COURSE SYLLABUS

FOR

B.Sc. FORESTRY

(w. e. f. 2015-16)

"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)

PRACTICAL

Histogram, frequency polygon, Bar chart, pie Chart. Measures of central tendency: Mean median and mode for raw and grouped data.Construction of frequency distribution table and its graphical representation. Measures of dispersion: Range, mean deviation, Quartile deviation and standard deviation for raw and grouped data. Paired't' test, Chi-square test for contingency tables and theoretical ratios Correlation and linear regression. Studies of computer components MS-Word, MS-Excel, MS-Power point.

Suggested Readings:

1. Ron Mansfield, The Compact Guide to Microsoft Office.
2. Chris Lewis, Essential Tips: Using the Internet
3. Gene Weisskopf, ABCs of Excel 97
4. Kenneth N.Berk(1998). Introductory Statistics.www.amazon.com
5. Arora P N (2003) Biostatistics.Himalayan publishers.
6. Marcello Pagano and Kimberlee Gauvreau (2008) Principles of Biostatistics.Jhon and Wiley sons ltd.

PAPER II. FOREST ENGINEERING AND SURVEYING CR.4 (3+1)

Engineering survey, scope and types of surveying, chain surveying, types and instrumentation traversing, triangulation, survey stations, base line, check and tie lines, ranging of survey lines, offsets and their types, chain of sloppy grounds, chaining across obstacles, cross staff surveying, compass surveying, chain and compass traversing, magnetic and true bearings, prismatic compass, local attraction, Plane table surveying, plane table and its accessories, methods of plane table surveying. Leveling Instruments, total station. Counter surveying. Map and reading, its method and importance in Forestry,

Building materials- concrete, brick, cement, sand and strength and characteristics, site selection for building construction. Forest roads – alignment, construction and drainage, retaining walls, breast wall, waterways and culverts. Bridges-types, selection of site, simple wooden beam bridges, check dams, spurs, farm ponds, earth dams.

PRACTICAL

Chain survey, compass traversing, plane table surveying, leveling, calculation of earth work for construction of forest. Earth dams, Alignment of forest roads. Design of simple wooden beam bridge. Design of retaining walls, Design of check dams.

Suggested Readings:

1. Ram Parkash (1983) Forest surveying. International Book Distributors, Dehradun.
2. B. C. Punmia (2005) Surveying. Firewall Media,
3. W. Schofield and M. Breach (2007).Engineering Surveying. British Library Cataloguing in Publication Data
4. Masani N J (2006) Forest engineering.Natraj publishers.
5. Michal & Ojha (1992) Principles of Agricultural Engineering, Vol.-I & Vol.-II.Kalyani publishers.

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SEMESTER-WISE CHOICE BASED CREDIT SYSTEM OF B.Sc. FORESTRY COURSE

B.Sc. I[st] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Introduction and Practices of Silvicultrure	3	--	1	4
02.	Fundamentals of Geology and Soil Science	3	--	1	4
03.	Cytogenetics and Plant Breeding	3	--	1	4
04.	Introductory Botany	3	--	1	4
05.	Basic Mathematics	3	1	--	4
06.	Physical Activities (NC)	--	--	--	1
		Total Credits			**21**

B.Sc. II[nd] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Introductory Forest Economics	3	--	1	4
02.	Forest Ecology, Biodiversity & Conservation	3	--	1	4
03.	Principles of Hydrology and Watershed Management	2	1	1	4
04.	Forest Soil - Chemistry and Fertility	3	--	1	4
05.	Environmental Science	3	--	1	4
06.	Silviculture Systems	2	--	1	3
		Total Credits			**23**

B.Sc. III[rd] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Forest Biotechnology	3	1	1	5
02.	Wood Anatomy	3	--	1	4
03.	Forest Mensuration	3	--	1	4
04.	Principles and Methods of Tree improvement	3	--	1	4
05.	Forest Management	3	--	1	4
06.	Structural Grammar and Spoken English (NC)	2	--	--	2
		Total Credits			**23**

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B.Sc. IVth Semester					
S. No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Wood Technology & Nanoforestry	3	--	1	4
02.	Nursery Management and Commercial Forestry	3	--	1	4
03.	Rangeland Management	2	1	1	4
04.	Remote sensing and Its application in Forestry	3	--	1	4
05.	Forest Pathology	3	--	1	4
06.	Forest Policy and Legislation	2	1	1	4
07.	Student Project	--	--	1	1
		Total Credits			**25**

B.Sc. Vth Semester					
S. No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Utilization of Non-timber Forest Products	3	--	1	4
02.	Forest Tribology & Ethno-Forestry	3	--	1	4
03.	Fundamentals of Horticulture and Its Application	2	1	1	4
04.	Tree seed Technology & Plantation Forestry	3	--	1	4
05.	Fundamentals of Wildlife & Its Management	3	--	1	4
06.	Introductory Crop Production and Meteorology	3	--	1	4
		Total Credits			**24**

B.Sc. VIth Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Fundamentals of Extension Education	2	1	--	3
02.	Agro Forestry system and Management	3	--	1	4
03.	Carbon Forestry	3	--	1	4
04.	Forest Entomology	3	--	1	4
05.	Marketing and Trade of Forest Produce	2	1	1	4
06.	Principles of Plant Physiology	3	--	1	4
		Total Credits			**23**

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B.Sc. VII[th] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Bio Statistics and Computer Application	3	1	1	5
02.	Forest Engineering & Surveying	3	--	1	4
03.	Wood Products & Utilization	3	--	1	4
04.	World Forestry Systems	2	1	1	4
05.	Entrepreneurship Development and communication skills	2	1	--	3
				Total Credits	**20**

B.Sc. VIII[th] Semester		
S.No.	Title of Paper	Credits
01.	Forest Institutes and Industrial Visit/training Project report writing, Presentation & Viva-voce	8
02.	Forestry Operations (Working Experience) Project report writing, Presentation & Viva-voce	9
03.	Socio-economic survey - village attachment	8
	Total Credits	**25**

Grand Total of Credits = 184

- The student project will be allotted in III semester and will be evaluated at the end of IV semester. Students may choose any project related to their curriculum. There will be no supervisor for this project.
- Visits to forest operation sites, forest nursery, wildlife habitat and plantation sites will be conducted as per the requirement of curriculum.

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MARKS DISTRIBUTION FOR B.Sc. FORESTRY PROGRAMME (4 YEARS/8 SEMESTERS)

B.Sc. I[st] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Introduction and Practices of Silvicultrure	60	40	100
02.	Fundamentals of Geology and Soil Science	60	40	100
03.	Cytogenetics and Plant Breeding	60	40	100
04.	Introductory Botany	60	40	100
05.	Basic Mathematics	60	40	100
06.	Physical Activities (NC)	--	50(NC)	50(NC)
07.	Practical	--	--	200
	Total			**700**

B.Sc. II[nd] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Introductory Forest Economics	60	40	100
02.	Forest Ecology, Biodiversity & Conservation	60	40	100
03.	Principles of Hydrology and Watershed Management	60	40	100
04.	Forest Soil - Chemistry and Fertility	60	40	100
05.	Environmental Science	60	40	100
06.	Silviculture Systems	60	40	100
07.	Practical	--	--	200
	Total			**800**

B.Sc. III[rd] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Forest Biotechnology	60	40	100
02.	Wood Anatomy	60	40	100
03.	Forest Mensuration	60	40	100
04.	Principles and Methods of Tree improvement	60	40	100
05.	Forest Management	60	40	100
06.	Structural Grammar and Spoken English (NC)	--	50(NC)	50(NC)
07.	Practical	--	--	200
	Total			**700**

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B.Sc. IV[th] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Wood Technology & Nanoforestry	60	40	100
02.	Nursery Management and Commercial Forestry	60	40	100
03.	Rangeland Management	60	40	100
04.	Remote sensing and Its application in Forestry	60	40	100
05.	Forest Pathology	60	40	100
06.	Forest Policy and Legislation	60	40	100
07.	Practical	--	--	200
08.	Student Project	--	50	**50**
	Total			**850**

B.Sc. V[th] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Utilization of Non-timber Forest Products	60	40	100
02.	Forest Tribology & EthnoForestry	60	40	100
03.	Fundamentals of Horticulture and Its Application	60	40	100
04.	Tree seed Technology & Plantation Forestry	60	40	100
05.	Fundamentals of Wildlife & Its Management	60	40	100
06.	Introductory Crop Production and Meteorology	60	40	100
07.	Practical	--	--	200
	Total			**800**

B.Sc. VI[th] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Fundamentals of Extension Education	60	40	100
02.	Agro Forestry system and Management	60	40	100
03.	Carbon Forestry	60	40	100
04.	Forest Entomology	60	40	100
05.	Marketing and Trade of Forest Produce	60	40	100
06.	Principles of Plant Physiology	60	40	100
07.	Practical	--	--	200
	Total			**800**

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B.Sc. VII[th] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Bio Statistics and Computer Application	60	40	100
02.	Forest Engineering & Surveying	60	40	100
03.	Wood Products &Utilization	60	40	100
04.	World Forestry Systems	60	40	100
05.	Entrepreneurship Development and communication skills	60	40	100
06.	Practical	--	--	200
	Total			**700**

B.Sc. VIII[th] Semester		Marks
S.No.	Title of Paper	Total
01.	Forest Institutes and Industrial Visits Project report writing, Presentation & Viva-voce	200
02.	Forestry Operations (Working Experience) Project report writing, Presentation & Viva-voce	200
03.	Socio-economic survey –village attachment Project report writing, Presentation & Viva-voce	150
	Total	**550**
	GRAND TOTAL	**5900**

- Internal assessment marks distribution will be as given below:
  - 01. Midterm test - 30 Marks
  - 02. Attendance - 05 Marks
  - 03. Assignment - 05 Marks
  - **Total - 40 Marks**
- Forest & Industrial visits/ Training, Forestry Operation (working experience) and Socio economic survey – village attachment will be evaluated by one external examiner from the outside of the Vishwavidyalaya and two Internal Examiners from the Department.
- Student project will be evaluated by a pannel of two Departmental teachers.
- Practical examination for each class will be evaluated by two teachers of the Department.
- Minimum passing marks for each theory paper will be 40 %.
- Minimum passing marks for each Student project, practical, training programme, attachment programme, Village surveys etc. will be 40%.

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SEMESTER – I

PAPER I. INTRODUCTION AND PRACTICES OF SILVICULTURE Cr.4 (3+1)

Definition, Classification of Forest and Forestry, branches of Forestry and their relationship. Status of forest in India and their role. Trees and their distinguishing features. Growth and development. Forest reproduction, flowering, fruiting, seedling behavior. Definition, objective and scope of silviculture.

