1.1.2

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Employability Contents	**Green**	
Entrepreneurship Contents	**Light Blue**	
Skill Development Contents	**Pink**	
Name of the Subjects/Related to all three Components (Employability/ Entrepreneurship/ Skill Development)	**Yellow**	

List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : Department of Forestry, Wildlife and Environmental Sciences

Programme Name : B. Sc. (Forestry)

Academic Year : 2017-18

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
1.	201 (B. Sc. Forestry)	Introduction and Practices of Silviculture
2.		Fundamentals of Geology and Soil Science
3.		Cytogenetics and Plant Breeding
4.		Introductory Botany
5.		Basic Mathematics
6.		Physical Activity
7.		Introductory Forest Economics
8.		Forest Ecology, Biodiversity and Conservation
9.		Principles of Hydrology and Watershed Management
10.		Forest Soil, Chemistry and Fertility
11.		Environmental Science
12.		Silviculture System
13.		Forest Biotechnology
14.		Wood Anatomy
15.		Forest Mentsuration
16.		Principles and Methods of Tree improvement
17.		Forest Management
18.		Wood Technology& Nanoforestry

19.		Nursery Management and Commercial Forestry
20.		Rangeland Management
21.		Remote sensing and Its application in Forestry
22.		Forest Pathology
23.		Forest Policy and Legislation
24.		Utilization of Non-timber Forest Products
25.		Forest Tribology & Ethno-Forestry
26.		Fundamentals of Horticulture and Its Application
27.		Tree seed Technology&Plantation Forestry
28.		Fundamentals of Wildlife &Its Management
29.		Introductory Crop Production and Meteorology
30.		Fundamentals of Extension Education
31.		Agro Forestry system and Management
32.		Carbon Forestry
33.		Forest Entomology
34.		Marketing and Trade of Forest Produce
35.		Principles of Plant Physiology
36.		Bio Statistics and Computer Application
37.		Forest Engineering & Surveying
38.		Wood Products &Utilization
39.		World Forestry Systems
40.		Entrepreneurship Development and communication skills
41.		Forest Institutes and Industrial Visit/training
42.		Forestry Operations (Working Experience)
43.		Socio-economic survey - Village attachment

Department : Department of Forestry, Wildlife and Environmental Sciences

Programme Name : M.Sc. (Forestry and Environmental Sciences)

Academic Year : 2017-18

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

1.	319 (M. Sc. Forestry and Environmental Sciences)	Silviculture
2.		Forest Biometry, Surveying & Engineering
3.		Forest Management, Remote Sensing & GIS
4.		Forest Ecology and Biodiversity Conservation
5.		Forest Protection
6.		Forest Statistics & Research Methodology
7.		Forest Policy, Laws and Environmental Legislation
8.		Forest Tree Improvement and Biotechnology
9.		Wood Technology and Nanoforestry
10.		Wildlife Biology and Conservation
11.		Forest Soil and Watershed Management
12.		Forest Products and Industries
13.		Environment and Global Climatic Changes
14.		Breeding Methods in Forest Trees
15.		Forest Trees Reproductive Biology and Seed Orchards
16.		Molecular Genetics of Forest Trees
17.		Quantitative Geneticsof Forest Trees
18.		Forest Genetic Diversity, Conservation & Environmental Impact
19.		Field Training (Attachment with State Forest Department for analysis of FGR & its distribution) Project report writing,

		Presentation & Viva-voce
20.		Industrial Training
21.		Computational Skills
22.		Forest Resource Analysis
23.		Production Management in Nursery and Plantation Forestry
24.		Finance and Marketing Management of Forest Resources
25.		Tree Business Management
26.		Forest Management for Environmental Conservation
27.		Field Training (Attachment with State Forest Department for analysis of Forest Management patterns & Management techniques)

Scheme and Syllabus

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)

DEPARTMENT OF FORESTRY, WILDLIFE & ENVIRONMENTAL SCIENCES
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR, CG

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**

29/6/15 29/6/15 29.6.15 29/6/15

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**

29.6.15 29/6/15 25/6/15 29/6/15

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.

29/6/15 29/6/15 29/6/15

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.

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. Arnson, 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

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

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:n 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

29.6.15

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.

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.

15

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 microspore 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. Kaima (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.

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. ICFRI. Publication, Dehradun.
3. Rao. K.R. and Juneja, K.B.S. (1992) Field identification of 50 important timbers of India. ICFRE Publi. Dehradun.

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 sissoo* 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. Hildebrand. 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 troathing.

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

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, Encalyptus*, 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.

Suggested Readings:

1. Fernandes, W. & Kulkarni (1986). - Towards a new Forest Policy. Natraj 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 Eral (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*, *Diascorea*, 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 Manoumani (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

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

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, Sl.No. 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.

