardization of protocols for DNA isolation of different forest tree species. Standardization of working protocol for different markers. Estimation of genetic diversity between/within forest tree population through molecular markers.

### Suggested Readings

American Soc. Of Plant Physiologists, Maryland, USA Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA

Bob B. Buchanan Wilhem Gruissem and Russel L. Jones. 2002. Biochemistry & Molecular Biology of plants. Wiley CDA

Brow T. A2007 Genomes – 3 – Garland Science House, New York.

Buchanan, BB, W Gruissem, RL Jones. 2000. Biochemistry and Molecular Biology of Plants.

David Freifelder 1996. Essentials of Molecular Biology, Panima Publishing Company, New Delhi.

Douglas S. Falconer, Trudy F.C. Mackay 2012. *Introduction to Quantitative Genetics*. Darling Kindersley, India Pvt Ltd.

Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. 2012 GENES XI 11 th Edition. Jones and Bartlett Publisher.

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John Wiley & Sons, Somerset NJ Alberts, B. Bray, D Lewis, J., Raff, M., Roberts, K and Walter 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.

Kole, Chittaranjan 2013. *Forest Trees: Genome Mapping and Molecular Breeding in Plants.*, Today & Tomorrow's Printers and Publishers New Delhi

Lewin B. 2000. Genes VII. Oxford University Press, New York.

Schnell, R J et al 2012. *Genomics of Tree Crops.* Today & Tomorrow's Printers and Publishers New Delhi.

S.M. Jain and S.C. Minocha. 2002. Molecular Biology of Woody Plants. Kulwer Academic Publisher, London.

Sandeep kumar, Mathias Fladung. 2003. Molecular genetics and Breeding of forest trees. Food product press. An imprint of Hawarth press. Inc New York. London. Oxford.

#### PAPER IV: QUANTITATIVE GENETICS OF FOREST TREES

CR 4(3+1)

##### Theory

Back ground of quantitative genetics, extension of Mendelian genetics into quantitative genetics, Statistical parameters used in quantitative genetics, polygenic traits, Selection theory for a quantitative character. Fisher's fundamental theorem on natural selection and its implications. Multiple-factor-hypothesis. Mating systems in forest trees, Random mating consequences in small populations

Pedigree population and inbreeding, inbreeding coefficient, rate of inbreeding, Effect of inbreeding on mean and variance, Heterosis and causes for heterosis in F1 and later generations. Models of gene action, estimation of population mean, phenotypic value, breeding value, dominance deviation G x E component of variance, interaction and environment deviation. Estimation of genetic components of variance through resemblance of relative's covariance. Heritability-its estimation and significance. Correlation characters- genetic and environmental correlations. Prediction of selection response: patterns, asymmetry, and causes. Selection criteria and use of information from relatives, response and indirect selection. Combining ability effects, Selection for combining ability, Threshold characters.

##### Practical

Quantitative and qualitative character analysis in forest tree species.

Phenotypic, genotypic correlations and path analysis of forest trees.

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Estimation of variance components from analyses of variance using various mating designs of forest trees.

Estimation of population mean, phenotypic value, and breeding value of a provenance.

### Suggested Readings

FAO, 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard*. Forestry Commission Bull.No.34.

Fins L, Friedman ST & Brotschol JY. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

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

Phundan Singh. 2012 Objectives of quantitative genetics. Ludhiana Kalyani Publishers.

R.K Singh and B.D. Chaudhary. 2012 Biometrical Methods in Quantitative Genetics Analysis. Kalyani Publishers.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Thirugna Kumar. 2012 Objectives Genetics and Crop Breeding. New India Publishing Agency.

White, TL, Adams, WT and D.B. Neal. 2007 *Forest Genetics*. CABI Publishing, UK.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GY & Stahl P, 1987. *Growing Exotic forests*. John Wiley & Sons.

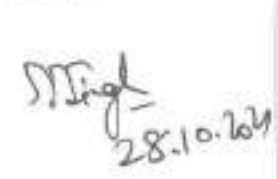
### PAPER V: FOREST GENETIC DIVERSITY, CONSERVATION & ENVIRONMENTAL IMPACT CR 4(3+1)

Forest biodiversity: concept, levels Values, Services and threats, Levels of Genetic Variation in Forest Trees. Characteristics of Forest Genetic Diversity, Ecotypes, Subspecies, Population, Metapopulation, Provenance, Land race, Cline. Dynamics of forest genetic diversity: Genetic erosion, Population bottleneck, Genetic drift, Selection, Migration and Mutation and induced genetic diversity in forest tree species. Diversity of biogeographic zones of India. Hotspots of forest genetic diversity. Forest Genetic resource mapping biodiversity indices, methodology of biodiversity conservation, Evolutionary mechanism of FGR due to Environmental Change. Some important threatened/endemic/critically endangered plants of India, Intellectual property rights. The







  
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Biological Diversity Act, 2002, Quarantine laws and FGR exchange. International initiatives in Biodiversity Conservation

### Practical

Visits and survey of forests biodiversity within their natural habitat. Measurement of forest biological diversity. FGR analysis of Natural stands in nearby forest area.

### Suggested Readings

1. FAO. 1985. *Forest Tree Improvement*. FAO Publ.
- Faulkner R. 1975. *Seed Orchard* Forestry Commission Bull.No.34.
- Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
- Fred W. Allendorf, Gordon H. Luikart, Sally N. Aitken. 2012. *Conservation and the Genetics of Population*, 2<sup>nd</sup> Edition ISBN: 978-1- 118- 40857-5, Wiley E-Book.
- Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
- Mahmut Caliskan.2012. *Genetics Diversity in Plants*. In Tech Publishers.
- MahmutCaliskan. 2012. *The Molecular Basis of Plants Genetics Diversity*. In Tech Publishers
- Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
- Padmini Sudarsana, Madhugiri Nageswara-Rao and Jaya R. Soneji. 2012. *Tropical Forest*. A free online edition of this book is available at [www.intechopen.com](http://www.intechopen.com)
- Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
- Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
- Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
- Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic forests*. John Wiley & Sons.