Site factors- Climatic, edaphic, physiographic, biotic factors and their interactions. Classification of climatic factors. Role played by light, temperature, rainfall, snow, wind, humidity, and evapo-transpiration in relation to forest vegetation. Edaphic factors, Physiographic factors and influence. Biotic factors- influence of plant insect wild animals man and domestic animals. Impact of controlled burning, grazing, influence of forest on vegetation. Micro climate and its effect.

Regeneration: Natural, Artificial and factors affecting it. Requirement for natural regeneration. Nursery: classification, site selection, layout, preparation of bed, sowing of seed, planting out, transplanting and maintenance. Dieback of seedling with examples.

Regeneration Survey. Forest types of India. Tending operation: Weeding, cleaning, thinning and improvement felling.

PRACTICAL

Acquaintance with various technical terms. 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 the natural regeneration, afforestation and reforestation success. Determine the soil profile in GGV nursery. Lay outing of nursery bed for sowing. Soil preparation practices for nursery bed. Plus tree identification for seed collection and seed collection. Seed cleaning & purity test of seed. Calculation of seed quantity. Seed sowing in nursery bed.

Suggested Readings:

1. Khanna, L. S. (1984) Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun.
2. Ram Prakash and L.S. Khanna. (1991) Theory and Practice of Silvicultural systems. International Book Distributors, Dehra Dun.
3. Dwivedi, A.P. (1993) A Text Book of Silviculture, International Book Distributors, Dehradun.
4. Dwivedi, A. P. (1992) Principles and Practice of Indian Silviculture, Surya Publication.
5. Champman, G.W. and Allan, T.G. (1978) Establishment Techniques for Forest Plantation F.A.O Forestry Paper No.8. F.A.O Rome.
6. Pradip Krishan (2013) Jungle trees of central India.Penguin Book distributors,India.

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PAPER- II. FUNDAMENTALS OF GEOLOGY AND SOIL SCIENCE Cr.4 (3+1)

Composition of earth's crust, soil as natural medium for plant growth, major components of soil, rocks-types-Igneous, Sedimentary and Metamorphic rocks, Soil minerals formation. Weathering of rocks and minerals-weathering factor, physical-Chemical-biological weathering and procedure of soil formation. Problem of soils: salted, permeable, flooded and sandy soils. Physical properties-texture, definition-methods of textural analysis, specific gravity-definition and measurement, bulk density. Pore space-definition-factors affecting soil porosity, soil colour-definition–its significance -soil moisture-organic matter, soil structure- definition-classification factors influencing genesis of soil structure, soil consistency, plasticity. Soil air, composition and factors influencing soil aeration, soil temperature-sources, and measurement, chemical properties. Soil organic matters decomposition, pH, nutrient availability-soil buffering capacity, Soil water forms-hygroscopic, capillary and gravitational-soil moisture, hygroscopic coefficient-wilting point- field capacity- moisture, water holding capacity, Soil orders- land capability classification.

PRACTICAL

Identification of rocks and minerals; Collection and preparation of soil samples, soil analysis for moisture, color, bulk density, organic matter, pH. EC: Textural analysis, study of soil profile, excursion tour for identification of rocks and minerals and profile study.

Suggested Readings:

1. Armson, K.A. Forest Soils, (1977), IBD Publisher, Dehradun.
2. Gale, M,R. Forest Soil Research, (2006). IBD Publisher, Dehradun.
3. Bredy,N.C Weil, R.R.(2009) Elements of nature and properties of Soil Sciences.Printice Hall of India.
4. Biswas, T.D. and S.K. Mukherjee (2001) Text book of soil Science. Tata Mc. Grew Hill, Publishning Co., New Delhi.
5. Wild, A. (1988) Soil conditions and plant growth. 11th edition, ELBS, London.
6. Mark Ashman and Geeta Puri (2008) A clear and concise introduction to soil science.Wiley-Blackwell publishers.
7. A.K.Kolay (1997) Basic concepts of Soil science.Wiley Estarn Ltd.
8. Das,D.K (2013) Introductory Soil Science.Kalyani publishers.

PAPER- III. CYTOGENETICS AND PLANT BREEDING Cr.4 (3+1)

Plant cell: its structure and function. Nucleus chloroplast and mitochondria. Chromosome its structure and function. Chromosomal aberration.Polyploidy.

Genetics and hypothesis theories. Physical basis of heredity. Cell reproduction, mitosis, meiosis and its significance. Linkage and crossing over. Mendel's principles of heredity. Deviation from mendelien inheritance, pleiotropy, threshold characters, co-dominance, chromosome theory of inheritance, gene

interaction, multiple alleles. Sex determination-theories, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity. Structure of DNA and its replication, RNA:its structure and function. Evidence to prove DNA as genetical material. Mutation and its classification.

Plant breeding its aim and objectives, modes of reproduction, methods of breeding, selection types an its importance. Hybridization, hybrid vigor. Mutation breeding.

PRACTICAL

Preparation of slide showing various stages of mitosis. Preparation of slides showing various stage of meiosis. Testing the viability and germination of pollen grains. Solving the problems based on Mendalian laws, floral morphology, selfing, emasculation and crossing techniques.Phenotypic variation analysis in trees of natural and plantation sites.

Suggested Readings:

1. Prasad,G.(1998).Introduction to Cytogenetics.Kalyani publishers New Delhi.India
2. Singh.P.(2005).Elementry of Genetics. Kalyani publishers Ludhiana.India
3. Zobel, B.J. and J. Talbert. (1984) Applied forest tree improvement. John Wiley & Sons, New York.
4. Hayer, H. and D. Smith (1975). Methods of plant breeding. McGraw Hill Book Co., London.
5. Richards, A.J. (1986) Plant breeding systems. George Allen and Urwin, London.
6. George Acquaah. (2012) Principles of Plant Genetics and Breeding, 2nd Edition. Wiley-Blackwell
7. B.D. Singh (2014) Fundamentals of Genetics. Kalyani Publishers
8. P.K. Gupta (2015) Cytology, Genetics and Evolution. Rastogi publications,Meerut,India.
9. Wikipedia.org.

PAPER IV. INTRODUCTORY BOTANY Cr.4 (3+1)

Introduction to Botany and general classification of plants. Parts of a typical flowering plant. Morphology of root, its modification, stem, modification of stem, leaves, types of leaves stipules, venation, modification of leaves, function of leaves and flower. Parts of typical flowering plants, position of floral parts and leaves viz. Hypogyny, Perigyny, Epigyny Bracts, Placentation, Types of placentation. Structure and types of plant tissues internal structure of dicot, and monocot stems, root and a typical leaf. Significance of life cycles with special reference to alternation of generation in Nostoc, Rhizopus, Funaria, Adiantum, Pinus and a flowering plant. Importance of plants in relation to environment.

PRACTICAL

Morphological studies of root, stem, leaf and flowers. Studies of permanent slides of histology and anatomy. Morphological studies of gametophytes and sporophytes of the plants pertaining to the life cycle. General survey of the local vegetation. A field trip during the semester.

Suggested Readings:

1. Shiva, M.P. A Handbook of Systematic Botany, (1986).IBD Publisher, Dehradun.
2. NCERT.A textbook of Botany.
3. Strasburger, Schenck, Noll, Fritz, Karsten and Lang, W. H.(2010). A textbook of Botany. Academic Press, New York.
4. Singh,V and Jain D.K. (2013) Biology. Nageen Prakashan Pvt Ltd.Meerut,India.
5. Singh Pande Jain (2002).A textbook of Botany. Rastogi publications,Meerut,India

PAPER V. BASIC MATHEMATICS Cr.4 (3+1)

Complex numbers, conjugate of complex numbers, properties of complex numbers, modulus, geometrical representation of complex numbers. Polar form, square root and cube root of a complex number, cube root of unity. Arithmetic progressions, Geometric progression, harmonic progression, binomial theorem for positive Index, measurement of an angle in radian and degree and its problems, trigonometric ratio and problems related to them. Addition, Subtraction and Product formula on Sin, Cos, Tan formulae. Coordinate of point, distance between two points, coordinate of a point dividing the line joining two points in m:m ratios (internally and externally), mid-point, centroid, incentre and circumcentre of a triangle, area of a quadrilateral, matrices, addition, subtraction, multiplication of matrices, transpose, adjoint and inverse of a matrix. Determinant and its properties.

Suggested Readings:

1. Agrwal, R.S. (2012) Elementary Mathematics.Kalyani Publishers,New Delhi.
2. NCERT, Elementary Mathematics
3. Prasad, G. (1980) Differential Calculus. Pothishala publications,Allahabad,India
4. Prasad, G. (1980) Integral Calculus. Pothishala publications,Allahabad,India.
5. Hall and Knight (2012). Higher Algebra. Book place,New Delhi.

PAPER VII. PHYSICAL ACTIVITIES & YOGA (NC) Cr.1 (1)

Introduction to physical education & yoga. Posture exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules and regulation of important games, skill development in any one of the game-football, hockey,cricket, volleyball, ball badminton, throw ball. Participation in one of the indoor games- shuttle badminton, chess and table tennis. Rules and regulation of athletic events – board jump, high jump, triple jump. Javelin throw, discuss throw, short put short and long distance running, safty education.

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Movement education. First aid training, coaching for major games and indoor games Asans and indigenous ways of yoga for physical fitness. Pranayama and meditation.

SEMESTER – II

PAPER- I. INTRODUCTORY FOREST ECONOMICS Cr.4 (3+1)

Basic concept of economics, Nature and scope of economics and its relationship with other sciences. Types of goods, Concept and types of demand, law of demand, measures of demand elasticity, Concept and types of supply, law of supply, measures of supply elasticity, Types and theory of utility, Diminishing law of utility, equimarginal utility and Hicks-Allen approach for determining consumer equilibrium, Concept of revenue, Factors of production, their definition and characteristics, Law of diminishing marginal returns. Market – its classification and price determination under different market situations. Theory of consumption, Ricardian theory of Rent. Marginal productivity theory of wages, liquidity preference theory of interest. Marginal productivity theory, risk talking and uncertainty bearing theories of profit. National income and its concepts. Concepts and types of inflation.