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.

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) Manjsha (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. Bibhuti Bhusan Mohanty(1962) A Handbook of Audio Visula Aids.Kitab mehal pvt ltd Allahabad.

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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COURSE SYLLABUS

FOR

M.Sc. FORESTRY & ENVIRONMENTAL SCIENCES

(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)

29/6/15 29/6/15 29/6/15

DEPARTMENT OF FORESTRY, WILDLIFE & ENVIRONMENTAL SCIENCES
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR, CG

SEMESTER-WISECHOICE BASED CREDIT SYSTEM OF M.Sc. FORESTRY& ENVIRONMENTAL SCIENCES

M.Sc. I[st] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credit
01.	Silviculture	3	--	1	4
02.	Forest Biometry, Surveying & Engineering	3	--	1	4
03.	Forest Management, Remote Sensing. & GIS	2	1	1	4
04.	Forest Ecology and Biodiversity Conservation	3	--	1	4
05.	Forest Protection	3	--	1	4
06.	Forest Statistics & Research Methodology	3	1	1	5
		Total Credits			25

M.Sc. II[nd] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credit
01.	Forest Policy, Laws and Environmental Legislation	2	1	1	4
02.	Forest Tree Improvement and Biotechnology	3	--	1	4
03.	Wood Technology and Nanoforestry	3	--	1	4
04.	Wildlife Biology and Conservation	3	--	1	4
05.	Forest Soil and Watershed Management	3	--	1	4
06.	Forest Products and Industries	3	--	1	4
07.	Environment and Global Climatic Changes	3	--	1	4
		Total Credits			28

29.6.15 29/6/15 29/6/15

SPECIALIZATION

FOREST GENETIC RESOURCES (FGR)

M.Sc. III[rd] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Breeding Methods in Forest Trees	3	---	1	4
02.	Forest Trees Reproductive Biology and Seed Orchards	3	---	1	4
03.	Molecular Genetics of Forest Trees	3	---	1	4
04.	Quantitative GeneticsofForest Trees	3	---	1	4
05.	Forest Genetic Diversity, Conservation & Environmental Impact	3	---	1	4
		Total Credits			**20**

M.Sc. IV[th] Semester		
S.No.	Title of Paper	Credits
01.	Field Training (Attachment with State Forest Department for analysis of FGR & its distribution) Project report writing, Presentation & Viva-voce	10
02.	Industrial Training Project report writing, Presentation & Viva-voce	09
03.	Computational Skills	05
04.	Student Project	01
	Total Credits	**25**

Grand Total of Credits = 98

- 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 the project.
- **Visits**: 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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SPECIALIZATION

FOREST MANAGEMENT (FM)

M.Sc. III[rd] Semester					
S.No.	Title of Paper	Lecture	Tutorial	Practical	Credits
01.	Forest Resource Analysis	3	—	1	4
02.	Production Management in Nursery and Plantation Forestry	3	—	1	4
03.	Finance and Marketing Management of Forest Resources	3	—	1	4
04.	Tree BusinessManagement	3	—	1	4
05.	Forest Management for Environmental Conservation	3	—	1	4
		Total Credits		**20**	

M.Sc. IV[th] Semester		
S.No.	Title of Paper	Credits
01.	Field Training (Attachment with State Forest Department for analysis of Forest Management patterns & Management techniques)	10
02.	Industrial Training Project report writing, Presentation & Viva-voce	09
03.	Computational Skills	05
04.	Student Project	01
	Total Credits	**25**

Grand Total ofCredits = 98

- 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 the project.
- **Visits:** Visits to forest operation sites, forest nursery, wildlife habitat and plantation sites will be conducted as per the requirement of curriculum.

DEPARTMENT OF FORESTRY, WILDLIFE & ENVIRONMENTAL SCIENCES
GURU GHASIDASVISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University established by the Central University Act.2009 No. 25 of 2009)

MARKS DISTRIBUTION FOR M.Sc. FORESTRY & ENVIRONMENTAL SCIENCES PROGRAMME

(2 YEARS / 4 SEMESTERS)

M.Sc. Ist Semester		**Marks**		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Silviculture	60	40	100
02.	Forest Biometry, Surveying & Engineering	60	40	100
03.	Forest Management, Remote Sensing & GIS	60	40	100
04.	Forest Ecology and Biodiversity Conservation	60	40	100
05.	Forest Protection	60	40	100
06.	Forest Statistics & Research Methodology	60	40	100
07.	Practical			200
	Total			**800**