### PAPER: VI. Urban Forestry

CR.2

#### Theory:

Introduction, objective and scope of urban forestry, History of Urban Forestry/Distribution and Ownership of the Urban Forest, Functions and Values of the Urban Forest, Urban Forest Environment, Tree Hazard Assessment and Management of Street, roads and parks, tree inventories and Valuation. The Urban Wildland Interface, Species selection for Street Tree and Park Management: Planting, Tree Maintenance, Removals, Urban Forestry Ordinances, biomass estimation for carbon stock assessment and mitigation. Carbon footprint calculation. Report writing on different aspects for the improvement of communication skills.

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References:

1. Urban forestry: planning and management by Malcolm Fisher, Syrawood publication house.
2. Forestry and forest resources edited by V.K. Prabhakar, Anmol Publication, New Delhi.
3. Urban and recreational forestry by S.S. Negi, International book distributors Dehradun.
4. Manual of forestry by S.S. Negi, Bishen singh, Mahendra pal singh, Dehradun.
5. Plantation Forestry by R.K. Luna

## SEMESTER- IV

### FOREST MANAGEMENT

#### **1. FIELD TRAINING (ATTACHMENT WITH STATE FOREST DEPARTMENT FOR UNDERSTANDING OF FOREST OPERATIONS AND MANAGEMENT PRACTICES CURRENTLY USED IN FOREST MANAGEMENT)**

Visit to modern forest nurseries, herbal gardens and watersheds. To study the medicinal and aromatic plants diversity, their conservation and domestication. Study the felling and logging operations, timber lots and industrially important products. Introduction to Working Plan, data generation-enumeration and volume/yield calculation. Writing of compartment history files. Study the catchment area treatment plant and FDA. Study the Regeneration and Management of regionally important forestry tree species. Laying out sample plots, stump analysis, preparation of local volume table and use of forestry field equipment's / instruments. Visit to National Parks, Sanctuaries and Bio-sphere reserves. Visit to ecologically degraded areas around cement plants, mined areas etc. and study rehabilitation measures adopted. Visit to plantation site and data collection for its growth pattern and feasibility.

#### **2. FOREST BASED INDUSTRIAL TRAINING**

Study the nature structure of Industrial Training and Business Organization: Raw material procurement and processing; Production, Marketing and Economics at Wood workshop and saw mills/wood seasoning and preservation treatment units/Pulp and Paper Industries/ Katha making industry/ Resin, Turpentine, Gums, Tendupatta, Chironji Industry; Herbal Pharmacies and other wood product industries.

#### **3. ICT TOOLS AND TECHNIQUES APPLICATION IN FORESTRY.**

Introduction to MS Office (Word, Excel, Power Point). Introduction of Statistical, GIS & plagiarisms softwares. Application of Remote sensing for forest resource measurements.

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Introduction to Multi-Media and its application. E-content survey consultation of scientific database concept of online learning platform (MOOCS, SWAYAM, NPTEL).

#### **4. STUDENT PROJECT DISSERTATION**

Field/laboratory based research work on different aspects of forestry, wildlife and environmental sciences

### **SEMESTER- IV**

#### **FOREST GENETIC RESOURCES**

##### **1. FIELD TRAINING (ATTACHMENT WITH STATE FOREST DEPARTMENT FOR ANALYSIS OF FGR FOREST OPERATIONS AND MANAGEMENT OF FOREST GENETIC RESOURCES)**

Learn to make FGR Inventory. Analysis of Provenance Variation. Identification of self and cross pollinating forest trees and its genetic diversity pattern analysis. Genetic diversity status on the basis of morphological markers. Population wise conservation priority zones of specific forest tree species. Species wise adaptability in the natural forest stands. Identification of plus tree and elite tree zones in forest. Flowering and seeding pattern of forest. Seed dispersal pattern and its influence on forest genetic resources. Identification of species wise seed production areas. Clone, seed, pollen and specimen collection. Identifying the factors which are threat to forest genetic diversity. Characterization of Genetic Potential against changing climate. Forest regeneration status. Making plans for long-term and short term tree improvement programmes. Development of practical step guide to the in-situ conservation of FGR. Forest genetic resource management by forest department.

##### **2. FOREST BASED INDUSTRIAL TRAINING**

Study the nature structure of Industrial Training and Business Organization: Raw material procurement and processing; Production, Marketing and Economics at Wood workshop and saw mills/wood seasoning and preservation treatment units/Pulp and Paper Industries/ Katha making industry/ Resin, Turpentine, Gums, Tendupatta, Chironji Industry; Herbal Pharmacies and other wood product industries.

##### **3. ICT TOOLS AND TECHNIQUES APPLICATION IN FORESTRY.**

Introduction to MS Office (Word, Excel, Power Point). Introduction of Statistical, GIS & plagiarisms softwares. Application of Remote sensing for forest resource measurements.

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Introduction to Multi-Media and its application. E-content survey consultation of scientific database concept of online learning platform (MOOCS, SWAYAM, NPTEL).

#### 4. STUDENT REPORT DISSERTATION

Field / laboratory based mini research work on different aspects of forestry, wildlife and environmental sciences.

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