Suggested Readings:

1. Edwin S. Mills (1975) Economic Analysis of Environmental Problems. New York: Columbia University Press
2. Fisher, A.C (1979) Resource and Environmental Economics. New York: John Wiley & Sons.
3. Orris C. Herfindahl (1969) Natural Resource Information for Economic Development. Baltimore: The Johns Hopkins University Press
4. Sharma, S.D (1975) A New Approach to Linear Programming. Meerut: Kedarnath, Ramnath and Co.
5. Tony Prato (1998) Natural Resource and Environmental Economics. Ames: Iowa State University Press
6. Subba S Reddy (2012) Agricultural Economics. Oxford and IBH publishers.

PAPER II. FOREST ECOLOGY, BIODIVERSITY AND CONSERVATION Cr.4 (3+1)

Historical development of ecology as a science. Concept of levels of biological organization. Ecosystem, classification and distribution. Forest environment- Major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology – Species interaction, Ecological succession, climax vegetation types, Methods to study effects of forest management on succession. Island Biogeography. Autecology of important tree species. Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Marine ecosystem and biodiversity, Principles of conservation biology, Ex situ and In situ methods of conservation, Genetical and evolutionary principles in conservation. Biosphere concept. Conservation – efforts in India and worldwide.

PRACTICAL

Study of microclimate and forest soils; Study of ecological modifications of leaves; Effects of fire on forest ecosystem; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems.

Suggested Readings:

1. Mishra, R. (1968) Ecology Work Book Oxford and IBH Publishing Co, Calcutta.
2. Odum, E.P (1983). Basic Ecology. Saunders College Publishing, Holt Saunders, Japan.
3. Odum, E.P. (1983) Fundamentals of Ecology, Natraj Publisher, Dehradun
4. Arvind Kumar (2005) Biodiversity and conservation. Today and Tommorow publishers, New Delhi.
5. FAO (2010-2015).Global forest resource Assessement.www.fao.org
6. FAO (2010-2015).State of forest resources. www.fao.org
7. Kumar and Asija. Biodiversity – Principles and conservation. Published by Updesh Purohit for Agrobios, Jodhpur, India.
8. Ashok Malik (2008) Dynamics of forest ecosystems. Today and Tommorow publishers, New Delhi.

PAPER III. PRINCIPLES OF HYDROLOGY AND WATERSHED MANAGEMENT

Cr.4 (2+1+1)

Definition and importance of hydrology. Hydrological cycle, weather and hydrology. Rainfall measurement and analysis, hydrologic properties infiltration, runoff, water holding capacity of soil. Free water, capillary water, hygroscopic water, ground water, evapotranspiration, water yield, interception, by stem flow, through fall, study of hydrographs. Influence of forests on hydrological cycle. Recharging of water wells and springs. Sedimentation, factors affecting Sedimentation. Flood and control measures. Water harvesting structure and farm ponds. Irrigation source: water wells, aquifers, water application methods, surface, subsurface, drip and sprinkler irrigation system.

Watershed management: objective, components and approaches for watershed management. Afforestation and forest management in watershed. Soil erosion, soil and water conservation practices and soil conservation structure like contour and graded bunding. Planning of watershed management activities, people's participation, preparation of action plan. Drainage: types of drainage systems, their selection, design, installation and maintenance.

PRACTICAL

Study of hydrological equipment, measurement and analysis of rainfall data. Study of different water harvesting structures, land leveling and its cost estimation, study of drip irrigation system, study of sprinkler irrigation system. Visit to watershed and its catchment area. Forest type study, drainage system and settlement under catchment.

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Suggested Readings:

1. P. Jaya Rami Reddy (2003) A textbook of hydrology.Kalyani publishers.
2. Hamilton, I.S. (1987) Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
3. Hamilton, I.S. (1988) Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
4. Moorthy,V.V.N. (1990) Land and Water Management, Kalyani Publishers, NewDelhi.
5. Oswal, M.C. (1999) Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
6. Rajesh Rajora, (1998) Integrated watershed Management, Ravat Publication, New Delhi.

PAPER IV. FOREST SOIL – CHEMISTRY AND FERTILITY Cr.4 (3+1)

Introduction; Forest soils cultivated soils. Properties of soils under forest and agricultural ecosystems. Soil colloids and exchange phenomenon. Essential nutrient elements occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N, P and K, Macro and micronutrient fertilizers and their uses, microorganism. Forest soil environment-distribution of various microorganisms in soil ecosystem and their interaction effects. Mineral Transformation-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers –their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N_2 fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur and micro nutrients. Mycorrhiza: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere concept.

PRACTICAL

Study the forest soil profile, determination of C.E.C. and exchangeable cations. Determination of available N,P & K content of soil, basic sterilization techniques, culturing and maintenance of micro organism occurring in soil, staining methods, study of decomposition of forest litter by CO_2- evolution method, preparation and inoculation technique for mycorrhiza and biofertilizers.

Suggested Readings:

1. Havlin J.L. and Tisdale S.L. (2013).Soil fertility and Fertilizers.Amazon.com
2. Halvin J and Pearson (2005). Soil fertility and fertilizers: An introduction to nutrient management.Printice Hall of India.
3. Biswas, T.D. and S.K. Mukherjee (1992) Text book soil fertility. Tata Mc. Grew Hill, Publishning Co., New Delhi.
4. Black, C.A. (1993) Soil fertility evaluation and control, Lewis publishers, London.
5. Kanwar, J.S. (1976) Soil Fertility – Theory and practice ICAR publication, New Delhi.

PAPER V. ENVIRONMENTAL SCIENCE Cr.4 (3+1)

Environment introduction, definition & importance. Components of environment, interaction with organism. Global and Indian environment, past and present status. Environmental pollution and pollutants. Air, water, food, soil, noise pollution, sources, causes and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazard waste management. Impact of different pollution on human. Organism and environment. Deforestation- forms and causes, relation to environment. Prevention and control of pollution- technological and sociological measures and solutions. Indian and global efforts. Climate change and its mitigation. Rio De Jenerio, Kyoto Protocol, Montreal Protocol. Environmental policy and legislation in India. Introduction to environmental impact assessment. Causes of environmental degradation- socio-economic factors. Human population growth and life style.

PRACTICAL

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

Suggested Readings:

1. Dhameja, S.K. (2007) Environmental Studies. S. K. Kataria and Sons, New Delhi 110006
2. Gupta, K.M. (2008) Environment and Ecology. Umesh Publication, New Delhi.
3. Srivastava, S. (2007) Environmental Studies. S. K. Kataria and Sons, New Delhi 110006
4. Deswal, S. (2007) Environmental Studies. S. K. Kataria and Sons, New Delhi 110006
5. Sharma,P.D (all editions).Ecology and Environment.Rastogi publications,Meerut,India.

PAPER VI. SILVICULTURE SYSTEMS Cr.3 (2+1)

Definition, Scope and classification. Even aged and uneven aged forest. Detailed study of silviculture system: Clear felling systems including clear strip, alternate and progressive strip system. Shelter wood system- Uniform system, Group system, Shelter wood strip system, Wedge system, Strip and group system, Irregular shelter wood system, Indian irregular shelter wood system, Selection system and its modifications. Accessory systems. Coppice system, Coppice of the two rotation system, Shelter wood coppice system, Coppice with standard system, Coppice with reserve, Coppice selection system, Pollard system.Conversion and its implications. Choice of silviculture system. Dauerwald concept. Culm selection system in Bamboo.Tending operations- weeding, cleaning, thinning, definition objective and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

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PRACTICAL

Perform a survey of forest area & chalk out a plan for Silviculture management. Study of vegetation features in G.G.V. campus & draw silvicultural treatment map. Assessment of growing stock of given site. Application of silviculture system in bamboo forest. Application of Tending operation carried out in forest crop.

Suggested Readings:

1. Ram Prakash and L.S. Khanna (1991) Theory and Practice of Silvicultural systems. International Book Distributors, Dehra Dun.
2. Khanna, L. S.(1984) Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun. P. 476.
3. Champman, G.W. and Allan, T.G. (1978) Establishment Techniques for Forest Plantation F.A.O Forestry Paper No.8. F.A.O Rome
4. David M. Smith. (1989) The Practice of silviculture. IBD Educational Pvt. Ltd. Dehradun, India.
5. Dwivedi, A. P. (1992) Principles and Practice of Indian Silviculture, Surya Publication

SEMESTER- III

PAPER I. FOREST BIOTECHNOLOGY **Cr.5 (3+1+1)**

Forest biotechnology its concept and utility. Plant cell, totipopentcy of cells, Embryogenesis, organogenesis and regeneration in vitro and somaclonal variation. Classification and physical properties of Carbohydrates, Proteins, Enzymes and lipids.

Macro-Propagation and its techniques, Micro propagation: Principles and application in forestry trees, meristem culture, Shoot tip culture and clonal propagation. Meristem culture and disease elimination. Anther, pollen and miscrospore culture, ovary and embryo culture, haploid, somatic hybrids. Plant growth hormones and environmental factors for plant tissue culture. Tissue culture as a tool for tree improvement.

Biomass energy production. Micrografting and its application to tree improvement. Genetic code. Genetic Engineering. Methods of gene transferees: direct and indirect genetic engineering, gene cloning and polymerase chain reaction. Molecular markers and its role in forest biotechnology. Role of molecular markers in tree improvement.

Recombinant DNA Technology: Restriction and modification enzymes; Vectors: plasmid, bacteriophage and cosmids. Application of genetic engineering in tree improvement in terms of disease, insect, drought and frost resistance. Transgenic trees.

Practical

Protocol and preparation of culture medium, Preparation of stock solutions. Sterilization techniques, preparation of culture medium for establishment of explants of forestry plants, multiplication of shoots, induction of roots, meristem culturing, callus cultures. Raising of tree seedling species under aseptic

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condition. Visit to Biotechnology Laboratory. Rooting, Hardening and planting out of tissue culture plants. Exercises on In-vitro pollination.

Suggested Readings:

1. Bajaj, Y.P.S. (1986) Biotechnology in Agriculture and Forestry Springer Verleg, New York.
2. Bonga, J.M. and Durjan, J. (1987) Cell and Tissue culture in Forestry Vol. I & II. Martinus Nijost Publishers, Dordrecht.
3. Burley, J. and B.T. Styles. (1976) Tropical trees: variation breeding and conservation. Academic Press, London. 4. F.A.O. (1985) Forest tree improvement. FAO Publication, Rome, Italy. 270 p.
4. White, T.M. and G.R. Hodges. (1989) Predicting breeding values with application in forest improvement. Kluwar Publishing, Netherlands.
5. Wright, J.W. (1976) Introduction to forest genetics. Academic Press, New York. 463 p.
6. Zobel, B.J. and J. Talbert. (1984) Applied forest tree improvement. John Wiley & Sons, New York.
7. Hainer,R. (1998). Biotechnology in Forest Tree Improvement. (FAO Bulletin 1994). International Book Distributors. Dehra Dun.
8. Khan I M (2014) Forest Biotechnology.Today and Tommorow publishers,New Delhi.