M.Sc. IInd Semester		**Marks**		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Forest Policy, Laws and Environmental Legislation	60	40	100
02.	Forest Tree Improvement and Biotechnology	60	40	100
03.	Wood Technology and Nanoforestry	60	40	100
04.	Wildlife Biology and Conservation	60	40	100
05.	Forest Soil and Watershed Management	60	40	100
06.	Forest Products and Industries	60	40	100
07.	Environment and Global Climatic Changes	60	40	100
08.	Practical			200
	Total			**900**

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SPECIALIZATION

FOREST GENETIC RESOURCES (FGR)

M.Sc. III[rd] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Breeding Methods in Forest Trees	60	40	100
02.	Forest Trees Reproductive Biology and Seed Orchards	60	40	100
03.	Molecular Genetics of Forest Trees	60	40	100
04.	Quantitative Geneticsof Forest Trees	60	40	100
05.	Forest Genetic Diversity, Conservation & Environmental Impact	60	40	100
06.	Practical			200
	Total			**700**

M.Sc. IV[th] Semester		Marks
S.No.	Title of Paper	Total
01.	Field Training (Attachment with State Forest Department for analysis of FGR & its distribution) Project report writing, Presentation & Viva-voce	150
02.	Industrial Training Project report writing, Presentation & Viva-voce	150
03.	Computational Skills	50
04.	Student Project	50
	Total	**400**
	GRAND TOTAL	**2800**

- 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%.

SPECIALIZATION

FOREST MANAGEMENT (FM)

M.Sc. III[rd] Semester		Marks		
S.No.	Title of Paper	Main Semester Exam	Internal Assessment	Total
01.	Forest Resource Analysis	60	40	100
02.	Production Management in Nursery and Plantation Forestry	60	40	100
03.	Finance and Marketing Management of Forest Resources	60	40	100
04.	Tree BusinessManagement	60	40	100
05.	Forest Management for Environment Conservation	60	40	100
06.	Practical			200
	Total			**700**

M.Sc. IV[th] Semester		Marks
S.No.	Title of Paper	Total
01.	Field Training (Attachment with State Forest Department for analysis of Forest Management patterns & Management techniques)	150
02.	Industrial Training Project report writing, Presentation & Viva-voce	150
03.	Computational Skills	50
04.	Student Project	50
	Total	**400**
	GRAND TOTAL	**2800**

- Internal assessment marks distribution will be as given below:
  - 04. Midterm test - 30 Marks
  - 05. Attendance - 05 Marks
  - 06. 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%.

SEMESTER-I

PAPER I: SILVICULTURE **CR.4 (3+1)**

Objective

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

Theory

Principles of Silviculture, Forest structure and their components. Forest ecosystem concept. Stand dynamics-forest succession, competition and toleranee, classification of world's forest vegetation. Forest types and their distribution.Ecophysiology of tree growth, effects of radiation and water relationship, mineral nutrient and temperature.Bioclimate and microclimate effect.Natural regeneration of important forest tree species (*Acacia nilotica, Cedrusdeodara, Dalbergiasisoo, Tectonagrandis, Gmelinaarborea, Shorearobusta, Eucalyptus spps. Bamboo* and*Pinusroxburghii*) Intermediate treatments.Artificialregeneration. Intensive studies pertaining to important commercial species. Advanced and modern nursery tools &techniques.

Practical

Acquaintance with various technical terms of silviculture.Study of forest composition. Recording the observations on shoot development, growth rings ,crown development , leafing, flowering, and fruiting in *(Acacia nilotica, Cedrusdeodara, Dalbergiasisoo, Tectonagrandis, Gmelinaarborea, Shorearobusta, Eucalyptus spps. Bamboo and Pinusroxburghii*.Study of site factors like climatic, edaphic, physiographic and biotic.Study of natural regeneration, Afforestation and Reforestation success. Lay outing of nursery bed for sowing. Classificaton of world's forest vegetation.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

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

Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.

Smith DM, Larson Be, Ketty MJ &Ashton PMS. 1997.

Jha, L. K.2014.*Advances in Agroforestry*, Today & Tomorrow's Printers and PublishersNew Delhi.

Lal J.B. 2011.*Forest ecology*,Natraj Publisher Dehradun.

Mishra, S R. 2010.*Textbook of Dendrology*, Today & Tomorrow's Printers and Publishers New Delhi

Patra, A K. 2013.*Agroforestry: Principles and Practices*,Today & Tomorrow's Printers and PublishersNew Delhi.

PradeepKrishan. 2013. *Jungle trees of Central India*. Penguin Books India.

Smith DM, Larson BC, Ketty MJ, and Ashton PMS.1997.*The Practices of Silviculture– Applied Forest Ecology*.John Wiley & Sons.

Raj, Antony Joseph & S B Lal. 2014.*Agroforestry: Theory and Practices*, Today & Tomorrow's Printers and PublishersNew Delhi.