PAPER II. WOOD ANATOMY **Cr. 4 (3+1)**

Introduction to Wood Anatomy. The plant body – Cell and organelles, meristems, promeristem, primary meristem, secondary meristem, apical and intercalary meristems. Simple tissues- parenchyma, collenchyma, sclerenchyma. Complex and vascular tissues. The secondary growth in woody plants. Mechanism of wood formation. Formation of early and late wood, growth rings, transformation of sapwood to heartwood. The macroscopic features of wood, bark, sapwood, heartwood, pith, growth rings, wood rays, resin or gum-canals. Cell inclusions. Physical properties of wood; colour, hardness, weight, texture, grain, lusture etc. Mechanical properties of wood i.e. modulus of elasticity, ultimate stress, fiber stress at elastic limit, important factor influencing strength properties. Chemistry of wood and wood components. Wood water relationship. Abnormalities in wood: deviation from typical growth form (leaning, bending, crook, fork, and buttress), grain deviation, false and discontinuous growth rings. Reaction wood, compression wood and tension wood. Disruption of continuity of inner wood, shakes, included bark, resin pockets, pith flecks, knots (live and dead).

PRACTICAL

Study of primary growth in typical dicot stem, Study of vascular bundles in monocots, comparative anatomical features of softwoods and hardwoods. Study of gross features of different types of wood; straight interlocked, spiral and wavy grain, texture, lusture, etc. Study of anatomical features of different types of wood pores /vessels Study of soft tissues in timbers and their distribution Study of wood rays and their types Study of non-porous woods, their physical and anatomical description Study of cell inclusions in wood.

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Suggested Readings:

1. Anonymous. (1976) Indian forest utilization. Volume I and II ICFRE Publication, Dehradun.
2. Mehta, T.(1981) A handbook of forest utilization. Periodical Expert Book Agency, Delhi. 298 p.
3. Rao, K.R. and Juneja, K.B.S.(1992) Field identification of 50 important timbers of India. ICFRE Publi. Dehradun.
4. Sharma, L.C. (1977)Development of forests and forest based industries, Bishen Singh Mahendra
5. Pal Singh, Dehradun. Trotter, H (1940) Manual of Indian forest utilization. Oxford University Press, New Delhi.
6. Trotter, H. (1982) Indian forest utilisation, Forest Research Institute and Colleges, Dehradun.
7. Terry Porter (2006) Wood Identification and Use.Guide Master Craftman publications.

PAPER III. FOREST MENSURATION Cr.4 (3+1)

Introduction, definition, objectives and scope of forest mensuration. Units of measurement, standards of accuracy implied in their expression. Accuracy, precision and Bias. 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 caliper measurements. Bark thickness and its conversion. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Tree form and method of studying forms. Measurement of cross sectional area, basal area, bole surface area and leaf area. Measurement of volume of trees. Preparation of volume tables, and its classifications, Calculation of log volume and sawn timber. Stand growth site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees. Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Forest inventory, definition, objectives, kinds of enumeration. Measurement of volume and yield of plantation area/stand. Recent developments of instrumentation in forest tree measurements.

PRACTICAL

Units of measurement and their uses. Instruments used in forest mensuration and their working principles, pertaining to tree height, diameter, basal area, bark thickness and crown measurements. Measurement of bark thickness, bark volume, bark area and crown parameters.

Suggested Readings:

1. Chaturvedi, A.N. and L.S. Kanna (1982) A handbook on Forest Mensuration. International Book Distributors
2. Avery, T.E. (1967) Forest Measurements. Mc Grand Hill Book Company, New York.
3. Hamilton, G.L.(1988) Forest Mensuration Handbook. Periodical Expert Book Agency.
4. Husch, B., C.I. Miller and T.N. Beers (1982) Forest Mensuration. The Ronald Press Company, New York.
5. Maslekar, A.R (1990) Foresters Companions. Jugal Kishore and Co. (Publn. Dvn.), Dehra Dun.

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PAPER IV. PRINCIPLES AND METHODS OF TREE IMPROVEMENT Cr.4 (3+1)

Tree improvement: Basic concepts .Reproduction in trees: vegetative and sexual reproduction. Pollination in trees. Inbreed and outbreed population in forest trees. Genetic variability and its role in tree improvement. Qualitative and quantitative traits in forest trees. Heritability, genetic advance, genetic gain, combining ability and their application. Geographic variation: Provenance, seed source, race, clines, ecotypes, varieties and sub-species .Genetic, environmental and phenotypic expression of trees.

Seed stands (seed production areas) and seed orchards. Plus tree selection, progeny trials and Location, management and establishment of seed orchard. Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties. Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement. Application of molecular markers in forest tree improvement.

PRACTICAL:

Floral biology & phonological observations in some important species. Estimation of pollen sterility and viability. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Different breeding methodsflow chart. Species and provenance selection techniques. Recording observation in provenance trial of some important species-recording variation & working out coefficient of variation. Sampling in seed collection. Recording stand density in seed stands, seed output; season of seed collection. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Exercise in plus tree selection. Seed orchards design, recording the design and observation in some forest trees.

Suggested Readings:

1. Zobel, B.J. and Talbert, J. (1984) Applied Forest Tree Improvement. John Wiley & Sons, New York.
2. FAO. (1985) Forest Tree Improvement, FAO Publication, Rome, Italy.
3. Faulkner, R. (1975) Seed Orchard Forestry Commission Bulletin No.34.
4. Fins, L., Friedman, S.T. and Brotschol, J.V. (1992) Handbook of Quantitative Forest Genetics, Klumer Academy, Dordrach, London.
5. Khosla, P.K. (1981) Advances in Forest Genetics. Ambika Publisher, New Delhi.
6. Khosla, P.K. (1982) Improvementof Forest Biomass. Pragati Press, Delhi.
7. Mandal, A.K. and Gibson, G.L.(eds) (1997). Forest Genetics and Tree Breeding. CBS Publi. & Distr., New Delhi
8. Khan I M (2014) Forest Biotechnology.Today and Tommorow publishers,New Delhi
9. Wright, J.W. (1976) Introduction to Forest Genetics. Academic Press, New York.

PAPER V. FOREST MANAGEMENT Cr.4 (3+1)

Introduction : Definition and scope of forest management. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. General definitions : management and administrative units, felling cycle, cutting section.

Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Increment - definition & types, CAI –MAI relationship. Growing stock : concept and definition determination of growing stock, density, quantity and increment. Normal forest: definition and concept. Even aged and un even aged models. Normal growing stock in regular, shelter wood system & selection system. Yield : Sustained and progressive yield concept and meaning. Yield regulation – general principles of yield regulation in even aged and un even aged forest crop. Working Plan : definition, objects and necessity, preparation of working plan. Joint forest management: concept and methodology. Criteria and Indicator for sustainable forest management.

PRACTICAL

Study of various records and forms maintained in the office of the RFO with regard to management of forests under their control. Visit to forest department and courts to observe working procedures.

Study of working plans of the forests and to prepare the working plan for one of the area. Estimation of MAI and CAI, Fixation of rotation for species.

Suggested Readings:

1. Ram Prakash. Forest management, (2006) IBD Publication, Dehradun
2. Osmaston, F.C. Management of Forests, (1984) IBD Publication, Dehradun
3. Speight, M.S. and D. Wainhouse (1989) Ecology and Management of Forest Insects. Clarendon Press, Oxford.
4. J B Lal (2007).Forest Management : Classical Approach and Current Imperatives. Natraj publishers, Dehra Dun.
5. Sen Rajkumar (2003) Forest Management and Sustainable Development.Today and Tommorow publishers.New D.
6. Brown, A. (1990). Forest Fireand its Control. NatrajPublishers, Dehra Dun.
7. Gupta, V.K. and N.K. Sharma. 1988. Tree Protection. Indian Society of Tree Scientists, Solan.

PAPER VI. STRUCTURAL GRAMMAR AND SPOKEN ENGLISH Cr.2 (2)

Applied grammar, introduction to word classes, structure of the verb in English. Uses of tenses. Study of voice. Use of conjuctions and prepositions. Sentence pattern in English. Spoken English, conversion of different situation in everyday life. The concept of stress, stress shift in words and sentences, words with silent letters and their pronunciations. The basic intonation patterns, Exercise in word classes. Study of the verb patterns, uses of tenses and voice, exercises in the use of conjuctions and prepositions. Exercise in sentence pattern, writing report on topics relating to horticulture/Forestry, using active and passive sentence, (i) conversations related to everyday situations. (ii) selection and practice of

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conversations for the study of the concepts of stress. Stress shift, silent letters in words and basic intonation patterns.

Suggested readings:

1. NCERT.English grammer and composition.
2. CBSC.English Grammer and Composition.
3. Jayashree Balan.(2010) Spoken English.Kalyani publishers,New delhi
4. E-Books.Spoken English.

SEMESTER – IV

PAPER I. WOOD TECHNOLOGY AND NANOFORESTRY Cr.4 (3+1)

Wood- macroscopic and microscopic features of wood as raw material, Merits and demerits of wood as raw material, kinds of woods– heartdwood, softwood; bamboos and canes. The physical features of wood. Mechanical properties of wood like tension, compression, bending, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Electrical and acoustic properties of wood. Wood water relationship– shrinkage, swelling, movement, fibre saturation, equilibrium moisture content.

Wood seasoning, principles, types, merits and demerits- air seasoning, kiln seasoning and chemicals seasoning. Seasoning defects and their control. Wood preservation – Need, principles, processes, types of wood preservatives (Water soluble, oil based, etc.). Classification of timbers based on durability. Wood working and sawing doctrine.

NanoForestry:- definition, concept, scope, application and Techniques, Elemental composition of wood through nano particle. Significance of nano forestry.

PRACTICAL

Preliminary idea regarding conversion and milling. Estimation of moisture content and density of wood by oven dry method and by moisture meters. Seasoning of timber. Seasoning defects and their remedies. Woodworking, tools used and various stages and types of joints in wooden members, wooden fasteners, dowels, carving, sanding etc. Polishing and finishing of wood. Surface coating applications and wood primers. Wood preservatives. Chemicals used and methods of wood preservation and fire retardant treatments.

Suggested Readings:

1. Mehta, T.(1981) A handbook of forest utilization. Periodical Expert Book Agency, Delhi.
2. Anonymous. (1976) Indian forest utilization. Volume I and II ICFRE Publication, Dehradun.
3. Rao, K.R. and Juneja, K.B.S. (1992) Field identification of 50 important timbers of India. ICFRE Publi. Dehradun.

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4. Trotter, H. (1982) Indian forest utilisation, Forest Research Institute and Colleges, Dehradun
5. Wadoo, M.S. (1992) Utilization of forest resources. Idris Publi. Srinagar.
6. Bruce Hoodey (1997) Understan wood: A craftman guide to wood technology.Taunton press.
7. Hill Callum A S (2006) Wood modification:chemical thermal and other process.Today and Tommorrow publishers.

PAPER II. NURSERY MANAGEMENT AND COMMERCIAL FORESTRY

Cr.4 (3+1)

Propagation concept, definition, methods and importance. Site selection, planning and layout of nursery area. Types of nursery, types of nursery beds, preparation of beds. Presowing treatments. Methods of seed sowing. pricking. watering methods, weeding, hoeing, fertilization, shading, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Type and size of containers. Merits and demerits of containerized nursery. Preparation of ingredient mixture. Vegetative propagation techniques - macro and micropropagation. Nursery practices for some important tree species.

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economic importance of the following conifer and broadleaved tree species of India. Conifers: *Cedrus deodara, Pinus roxburghii, and Juniperus macropoda.* Broad leaved species: *Tectona grandis, Shorea robusta, Acacia nilotica, Acacia catechu, Dalbergia sissoo, D. latifolia, Ecalyptus spp. Albizzia lebbeck. Albizzia procera, Azardirachta indica Madhuca indica. Santalum album, Terminalia Spp and Bamboo Spp.*

PRACTICAL:

Preparation of production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium and large sized seeds. Pricking and transplanting of pricked out stock within nursery in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Study of vegetative techniques – cutting, grafting etc. Visit to tissue culture laboratory and other nurseries

Study of species composition in surrounding areas. Study of morphology and phenology of tree species growing in the area. Study of artificial regeneration of Pines, Bamboo, Oak, *Dalbergia sisoo* and *Acacia catechu*, etc. Practicing thinning in Bamboo clumps. Study on tree responses to the abiotic and biotic factors viz., light, fire, drought, frost, root suckering, coppicing and pollarding, etc. To study quality characters of nursery planting stock.

Suggested Readings:

1. Vinod Kumar (2011) Nursery and plantation practices in India. Today and Tommorrow publishers.
2. Mishra S.R (2010) Textbook of Dendrology. Today and Tommorrow publishers.

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3. Kumar, V. (1999) Nursery and plantation practices inforestry. Scientific publication. Jodhpur.
4. Chaturvedi, A.N. (1994) Technology of forest nurseries, Khanna Bandhu, Dehradun.
5. Duryea, M. L. and Landis, T.D. (1984) Forest nursery manual: Production of bare root seedlings. Martinus Nijhoff. The Hague.
6. F.A.O (1978) Establishment techniques for plantations, F.A. O. Publication, Rome, Italy.
7. Jackson, M.B. (1980) New root formation in plant and cuttings, Martinus Nijhoff Publishers, The Netherlands.
8. Kumar, V. (1999) Nursery and plantation practices in Forestry. Scientific Publication. Jodhpur.

PAPER III. RANGELAND MANAGEMENT Cr.4 (2+1+1)

Introduction and definition. Relationship with other disciplines. History and development. Types and distribution around world. Grasses : characters and classification. Characteristics of rangelands: components of vegetation, nutrient value of forages and environmental factors. Importance of rangelands. Indian rangelands : origin, distribution, characteristics, status and management. Ecology in relation to grazing.

Ecological concepts relevant in rangeland management, animal – plant interactions, effect on vegetation and plant succession. Plant morphology and physiology in relation to grazing factors – factors influencing food synthesis and reproduction.

Range inventory – mapping, methods of sampling and evaluation, purposes and principles, Carrying capacity. Intensity and frequency of use. Range management –topography, animal species, forage preference, density. Grazing – grazing intensity, season of grazing, types – their merits and demerits. Animal unit (A.U.). Fire – controlled burning, effect of fire on vegetation and fauna. Weed control – types, their characteristics, chemical and biological control. Range improvement – range seeding, introduction of grasses and legumes, fertilization, soil and water conservation strategies. Multiple uses.

PRACTICAL:

Identification of grasses, forbs and legumes and fodder trees; Rangeland inventory – ground cover, plant height, relative dominance, etc.; Assessing nutrient; Estimating range condition from plant composition; Determine range utilization, carrying capacity of rangelands; Indicators of heavy grazing; Studying plant preference by grazing animals; Grazing systems: simulations, indicators of heavy grazing.

Suggested Readings:

1. Vijendra Das,L.D.(1998). Forage Crops. International Book Distributors, Dehradun.
2. Simmonds, W.W. 1986. A short review of farming systems research in the tropics. Expl. Agric.
3. Francies, C.A. (1986). Multiple Cropping System Mac. Millan – New York.
4. Hidebrand. P.E.X. and F. Poey (1985). Onfarm agronomic trials in farming systems research and extension. Tynne Pienner Publishers. Boulder – Colombo.
5. Jeswani,L.M. and Baldev,B.(1990). Advances in Pulse Production technology. ICAR, New Delhi.

6. Malsen,L.J.G.V. and S.Somaatmadja,(1993). PROSEA - Plant Resources of South East Asia. No.1. Pulses. International Book Distributors, Dehradun.
7. Zandstra, H. E.Price, J. Lisinger and R.S. Morris, (1981) Methodology for on-farm cropping systems. Research, IRRI. Los Banos – Philippines.

PAPER IV: REMOTE SENSING AND ITS APPLICATION IN FORESTRY

Cr.4 (3+1)

Remote Sensing definition, scope, merits and brief history of RS. RS used for forestry in Indian context, Sources of Energy and its interaction with Earth surface features, especially forest, Electromagnetic spectrum and its properties, orbit, sensor and platforms, Space Imaging Satellites used for forestry application.

GIS concept, components, variables, advantage and limitation, digital image concept, source of data and formats Hardware and Software used for Digital Image Processing. Procedure used for forest mapping and species identification, thematic image classification, GPS system and ground truthing, map, features types and uses, and map preparation. Application of remote sensing for forest identification and stock mapping, forest land use/land cover classification, change detection analysis, fire mapping.

PRACTICAL

Familiarization with hard copy and soft copy of images, map reading of SOI toposheets, introduction to different GIS and RS Software, File export import/ translation, Conversion of file formats, image, Projection, File sub setting, mosaicing, digitization, feature identification, GPS survey and point location, unsupervised and supervised classification of images for forest type and stock mapping, forest land use/land cover classification, field visit for ground data collection and trouthing.

Suggested Readings:

1. Curran, P.J. (1985) Principles of Remote Sensing, Long man Group Ltd., England
2. Janssen, L.F.(2000) Principles of Remote Sensing. ITC. Edl. Text Book Series II. The Netherlands
3. Rolf A.de By. (2000) Principles of Geographical Information Systems. ITC. Edl. Text Book Series I. The Netherlands
4. Sabins, F.F.(1978) Remote Sensing-Principles and Interpretation. W.H.Freeman and Co., San Francisco.
5. Sharma, M.K.(1986) Remote Sensing and Forest Surveys, International Book Distributors, Dehra Dun

PAPER V. FOREST PATHOLOGY

Cr.4 (3+1)

Relation of plant pathology with forest pathology and other sciences, classification of tree diseases. Role of microbes and fungi in a natural forest ecosystem. Broad classification of different pathogens causing tree diseases. General characteristics of fungi, bacteria, viruses, phytoplasma and phanerogames. Important characters of ascomycetes and basidiomycetes. Growth and reproduction of

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plant pathogens, Dissemination and survival of plant pathogens. Distribution, economic importance, symptoms, etiology and management of the following. Diseases of important tree species like Teak, *Dalbergia sp., Acacia spp.*, Neem, Cassia, Sal, *Albizia, Terminalia,* Mango, Pines, Deodar, Eucalyptus, Bamboo, Casuarinas. Types of wood decay. Principles of disease management. Fungicides and their use in nurseries and plantations. Nursery diseases of important forest species.

PRACTICAL

Study of different pathological instruments, collection, observation and preservation of diseased specimen and observation of other pathogenic structure: microscopic characters of pathogen (fungi, Bacteria) preparation of culture media, isolation and sub culturing of pathogens; methods of inoculation and proving pathogenicity. Symptom, sign and diagnosis of tree disease; Assessment of tree disease loss. Symptoms, etiology and control of diseases/disorders of important tree species (Teak, *Dalbergia, Eucalyptus*, Bamboo, *Cassia, Terminalia*, Neem, *Albizia*, Sal, and *Acacia*. Fungicides, methods of their application. Visit to nurseries and plantation.

Suggested Readings:

1. Bakshi, B.K. Forest Pathology. (1976) Principles and Practices in Forestry. Controller of Publications, New Delhi.
2. Khanna, L.S. (1984) Forest Protection, Khanna Bandhu, Dehra Dun.
3. Beeson, C.F.C. (1941) Forest Insects of India, The Ecology and Control of the diseases. International book distributers, Dehra Dun.
4. Ferraz, L.C. and D. Brown. (2002). An Introduction to nematodes - Plant Nematology. Pensoft Publishers. 221 pp.
5. Gupta, V.K. and N.K. Sharma. (1988). Tree Protection. Indian Society of Tree Scientists, Solan.
6. Herrick, G.W. (1988). Insect Enemies of Trees. Pioneer Publishers, Jaipur.
7. Paul D Menan (2003) Tree and disease concept. Prentice hall Inc.

PAPER VI. FOREST POLICY AND LEGISLATION Cr.4 (2+1+1)

Origin of Forestry- Historical background and introduction of forest policies of India namely 1894, 1952 and 1988 to protect the Indian Trees. Use of IPC and CRPC in forest administration. Indian forest Act 1927, Tendu patta (Vyapar Viniyaman) Adhiniyam 1964, Transit Rules 1961, Forest conservation Act 1980, Grazing rules 1968, Kastha Chiran (Viniyaman) Adhiniyam 1987, Fixation of Rates of Timber and Other Produce. Biodiversity Act, Lok Vaniki Adhiniyam. Chhattisgarh Medicinal plant Act, Forest Rights Act 2006- Privilege concession and Rights of forest dwellers.