PAPERII. FOREST BIOMETRY, SURVEYING & ENGINEERING Cr.4 (3+1)

Objective

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

Theory

Measurements of tree diameter, girth, height, form Factor.Estimation of volume, quarter girth formula, estimation of tree age, increment, growth and volume table.Yield of individual tree and forest stands.Forest inventory, sampling methods adopted in forestry, random and non random sampling, point and crown sampling method, measurement of stand density. Forest Surveying: methods, Different methods of chain, plane table and compass surveying. Maps and map reading.Basic principles of Forest Engineering, building materials(cement,sand and concrete). Roads-alignment, component, types of roads,Bridges; General principles, objectives, types, simple design and construction of timber and otherbridges.

Practical

Measurements of height, girth, diameter of trees.Calculations of volume of felled as well as standing trees, Volume table preparation, Application of sampling procedures, Handling of GPS.Use of different methods of surveying chain compass and plain table.

Suggested Readings

Bena Singh.2011.*A Survey of the Forestry Research*, Vista International Pub.

ChaturvediAN &Khanna LS. 1994. *Forest Mensuration*, International Book Distributor.

Ram Parkash, 2009. *Forest Surveying*.KhannaBandhu.

Harry G. Champion and S.K. Seth.2005. *A Revised Survey of the Forest Types of India*, Natraj Publication.

McGraw-Hill. Simmons CEO 1980.*A Manual of Forest Mensuration*,Bishen Singh Mahender Pal Singh, Dehradun.

Ram Prakash 1983. *Forest engineering*, International book distributors.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*,McGraw-Hill Publ.

PAPER III: FOREST MANAGEMENT, REMOTE SENSING & GIS Cr.4 (2+1+1)

Objective

To provide knowledge to students about forest management through Remote Sensing and GIS technique.

Theory

Principles of forest management, Development of forest management in India. Concept of Normality, Normal Forest, Causes of abnormity in forest management Sustainable Forest Management, Rotation: Meaning and types, Increment, Types of increment. Yield: Types of Yield. Yield regulation in regular forest, yield regulation in irregular forest Management. Units: Working circles, felling series, cutting sections, coupes, periodic blocks and felling cycles. Silviculture system: Definition and types, Bamboo forest management and Working Plan prescriptions. Ecosystem management, Site quality, Stand density, Criteria and Indicators.

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

Practical

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

Suggested Readings

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

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

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

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

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

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

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

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

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

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

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Paper IV. FOREST ECOLOGY AND BIODIVERSITY CONSERVATIONCr.4 (3+1)

Objective

To develop understanding of students about ecological aspects of forest resource and biodiversity conservation.Consequences of depleting biodiversity and sustainable use of biodiversity: Issues and challenges.

Theory

Forest ecology, forest community dynamics, forest community structure and function, ecology of forest landscape spatial heterogencity: Hierarchy issues in ecology. Conservation of natural resources (Hotspot areas, Wildlife Sanctuaries, National parks, Biosphere reserve-terrestrial and aquatic, Botanical Gardens, Zoological Parks), Important Plant and wildlife ecological indicator species, endangered species, Coral reefs, Mangrove forest.Global warming and forests.Green House Effect,Ozone depletion and its consequences.Biodiversity Conservation laws and acts.Forest genetic resources of India.Survey exploration and sampling strategies.Documentation and evaluation of forests genetic resources (FGR), *in situ* and *ex situ* conservation of genetic resources.Biological diversity and its significance to sustainable use.Handling and storage of FGR.Intellectual property rights, Quarantine laws and FGR exchange.

Practical

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

Suggested Readings

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

Kumar Arvind. 2005. *Biodiversity and Conservation*, Today & Tomorrow's Printers and Publishers New Delhi.

Dhyani SN. 1994. *Wildlife Management*, Rawat Publ.

Malik, Ashok. 2008. *Dynamics of Forest Ecosystems*, Today & Tomorrow's Printers and PublishersNew Delhi.

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

Khan TI &Al-Azmi DN. 1999.*Global Biodiversity Conservation Measures*.Pointer Publ.

Kimmins JP.1976.*Forestry Ecology*, Macmillan.

Nautiyal S &Koul AK. 1999.*Forest Biodiversity and its Conservation Practices in India*, Oriental EnterprisesNew Delhi .

Ramakrishnan PS. 1992.*Shifting Agriculture and Sustainable Development*,Man and

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Biosphere Series.The Parthenon Publ.Group.

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

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

Objective

To provide knowledge to students about forest protection through diseases &pest management.