PRACTICAL

Visit to different saw mill, High court, District Court and Lower Court. Tendu patta Collection center. Study the effect of mined out area on forest, forest depot.

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Suggested Readings:

1. Fernandes, W. & Kulkarni (1986), - Towards a new Forest Policy. Natral Publishers, Dehra Dun.
2. Forest Policy (1988), Governmentof India Publication, Delhi.
3. Indian Forest Acts with short Notes (1975), Allahabad Law Agency, Allahabad.
4. Podder Erai (2011) Forestlaw and policy in India. Today and Tommorrow publishers.
5. Khanna, L.S., Wildlife (Protection) Act 1972 as amended upto date with commentary, Khanna Bandu, Dehra Dun.
6. Negi, S.S. (1985), Forest Law. Natraj Publication, Dehra Dun.

SEMESTER - V

PAPER I. UTILIZATION OF NON-TIMBER FOREST PRODUCTS Cr. 4(3+1)

Introduction, methods of collection, management and importance of Non-Timber Forest Products (NTFP). Fodder grasses, canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tannins- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Tendu leaves– sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits, spices, poisons and bio-pesticides. NTFP management, Dependency of forest dwellers on NTFP. Potential and challenges of non timber economic growth of country. Scenario of NTFP obtained from forests of Chhattisgarh (Central India).

PRACTICAL

Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and tree leaves. Study of canes and bamboos and their sources. Study of essential oils and their sources. Study of non-essential oils and their sources. Study of gums and resins and their collection. Study of tans and dyes and their sources. Study of fibers, flosses and their collection from nearby forests. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, spices, wild fruits, poisons and bio-pesticides and their collection from nearby forests. Visit to nearby extraction units.

Suggested Readings:

1. Dwivedi, A.P. (1993) Forests - the non-wood resources. International Book Distributor, Dehradun. 352 p.
2. Taank P (2010) Forest product and their utilization. Today and Tommorrow publishers.
3. Anonymous. (1961) Wealth of India - Raw Materials. C.S.I.R., New Delhi

4. Troupe R.S (2007) Manual of Indian forest Utilization (Second edition). Today and Tommorrow publishers.
5. Mehta T (2012) A handbook of forest utilization. Today and Tommorrow publishers.
6. Gupta, T. and Guleria, A. (1982) Non-wood forest products in India : Economic potential. Oxford and IBH Publication, New Delhi. 147 p.
7. Sharma, L.C. (1977) Development of forests and forest based industries, Bishen Singh Mahendra Pal Singh, Dehradun.

PAPER II –FOREST TRIBOLOGY AND ETHNOFORESTRY Cr. 4(3+1)

Forest and tribes- their relationship, Major tribes in India and Chhattisgarh. Forest ecosystem and cottage industries. Role of tribal in forest protection, development and conservation. Tribal welfare and social forestry, Tribal and co-operative movements. History of tribal welfare and administration- the constitutional safeguards for the schedule tribes. Policies, planes and programmes of tribal development and their implementations.

History, scope, opportunities and constraints in the cultivation and management of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and aftercare, training and pruning, nutritional and water requirement, plant protection, harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants: Pepper, Periwinkle, *Rauvolfia*, *Dioscorea*, Isabgol, Myrobalans (aonla, harde, baheda), *Ammi majus*, Belladonna, *Cinchona* and other species relevant to local conditions. Aromatic Plants : Citronella grass, Khus grass, Sweet flag (bach), *Mentha*, Musk mallow, *Ocimum* and other species relevant to the local conditions. Study of active constituents of a few important medicinal and aromatic plants, their extraction and use. Endangered medicinal and aromatic plants of India and their conservation. Value addition process of medicinal plants.

PRACTICAL

Morphological description and identification of various medicinal plants. Collection of medicinal plants and plants part from natural habitats. Survey and study of nursery techniques including training and pruning of medicinal plants. Harvesting, drying, grading, storage and processing techniques. Study of plants parts used in drugs preparation. Visit to nearby medicinal and aromatic plantation area/ nursery/ ayurvedic pharmacies. Study the tribal groups of India. Study the important medicinal plant used by traditional healers.

Suggested Readings:

1. Tiwari, S C (2010) Ethnoforestry: The Future of Indian Forestry.Today and Tommorow publishers. Delhi
2. R.K. Sinha (1996) Ethnobotany : the renaissance of Traditional Herbal Medicines.Ina shree publishers.

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3. C.M. Cottan (1996) Ethnobotany: Principles & Applications.jhon wiley and sons Ltd.
4. V.P. Agrawal (2002) Forest in India.Oxford and IBH publishers.
5. Ashok Ranjan Basu & S. Nijhavan (1985) Tribal Development Administration in India. Mittal publications.

PAPER III. FUNDAMENTALS OF HORTICULTURE & ITS APPLICATION

Cr. 4(2+1+1)

Horticulture: definition, component and importance, area and production, exports and imports, fruit and vegetable zones in India and other states, Nursery management practices, vegetable gardens, Nutrition and kitchen gardens landscape garden, establishment of orchard high density and meadow orchard-principles, planning and layout, precision farming of fruit, planting system and planting densities, production and practices for important fruit, vegetable and flower. Vegetative propagation techniques-budding, grafting, cutting, integrated fertilizer management and IPM in horticulture. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management, weed management, cropping systems, intercropping, multi-tier cropping, mulching principles of organic farming.

PRACTICAL

Feature of orchard, planning and layout of orchard, tools and implements, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting system, Training and Pruning of trees, Preparation of fertilizer mixtures and field application, preparation and application of growth regulators, Layout of different irrigation systems, Identification and management of nutritional disorder in fruits and vegetables, Assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

Suggested Readings:

1. Jitendra Singh (2007) Basic Horticulture. Kalyani publishers.
2. J.S. Bal (2002) Fruit Growing in India. Kalyani publishers
3. Dr. K.L.Chadha, for ICAR, Govt. of India.(2015) Handbook of Horticulture. Jain book Agency.
4. George Acquaah (2002) Horticulture - Principles and Practices. Jain book Agency.

PAPER IV. TREE SEED TECHNOLOGY AND PLANTATION FORESTRY

Cr. 4(3+1)

Seed formation in trees. Classification of tree seed. Seed structure and chemical composition. Seed germination, seed viability and factors affecting seed viability. Seed Dormancy and pre-treatment of breakdown dormancy. Determining optimal harvest maturity indices. Seed collection methods - Equipments and planning. Seed Processing- seed extraction, drying, cleaning, grading, treating, bagging, labeling and storage. Storage of orthodox, recalcitrant seeds and fumigation and seed treatment. Seed Cryopreservation. Seed quality testing- purity, viability moisture, purity, vigor,

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germination, test of viability. Seed certification. Quality seed production technologies- Seed orchards, selection of seed trees, Plus tree & Elite tree.

Role of plantation forestry in meeting the wood demand- plantation forestry in India and abroad, planting programme, site preparation ,choice of species , planting pattern, spacing, planting method. Nutritional dynamics and irrigation of plantation, protection and after care of plantation- weed control, climber cutting staking, pruning and thinning of plantation for quality production, failure of plantations. Biofuels – important biofuels and their silvicultural management. Identification of important fuel woods and petro-crops. Study of different biofuels used in India. Determination of calorific value, moisture and ash content and biomass.

PRACTICAL

Identification of seeds of tree species; Seed maturity tests; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments. Planting geometry and calculation of planting stock, Study of different presowing treatments

Planting geometry and calculation of planting stock. Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacia and Bamboo plantations.

Collection of data for survival and growth performance of different plantation. Use of fertilizers, weedicides for plantation management.

Suggested Readings:

1. Agrawal, P.K. and M. Dadlani (1987) Techniques in Seed Science and Technology,South Asian Publishers, Delhi.
2. Agrawal, R.L. (1996) Seed Technology. Oxford & IBH, Publishing Co., New Delhi.
3. Anon. (1965) Field Inspection Manual and Minimum Seed Certification Standards, NSC Publication, New Delhi.
4. Faulkner, R. (1975) Seed orchard. Forestry Commission Bulletin No.54.149 p.
5. Lars Schmidt (2000) Guide to Handling of tropical and sub-tropical forest seeds. Danida Forest Seed Centre, Denmark.
6. Nema, N.P. (1987) Principles of Seed Certification and Testing; Allied Publishers Pvt, Ltd, New Delhi.
7. Renugadevi, J and V Manonmani (2011) A handbook of seed testing.Agribios

PAPER V. FUNDAMENTALS OF WILDLIFE AND ITS MANAGEMENT
Cr. 4(3+1)

Introduction: Definition of wildlife, free living, captive, domesticated and feral animals. Justification of wildlife conservation, uses, values and negative impact of wildlife. Zoogeographic regions and biomes of the world. India's uniqueness in biodiversity, reasons and causes of wildlife depletion. Biogeographic

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classification of India. Status and distribution of wildlife in India. Scientific and common names of important mammals, birds and reptiles. Rare, endangered and threatened species of mammals, birds and reptiles of India. Agencies involved in wildlife conservation, Govt. and NGO's. BNHS, WWF, Indian Board for Wildlife, CITES. Biological basis of wildlife management. Basic requirements of wildlife – food, water, cover and space, limiting factors. Wildlife ecology: Relevance of basic ecological concepts such as foodchain, foodweb, ecological pyramids, habitat, ecological niche, carrying capacity, density, prey-predator relations and population dynamics. History of wildlife management and conservation in India; cultural background. Habitat management: Purposes, principles, practices and tools-fire, cutting, grazing. Habitat interspersion and edge effect. Provision of water, saltlicks and food. Zoning – core, buffer, tourism and multiple use in protected areas. Wildlife damage control: Mitigating human – wildlife conflict: fences, trenches, walls, lure crops, repellents, translocation and compensation. Captive wildlife : Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities. Wildlife (Protection) Act, 1972. Protected areas –Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES. Conservation: Meaning, principles and strategies, in-situ and ex-situ conservation, conserving biodiversity.

PRACTICAL

Identification and study of wildlife in a nearby zoo. Bird watching: Preparation of inventory of an area. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey.

Suggested Readings:

1. Dwivedi A P (2009) Managing wildlife of India.International Book Distributors.Dehradun, India.
2. Singh S K (2009) Textbook of wildlife management. Today and Tomorrow publishers..
3. Aaron, N.M. (1973) Wildlife ecology. W.H. Freeman Co. San Francisco, U.S.A.
4. Anon, (1990) Collection and preservation of animals. Zoological Survey of India.
5. Rajesh Gopal, (1992) Fundamentals of wildlife management. Justice Home, Allahabad, India.
6. Robert, A.W. (1979) The ecology and evolution of animal behavior. Good Year Pub. Co. California, U.S.A.
7. Robert, G.H. (1978) Wildlife management. W.H. Freeman and Co., San Francisco, U.S.A.