Theory

General concept of forest protection. Forest Fire. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

Disease concept and disease cycle.Biodegradation of wood - microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots - factors affecting heart rots.damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health. Important diseases of forest trees- Teak, Sal, Shisham, *Acacia*, *Dalbergia*, Deodar, Pines and Casuarina. Insect pest of Sal, Teak, Shisham, Babool, *Ailanthus*, Pines, Deodar, Casuarinas and *Albizia*. Biological control of insect pests and diseases of forest trees. Nature of disease resistance. Molecular tools for developing disease resistance trees.

Practical

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

Suggested Readings

Bakshi BK. 1976. *Forest Pathology*.Controller of Publications. GOI.

Jha LK &SenSarma PK. 1994.*Forest Entomology*.Ashish Publ. House.

S SNegi,2006.*Handbook of Forest Protection*. International Book Dist., Reprint

Schmidt, Olaf.2006.*Wood and Tree Fungi: Biology Damage Protection and Use*, Today & Tomorrow's Printers and Publishers,New Delhi.

Paul. D. Mennan, 1991. *Tree Diseases Concept*. Prentice Hall.

Stebbings EP. 1977 *Indian Forest Insects*.JK Jain Bros.

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PAPER VI.FOREST STASTISTICS& RESEARCH METHODOLOGYCR.5 (3+1+1)

Objective

To provide exposure about methods of statistical analysis, design and sampling techniques.

Theory

Introductory: Statistics scales of measurement, concept of graphical, exploratory and inferential data analysis, important variables of forestry sector, Mean, Median, Mode and SD. Concept of Probability.

Correlation and regression: Simple, Rank, Partial, Multiple, infractass correlations, Coefficient of determination. Linear and nonlinear regressions. Tests, if significance - t, F, z, and χ^2, testing significance of correlation and regression coefficients, analysis of variance (ANOV A) - one way and two way classification with single: and more than one cell frequency. Design of Experiments. Principles of experimental designs, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Split Plot and Strip Plot Designs.

Practical

Fitting of probability distributions, Computation of correlations and regressions, Tests of significance - t, F, z and χ^2. Laying out of designs in the field (i)Latin Square, (ii) Randomized block design, (iii) Split plot design, (iv) Data analysis of the above designs.

Suggested Readings

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

Matinl. 1976.*Principles of Database Management.* Prentice Hall Pasc UG & Sukhatme MU. 1978.

Mend R & Relay 1. 1987. *Statistical Tools for Agro-Forestry Research - Bivariate Analysis for intercropping Experiments.* ICRAF, Nairobi.

P.N.Arora, 2003.*Biostatistics*, Himalayan Publishing House.

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

Text Book of Forest Tree Breeding ICAR.

SEMESTER-II

PAPER I. FOREST POLICY, LAWS AND ENVIRONMENTAL LEGISLATION Cr.4 (2+1+1)

Objective

To develop understanding of students about forest policy, laws and Environmental Legislation.

Theory

Forest policy- Relevance and scope, National Forest Policy – 1894, 1952 and 1988:General principles of criminal law; Indian Panel Code, criminal procedure code; Forest laws, Indian Forest Act -1927, general provision and detailed study; Forest Conservation Act 1980, Wildlife Protect Act 1972.Important Forest Rules and Guidelines. Forest Right Acts, 2006. Chhattisgarh State Forest Acts and Rules.Important case studies and landmarkjudgments.

Practical

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

Suggested Readings

Chaturvedi A.N 2011.*Forest Policy and law*, KhannaBandhu.

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

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

Poddar A.K. et al. 2011.*Forest Laws and Plicies in India*, Today and TomarrowPrinters and PublishersNew Delhi

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

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

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

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

SairamBhat 2010. Natural Resources Conservation Law, Sage.

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

PAPER II.FOREST TREE IMPROVEMENT AND BIOTECHNOLOGY CR.4 (3+1)

Objective

To acquaint the students about general principles of tree breeding with examples ofimportant trees.

Theory

General concept of forest tree breeding, tree improvement and forest genetics.Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics, Attractants for pollinators, Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms. A Variation in trees importance and its causes. Natural variation as a basis for tree improvement.Geographic variations – Ecotypes, clines, races and land races.Seed, seed formation, dispersal, storage, stratification and seed dormancy.Selective breeding methods- mass, family, within

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family, family plus within family. Plus tree selection for wood quality. Progeny and clone testing.Seed orchards - type, functions and importance.Estimating genetic parameters and genetic gain.Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis.Species and racial hybridization. Indian examples - Teak, Sal, Shisham, *Eucalypts*, *Acacias*, Pines And Poplars.Polyploidy, aneuploidy and haploidy in soft and hardwood species.Induction of polyploidy.Hardy-weinberg law, null hypothesis, Wohlund's Principle.

Biotechnology in tree improvement: Mutation breeding, Tissue Culture, Micro-propagation, Genetic engineering, Transgenic plants, Molecular marker and its application in forestry.

Practical

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

Suggested Readings

Khan IM. 2014 Forest Biotechnology, Today and Tomorrow Printers and PublishersNew Delhi.

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

Surendran C, Sehgal RN &Paramathma M. 2003.*Text Book of Forest Tree Breeding*. ICAR Publ.

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

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

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

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

PAPER III.WOOD TECHNOLOGY AND NANO FORESTRY CR.4 (3+1)

Objective

To acquaint with the physical characteristics and strength properties of wood.

Theory

Wood as a raw material, kinds of wood : hard wood, soft wood, bamboos and canes. Merit and demerits of wood as a raw material. The physical features of wood. Mechanical properties of wood- tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacity.

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Suitability of wood for various uses based on mechanical and physical properties. Electrical and acoustic properties of wood.Wood water relationship- shrinkage, swelling, movement, fiber saturation, equilibrium, moisture content. Wood seasoning, principles and types- air seasoning, kiln seasoning &chemical seasoning. Refractory classes of timber, kiln schedule.Seasoning defects and their controls. Wood preservation- needs, principles, process, types of wood preservatives (water soluble, oil based, etc). Classification of timbers based on durability. Methods of preservation. Pressure methods- full cell process, empty cell process. Wood machining: Sawing – techniques, kinds of saws – cross cut edging, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.Nanotechnology potential in forest product industry, Nano cellulose technology.Basic concepts of Nano forestry, tools techniques and significance.

Practical

Determination of wood density, study of thermal, electrical and acoustic properties ofwood.Determination of tensile and bending properties of wood.Determination of moisture content and swelling coefficients of different woods. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters.Treatment of wood with different types of preservatives.

Suggested Readings

Chauhan Laxmi and R. Vijendra Rao. 2003.*Wood Anatomy of Legumes of India. Their Identification, Properties and Uses*, BSMPS.

Hill, Callum A S. 2006. *Wood Modification: Chemical Thermal and Other Processes*, Today & Tomorrow's Printers and Publishers New Delhi.

Mehta T.1981. *A handbook of Forest Utilization*.Periodical Expert Book Agency.

Printers and Publishers New Delhi 2006.

Rao KR &Juneja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.

Schmidt, Olaf. *Wood and Tree Fungi: Biology Damage Protection and Use*, Today & Tomorrow's Printers and Publishers New Delhi.

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh MahenderPal Singh, Dehradun.

Terry Porter. 2006. *Wood: Identification and Use*,Guild of Master Craftsman Pub.

Trotter H., 1982.*Manual of Indian Forest Utilization*.FRI&College, Dehradun.

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

Negi S.S. 1997. *Wood Science and Technology*.International Book Dist.

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PAPER IV WILDLIFE BIOLOGY AND CONSERVATIONCR.4 (3+1)

Theory

Introduction/Conservation ethics- Definitions, Values, Zoological classification, Sign and symptoms.Animals behavior & adaptations, Wild life Ecology, Basic concepts, Wildlife habits and habitat, Wildlife Ecology: Wildlife habitat and component Wildlife conservation: Definition, Concept, significance. Wildlife conservation movement. Wildlife conservation in India, In-situ and Ex-situ wildlife conservation, Role of protected area in wildlife conservation, some rare and threatened wildlife species of world particularly India, special project for endangered species, Project tiger, GirLion Project, Crocodile Breeding Project, Wildlife Conservation organization- National and International.

Wild life management: Wild life management its scope as a natural resource, current status of wildlife management, Management of certain animals: small game management water fowl, Pigeon, aquatic animal, Reptile, Big game management, Tiger, Bear, Elephant, Rhinoceros, deer, Biological basis of management- animal population, shelter, food, WL Policy Legislation and administration policies and programmes, Wild life protection act 1972, wild life education, Age and Sex determination, Tiger census, Preservation of biological material, National Park and Sanctuaries of (C.G), Biotelemetry, Forensic Analysis.

Practical

Study of mammals birds and animals in university premises, Identification of pugmark, evaluation of Roosting cover in university premises, Plotting of National Park and Sanctuaries.

Suggested Readings

Agarwal, K.G.,2000.*Wildlife of India: Conservation and management*, Nidi Publishers India.

GopalRajesh.,1993. *Fundamentals of wildlife management*, Justice Home Publication, Allahabad.

Hoseni B.B, 1997. *Concept of Wildlife management*, Daya Publishing House, Delhi.

James, *A.* 1984 *Principles of wildlife management*, Inc Bailey, John Wiley & Sons,New York.

Hunter, M.L., Jr., 1990.*Wildlife forest and forestry principals of managing forest for Biological diversity*.,Printice Hall,.