PAPER VI. INTRODUCTORY CROP PRODUCTION AND METEOROLOGY
Cr. 4(3+1)

Meaning and scope national and international agriculture research institute in India. Agro-climatic zones of India and Chhattisgarh. Tillage, crops stand establishment, planting geometry and its effect on

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growth and yield cropping system, harvesting. Crop production of wheat, rice, sugarcane, pulses and oil seeds. Meteorology: weather and climate, micro-climate, weather elements, earth's atmosphere composition and structure, solar radiation, nature, properties, solar constant and energy balance, atmospheric temperature, factors affecting, horizontal and vertical distribution, variations and global warming, air pressure variations, wind factors, cyclones, and anticyclones, atmospheric humidity, vapour pressure and saturation, process of condensation, formation of dew, fog, mist, snow, rain and hail. Formation and classification of clouds, introduction to monsoon, basics of weather forecasting.

PRACTICAL

Study of Tillage implements, practice of ploughing, practice of puddling, study of seeding, equipments. Different methods of showing, study of manures, fertilizers and green manure crops/seeds.(Including calculation). Study of intercultivation implements and practice, practice of methods of fertilizers applications in ongoing field operations. Site selection for agromet observatory, measurement of temperature, measurement of rainfall, measurement of evaporation, measurement of atmospheric pressure, measurement of sunshine duration and solar radiation, measurement of wind direction and speed and relative humidity. Study of weather forecasting and synoptic chart.

Suggested Readings:

1. Ghadekar S R (2008) , Textbook of Agrometeorology.Agromet publishers.
2. Norman, David Douglas, Malcolm FAO (2007) Farming Systems Development And Soil Conservation FAO.Jain Book Agency.
3. Kafi, Mohammad Khan, Muhammad Ajmal (2008) Crop And Forage Production Using Saline Waters Nam S&T Centre. Jain Book Agency.
4. Chhidda Singh et al (2012) Modern techniques of raising field crops.Oxford and IBH publishing company, New Delhi.
5. Varshnaya M C and Balakrishna Pillai (2012) A textbook of agriculture metrology. ICAR,New Delhi Publications.

SEMESTER – VI

PAPER I. FUNDAMENTALS OF EXTENSION EDUCATION **Cr. 3(2+1)**

Extension education: Meaning, definition, nature, scope, objectives, principles, approaches and history. Forestry extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in forestry programmes. Motivation of women community, children, youth and voluntary organizations for forestry extension work. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND). Audio– visual aids: importance, classification and selection.

Programming planning process –meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership.

PRACTICAL

Visit to study, structure, function, linkage and extension programmes of ICFRE institutes/voluntary organization/mahila mandal, village, panchayat, state dept. of forests/All India radio (AIR). Exercises on distortion of message, script writing for farm broadcast and telecasts, planning. Preparation and use of NPVA like poster, charts, flash cards, folder etc. and AVA like OHP and 35mm slide projectors transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes.

Suggested Readings:

1. FAO (1986), Forestry Extension Organisation, Sl.No.68, FAO Publication, Rome, Italy.
2. FAO, Planning Forestry Extension Programs, FAO, Bangkok, Thailand.
3. Information Kit, International Institute of Rural Reconstruction, Silong, Philippines.
4. Research and Extension, Common Wealth Science Council, London, U.K.
5. DESAI, R.C. (1989), Farmers Societies and Agricultural Development. Natraj Publication, Dehra Dun.
6. FAO (1987), Forestry Extension Methods, SLNo. 80, FAO Publication, Caracall, Rome, Italy.
7. Supe S V (2009) A textbook on extension education.Agrotech publishing academy,Jodhpur.
8. Jha and Sharma P K (2001) Manual of forestry extension education. Today and Tomorrow publishers.

PAPER II. AGRO FORESTRY SYSTEM AND MANAGEMENT Cr. 4(3+1)

Indian agriculture- structure and constraints. Land use definition, classification and planning. Agroforestry- definition, aims objectives and need. Traditional Agroforestry systems: Taungya system, Shifting cultivation, Wind break, Shelterbelts, Homestead gardens. Alley cropping, high density short rotation plantation systems, silvicultural woodlots/energy plantations. Classification of agroforestry system-structural, functional, socio-economic and ecological basis. Multipurpose tree species and their characteristics. Tree architecture, canopy management- lopping, prunning, pollarding and hedging. Diagnosis and design. Agroforestry systems in different agroclimatic zones, components, production and management techniques. Tree-crop interface. Economics of agroforestry systems. People participation, rural entrepreneurship through agroforestry and industrial linkages. Analysis of fodder and fuel characteristics of tree/shrubs.

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PRACTICAL

Study characteristics of trees/shrubs/grasses for agroforestry. Volume and biomass estimation. Crown measurement, light interception and moisture measurement in agroforestry systems. Litter estimation and nutrient analysis, soil analysis, quantification of fertilizer doses, Annual crops/grass growth measurements and yield estimation carbon storage assessment.

Suggested Readings:

1. Dwivedi, A.P. (1992) Agroforestry principles and practices. Oxford and IBH Publication Co., New Delhi.
2. Chundawat D S and Gautam S K (2010) Textbook of agroforestry.Oxford and IBH publishing co pvt. Ltd.
3. Nair, P.K.R. (1993) An introduction to agroforestry. Kluwer Academic Publishers. 499 p.
4. Huxley, P. (1999) Tropical agroforestry. Blackwell Science, Oxford. 371 p.
5. Khosla, P.K. and Khurana, D.K. (1987) Agroforestry for rural needs. Vol. I and II, ISTS, Solan, H.P.
6. Ong, C.K. and Huxley, P.K. (1996) Tree crop interactions – A physiological approach. ICRAF, Kenya. 386 p.
7. Ramakrishnan, P.S. (1992) Shifting agriculture and sustainable development. Man and biosphere series. The Parthenon Publishing Group. 424 p.
8. Sen Sarma, P.K. and Jha, L.K. (1993) Agroforestry. Indian Perspectives. Ashish Publishers, Delhi.

PAPER III. CARBON FORESTRY Cr. 4(3+1)

Forests, Carbon and global climate. Forests and global carbon cycle. The key components of Forest Carbon: Carbon organic & inorganic, Carbon Source, Carbon Flow, Carbon Flux, Carbon Sink, Carbon Offset, Carbon Fertilization, Carbon footprint, Carbon Capture and Sequestration(CCS), Impacts of stand management on tree carbon stocks, Carbon in Woody debris and litter, BioSoil – a new forest soil survey. Trees and Forests as collectors of carbon. Forest operations effects on carbon flux.

The dynamics of carbon accumulation in tropical and temperate forests. Forest Soils as Carbon Reservoirs. Carbon Trade, Carbon Budget, Carbon Marketing, Carbon Dioxide Equivalent. The Potential Contribution of Indian Forests in carbon forestry. Carbon in Wood Products. Tree species wise Database for carbon stock. Carbon neutrality, carbon offset and carbon trading schemes. Forest Carbon management. Social Value Of forest Carbon. International Negotiations and the Political Context: Kyoto protocol.

PRACTICAL

Estimation of carbon content (organic/inorganic) in a wood, soil, litter and other forest based products, Sequestration of carbon in harvested wood products, Estimation of carbon flux, and CCS of forest trees/stands. Preparation of carbon inventories of different forest trees/stands. Establishment of forest carbon database, Survey to study the political/social context of carbon forestry.

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Suggested Readings:

1. Ashton, M.S., Tyrrell, M.L., Spalding, D., Gentry, B. (Eds.) (2012) Managing Forest Carbon in a Changing Climate. Springer Dordrecht Heidelberg London New York
2. H S Gupta, M Yadav, M Verma, A David, U K Sharma and and C P Kal (2014) Science and Business of Carbon Forestry.TERI press, New Delhi.
3. Malti Goel, M Sudhakar, and R V Shahi (eds) (2006) Carbon Capture, Storage and Utilization: a possible climate change. UNFCCC report -2006.
4. Thompson, D. And Matthews, R.W. (1989).The storage of carbon in trees and timber. Research Information Note 160. Forestry Commission, Edinburgh.
5. Schlamadinger B. And Marland G. (2000).Land use and global climate change: Forests, Land Management, and the Kyoto Protocol. Pew Center on Global Climate Change (www.pewclimate.org/projects/land_use.cfm).
6. Nabuurs, G.-J. (1996).Significance of wood products in forest sector carbon balances. In: Forest ecosystems, forest management and the global carbon cycle, eds M.J. Apps and D.T. Price. NATO ASI Series I, Springer-Verlag, Berlin.
7. Khosla, P.K. (1982). Improvement of forest biomass. Pragati Press, Delhi

PAPER IV. FOREST ENTOMOLOGY Cr. 4(3+1)

Definition, importance and scope of Entomology. Definition of insect and its position in the Animal Kingdom. Important characters of phylum arthropoda and class insecta. External morphology of generalized insect. Insect growth and development, Reproduction in insects, immature stages (Egg. Larvae/Nymph and Pupae); metamorphosis in Insects Taxonomic classification of class Insecta, diagnostic characters of the orders and major families of economic importance. History and importance of Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests : types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest (Tectona, *Dalbergia* sp., Sal, Albizia spp., Sandal, Ailanthus, Gmelina, Terminalia, Deodar, Pines); Plantation forest species (Eucalyptus, Bamboo, Casuarina, Neem, Acacia) Fruit trees (Emblica, Ber, Eugenia, Tamarind). Insect pests of freshly felled trees, finished timbers and their management.

PRACTICAL

Study of different types of insects; Study of immature stages of insects; Study of insect collection, pinning, labelling and preservation; Study of predators and parasites; Study of insecticides and their formulations, plant protection appliances; Study of insect pests of forest seeds; Study of insect pests of forest nurseries; Study of insect pests of standing trees, freshly felled trees and finished products, Visit to forest nurseries and plantations.