Singh, S K.,2009. *Textbook of Wildlife Management*, Today & Tomorrow's Printers and Publishers New Delhi.

Stephen H, Berwick and V.B, Sharia, 1995.Wildlife *Research and management*, Oxford University Press, Oxford,.

PAPER V. FOREST SOILS AND WATERSHED MANAGEMENT(CR.4 (3+1)

Theory

Definition and importance of forest soils; Origin, classification and nomenclature of soils; Soil profile; Soils of major forest biomes; Difference between forest soil and other arable soils; Important physical, chemical, and biological properties of forest soils; Forest soil survey; land use type and forest plantations; Forest-soil types; Silviculture practices and forest soils.

Organic matter content, litter decomposition and C:N ratio in forest soil; Forest soil fertility, nutrient management and biological nitrogen fixation; Management of forest nursery soil.

Soil degradation-problems and impact on forest ecosystems; Forest fire and soil resilience; Forest soil pollution; Characteristics, ecology and management of tropical forest soils.Problems and prospects in management of tropical dry and moistdeciduous forest soils.

Watershed management concept, Problems of land degradation, Soil and water conservation measures for arable and non-arable lands, Storage and recycling of water, Criteria for watershed size determination.

Watershed work plan for degraded sites.Rehabilitation of degraded lands and prevention of natural hazards.

Practical

Determination of soil moisture, texture, porosity, bulk density, particle density and water holding capacity; Determination of pH, EC, organic C & N,Study of forest soil profile in field, Studies on nitrogen fixing and phosphorous absorbing microbes; Studies on fertilizers, biofertilizres and FYM uses in forest nursery, visitsto nearby forest nursery and watershed areas.

Suggested Readings:

A K Mani, R Santhi and K M Sellamuthu. 2008.*Fundamentals of Forest Soils*, Satish Serial Pub.

DhuruvaNarayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed management* ICAR Publication, New Delhi.

Murty, J.V.S.1995. *Watershed management in India*. Wiley Eastern, New Delhi.

Singh, P.K. 2000.*Watershed management: Design and Practices*. E-media publications,Udaipur, India.

N.C. Brady 1990.*The Nature and Properties of Soils*: MacmillanPublishing Company, New York (10th Edition).

Negi S.S., 2000. *Forest Soils*, International Book Distributors, .

Osman, Khan Towhid. 2013. *Forest Soils: Properties and Management*. Springer Science publ.

R.F. Fischer and D. Binkley (2000).*Ecology and Management of Forest Soils*

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

PAPER VI. FOREST PRODUCTS AND INDUSTRIESCR.4 (3+1)

Objective

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

Theory

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products.

Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes.

Cell wall constituents.Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood – water and organic solvent soluble.

Taping of oleoresin from major pine species. Types of the gums and their extractions (arabic, ghatti and tragacanth).

Recovery and uses of volatile oils, tannins, katha and cutch. Nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents -- Henicellulose and lignin. Extraction of essential oils, resins, tannins and gum, Characterization of pulp & rate of pulping. Identification and properties of wood and non wood products used for forest based industries. Visit to nearby forest based industries.

Suggested Readings

Anonymous. 1981. *Wealth of India* CSIR.

Anonymous. 2007. *Year Book: of Forest Products* FAO

Dwivedi AP. 1993. *Forestry in India.* Surya Publ.

Krishnamurthy T. *Minor Forest Products of India.*Oxford &IBH.

Mehta T. 1981. *A Handbook of Forest Utilization.*Periodical Expert Book Agency.New Delhi.

Praveen Taank, 2010. *Forest Product and their Utilization.* Cyber Tech . .

Shiva. M.P., 1998., *Timber Forest Products and Shrub and Herb Species of NTFP Importance* : , Indus: .

T. Krishna Murthy. 2010. *Minor Forest Products of India : Non-Timber Forest Products of India* : BS Pub, Second Edition.

Tewari, D. D., 2008. *Management of Non-Timber Forest Product Resources of India:*An Analysis of Forest Development Corporations. Lucknow: International Book Distributing Company, Lucknow.

Troup, R S.,2007. *Manual of Indian Forest Utilisation* Today & Tomorrow's Printers and Publishers.

PAPER VII: ENVIRONMENT AND GLOBAL CLIMATIC CHANGES
CR.4 (3+1)

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

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

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

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

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

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

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

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

Practical
Impact of particulate matter on environment, Impact of coal mining on environment Impact of cement pollution in environment.Effect of effluent from several industries on environment.Reclamation of mining wastes with microorgsnisms. Bio-accumulation studies on metals by microorganisms.Assessment of environmental impact on polluted sites.Assessing the awareness of environmental regulation and control methods.Impact of power stations on plant, microorganisms, animals and soils ecosystems, EIA of polluted river ecosystem, Environmental Impact Assessment.