Suggested Readings:

1. Satha T V (2009) A textbook of forest entomology.Today and tomorrow publishers.
2. Brues, T.C., A.L. Melander and E.M. Carpenta, (1954) Classification of Insects, Cambridge Man, USA.
3. Perris, G.F. (1928) The principles of Systematic Entomology. Standford University Press. California.
4. Richards, O.N. and R.G. Davies (1977) Imm's General Textbook of Entomology. 10th ED. Chapman and Hall.
5. Kapoor, V.C. (1988) Theory and Practice ofAnimal Taxonomy. Oxford and IBH Publishing Co. Pvt Ltd, New Delhi.
6. Mayr, E. (1969) Principles of Systematic zoology. McGraw Hill book Company, New York.
7. Mayr, E., E.G. Linslay and R.L. Usinger (1953) Methods and principles of Systematic zoology. McGraw Hill Book Company, London. 336p

PAPER V. MARKETING AND TRADE OF FOREST PRODUCE Cr. 4(2+1+1)

Nature and scope of marketing. Approaches to marketing and the study of marketing functions with special reference to forestry. Classification of market, market structure and conduct of important timber and non-timber markets. Marketing channels, costs, margins and price spread – concepts and applications. Concepts of market integration and marketing efficiency. Role of public and private agencies in marketing of forest produce. Fundamentals of international trade. Domestic and international trade in timber and non-timber forestry outputs. Demand forecasts – concept and methods. IPRs and their implications for forestry and allied sectors in the country.

PRACTICAL

Library review of studies on marketing, visit to local timber and non timber markets, collection and analysis of price and quantity data for various forest products, study of marketing channels and price spread for important timber and non timber forest products.

Suggested Readings:

1. T. Mehta (1981) A Hand Book of Forest Utilization.International book distributors,Dehradun.
2. Steven Allen Sinclair.(1992) Forest products marketing. McGraw-Hill Ryerson, Limited
3. Teerath Gupta & Amar Gupta (1980) Non-Wood Forest Products of India.Oxford and IBH pub. Co. New Delhi.
4. Fisher, A.C.,(1979) Resource and Environmental Economics.New York: John Wiley & Sons.
5. Choudhury, Monalisa Barua, Nayan.(2012) Marketing Of Processed Fruit And Vegetable.Jain Book Agency.

PAPER VI. PRINCIPLES OF PLANT PHYSIOLOGY Cr. 4(3+1)

Water relation in plants: role of water in plant metabolism, osmosis, imbibitions, diffusion, water potential and its components. Absorption of water, mechanism of absorption, ascents of sap. Stomata, structure, distribution, classification, mechanism of opening and closing of stomata, guttation,

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transpiration, factors affecting transpiration. Different types of stresses: water, heat and cold tolerance, mechanism of tolerance. Plant nutrition essentiality. Mechanism of absorption, role in plant metabolism, Photosynthesis, importance of photosynthesis, structure and function of chloroplast, dark and light reactions, Factors affecting the photosynthesis. CO2 fixation, C3, C4 and CAM plants, advantages of C4 pathway. Photorespiration and its implications.. Respiration, glycolysis, Krebs cycle and electron transport System, ATP synthesis and factor affecting the respiration. Phyto hormones and its physiological role in controlling plant process. Environmental stimuli for plant development.

PRACTICAL

Measurement of water potential by different methods, Osmosis- endo and exo-osmosis demonstration, Plasmolysis- demonstration, Root pressure- demonstration, Transpiration rate, Studying the structure of stomata, Studying of opening and closing the stomata, Demonstration and importance of light in photosynthesis, separation of xanthophylls, Chlorophyll in plants.

Suggested Readings:

1. Taiz, L., Zeiger, E., Ian M. Moller and Angus Murphy-Sixth edt. (2015). Plant Physiology and Development. published by Sunderland:Sinuaer Associates
2. Taiz, L. and Zeiger,E (2010) .Plant Physiology.Sunderland:Sinuaer Associates.
3. Verma V. (2009) Textbook of Plant Physiology. Ane books Pvt. Ltd. New Delhi .
4. Salisbury, F and Ross Cleon (1988) .Plant Physiology. Oxford and IBH,publishers.
5. William G. Hopkins and Norman P A Huner (2008).Introduction to plant physiology.Published by Jhon Wiley and sons inc.
6. Majumdar (de) Manisha (2011) Plant physiology.E-book on www.bookrix.com.
7. Kramer, P.J. and Kozlowski, T.T. (1960) Physiology of trees. Mc Graw Hill Book Company, New York.
8. Kramer, P.J. and Kozlowski, T.T. (1979) Physiology of Woody Plants. Academic press, New York.
9. Larcher, W. (1980) Physiological Plant Ecology. Springer -Verlag, New York.

SEMESTER –VII

PAPER I. BIOSTATISTICS AND COMPUTER APPLICATION **Cr.5 (3+1+1)**

Definition and application of statistics, types and source of data, classification and tabulation of data, frequency distribution, graphical representation of data, (Bar diagram, pie chart, histogram, frequency polygon) measures of central tendency (mean, median, mode) measures of Dispersion (range, standard deviation, Mean deviation, Quartile deviation, variance, coefficient of variation), Probability, Test of signification: basic concepts,(Z- Test, X^2-Test, t-Test, F-test,), regression, Correlation : (scatter diagram, correlation co-efficient, its properties).Computer application: Introduction to computers and personal computers, basic concepts, operating system, MS Office, Excel, Power Point, introduction to Multi-Media, application of Statistical software's in Forestry.

PAPER III. WOOD PRODUCTS AND UTILIZATION CR.4 (3+1)

Paper and Pulp industry. Raw material, pulping-mechanical, chemical, semichemical and semi-mechanical, pulp bleaching, stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products. Manufacture, properties and uses of composite wood-plywood, fiber board, particle board and hard board. Adhesives used in manufacture of composite wood. Improved wood-definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Saccharification of wood, production of wood molasses, alcohol and yeast. Cutch and Katha, Lac and manufacture of shellac. Resin-tapping and manufacture of turpentine and rosin, charcoal burning.

PRACTICAL

Visit to paper industry to study pulp and paper making. Characterization of pulp rate and pulping, identification and properties of wood& non-wood product used for forest based industries. Study of different types of papers. Study of different types of paper boards. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiber boards, particle boards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations.

Suggested Readings:

1. Sharma, L.C. (1977) Development of forests and forest based industries, Bishen Singh Mahendra Pal Singh, Dehradun.
2. Trotter, H. (1940) Manual of Indian forest utilization. Oxford University Press, New Delhi.
3. Trotter, H. (1982) Indian forest utilisation, Forest Research Institute and Colleges, Dehradun.
4. Wadoo, M.S (1992) Utilization of forest resources. Idris Publi. Srinagar 252 p.
5. Mehta, T. (1981) A handbook of forest utilization. Periodical Expert Book Agency, Delhi.
6. Anonymous. (1976) Indian forest utilization. Volume I and II ICFRE Publication, Dehradun.
7. Hill Callum A S (2006).Wood modification :chemical,thermal and other processes.Today and Tomorrow publishers.

PAPER IV. WORLD FORESTRY SYSTEMS Cr.4 (2+1+1)

Geographical distribution of forest and their classification. Critical examination of world forest resources, productivity potential and increment of world forests. Forest resources and Forestry practices in different regions of the world- North and South America, Europe, Africa. China, Japan, Russia, South East Asia and Australia. Forest development and economy, forest based industry of the world. Recent trends in Forestry development in the world. International Forestry Organizations.

PRACTICAL

Plot the different biomes of the world on map. Study about the different Biogeographic regions of India & plot them on a map. Study of distribution of forest resources of India. Plot the different hot spots of India on a map. Study of different hot spots of the world & plot it on a map.

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Suggested Readings:

1. Champion and Seth (1968)Forest Types of India.Natraj publishers.
2. V.P. Agrawal (1985)Forestry in India.Oxford and IBH publications,New Delhi
3. M.P Shrivastava (1997) Introductory to Forestry.www.amazon.com
4. Negi.S.S(1998)World Forest Systems.Natraj Publishers.

PAPER V. ENTREPRENEURSHIP DEVELOPMENT & COMMUNICATION SKILLS

CR.3 (2+1)

Entrepreneurship Development, Concept of entrepreneurship entrepreneurial and managerial characteristics managing an enterprise, motivation and entrepreneurship development. Entrepreneurship development programme, SWOT analysis. Government schemes and incentives for promotion of entrepreneurship. Export and import policies relevant to Forestry sector. Venture capital. Contract farming and joint ventures, public private partnership, Social responsibility of business. Assessing overall business environment in Indian economy. Overview of Indian social, political and economic systems and their implication for decision making by individual entrepreneur. Globalization and emerging business / entrepreneurial environment.

Communication Skills: meaning and process of communication. Verbal and non verbal communication; listening and note taking , writing skills, oral presentation skills, field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting, individual and group presentation, public speaking, group discussion. Organizing seminars and conferences.

Suggested Readings:

1. O.P. Dahama & O.P. Bhatnagar (1987) Education & Communication for Development. Oxford University Press, New Delhi
2. G.L. Ray(2011) Extension Communication and Management.Kalyani publications.
3. A.S. Sandhu (2004) A Text Book of Agricultural Communication. Kalyani publications
4. Bilhuti Bhusan Mohanty(1962) A Handbook of Audio Visula Aids.Kitab mehal pvt ltd Allahabad.

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SEMESTER - VIII

❖ **FOREST INSTITUTES AND INDUSTRIAL VISIT/ TRAINING.** **CR.8 (8)**

Works to be undertaken:

- Study the nature of industrial and business organization- structure
- Raw material- Collection and processing of raw material.
- Production and management process.
- Marketing and financial management.

❖ **FORESTRY OPERATIONS (WORKING EXPERIENCE)** **CR.9 (9)**

Visit to modern forest nurseries, Herbal garden and watersheds. Study the felling and logging operations, timer lots and important industrial products. Study working plan. Enumeration, volume and yield calculation and component history file. Study the CAT(Catchment area treatment plan) and FDA(Forest development agencies). Use of Forestry equipments/instruments. Study the regeneration and management of important Forestry tree species. Sample plots, layout studies, stump analysis, preparation of local volume table.

❖ **SOCIO-ECONOMIC SURVEY- VILLAGE ATTACHMENT.** **CR.8 (8)**

Data collection with respect to village profile in respect of socio-economic and cultural status, farm technology used etc. Bench mark survey of plant resources (cropping pattern, yield system etc). Schedule development, tabulation, analysis and preparing plan of work. Understanding local Forestry and other village level institutions (Panchayat, village forest community, corporations, youth/women groups etc.). People's participations in development programmes with special reference to Forestry. Exercise on the use of extension methods and teaching aids for transfer of technology.

❖ **STUDENT PROJECT** **CR.1 (1)**

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