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

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

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

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

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

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

SEMESTER- III

SPECIALIZATION COURSES

Following two specialization courses will be offered to the students and students have to select only one specialization courses during the semester.

A. FOREST GENETIC RESOURCES
B. FOREST MANAGEMENT

A. FOREST GENETIC RESOURCES

PAPER I. BREEDING METHODS IN FOREST TREESCr.4 (3+1)

Objective

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

Theory

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy- Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes.

Long-term and short-term breeding populations. Selective breeding methods- mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, subjective evaluation. Selection for different traits.

Genetic testing programs - mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs - open pollinated mating and polycross mating.

Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection. Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and

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salt resistance.

Tree improvement case histories. Calculating gene and genotype frequencies.Flow chart for different breeding methods.

Practical

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

Suggested Readings

Breeding.ICAR.

FAO. 1983. *Forest Tree Improvement*. FAO Publ.

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

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

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

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

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

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

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

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

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

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

PAPER II.FOREST TREES REPRODUCTIVE BIOLOGY ANDSEEDORCHARDS CR.4 (3+1)

Objective

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

Theory

Importance and application of reproductive biology in tree breeding.Modes of reproduction: vegetative, asexual, sexual reproduction their breeding systems and sex expression. Monoecy, dioecy and its evolution. Out-crossing mechanism in forest trees. Environmental effects on sex expression. Floral biology. Initiation and development- Microsporogenesis, Megasporogenesis, modes of pollination. Self

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and out-crossing.Fertilization in hardwood and softwood species.Embryo development, seed development, Seed dispersal and gene flow.Seed orchard need, establishment of seed orchard , hybrid and research seed orchard, selection and preparation of seed orchard site, isolation, orchard size, orchard design.Seed orchards – production and management, different types of seed orchards – SSO and CSO- merits and demerits.Progeny testing and its importance.Pests and disease management.Importance of seed orchards in gene conservation.Seed production area- its production and management.

Practical

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

Suggested Readings

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

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

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

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

Khrwer.

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

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

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

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

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

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

PAPER III.MOLECULAR GENETICS OF FOREST TREES **CR.4 (3+1)**

Theory

Genome: Nuclear Genome, Mitochondria Genome, Chloroplast Genome and Evolution of the three Plant Genomes. Transcription and translation of forest tree Genes. DNA replication.Genetic code.Gene expression.Regulation of Gene Expression.DNA damage, repair and recombination.

Genetic diversity/Genetic variation of forest trees: causes and advantages. Genetic characterization of forest tree species.Morphological, Biochemical and Genetic markers. Molecular markers: Dominant and codominant, Types of molecular markers: advantages and disadvantages. Techniques in molecular

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genetics of forest trees: DNA isolation, DNA quantification, DNA restriction; Primer ,gel electrophoresis; southern, northern and western blotting; nucleic acid hybridization; polymerase chain reaction, gene sequencing .

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

Associate mapping through molecular markers.Social issues in molecular genetics.Bioinformatics.

Practical

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

Suggested Readings

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

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

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

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

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

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

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

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

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

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

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

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

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

PAPER IV: QUANTITATIVE GENETICS OF FOREST TREES CR 4(3+1)

Objective

Toimpart knowledge in the field of biometry as applied to breeding, population, provinces and making experience in forest genetics and tree breeding.

Theory

Historical aspects of quantitative genetics; multiple-factor-hypothesis.Population structure, mating systems.

Hardy- Weinberg equilibrium: properties and implications of equilibrium, influence ofmutation, migration and selection. Random mating consequences in small populations.Random drift, inbreeding coefficient, rate of inbreeding.

In breeding in pedigreed population, inbreeding coefficient under regular systems of inbreeding. Statistical parameters used in studying polygenic traits.

Testing and estimating: population mean and components of phenotypic value, breeding value, dominance, interaction and environment deviation. Models of gene action, significance of different genetic components, G x E component of variance.

Estimation of genetic components of variance through resemblance of relatives.Fisher's fundamental theorem on natural selection and its implications. Heritability-its estimation and significance.

Selection theory for a quantitative character. Prediction of selection response: patterns, asymmetry, and causes. Selection criteria and use of information from relatives. Correlation among characters, correlation response and indirect selection.

Effect of inbreeding on mean and variance.Heterosis and causes for heterosis in F1 and later generations.Combining ability effects, variances and selection for combining ability. Threshold characters.

Practical

Quantitative and qualitative character analysis in forest tree species.Phenotypic, genotypic correlations and path analysis of forest trees.Estimation of variance components from analyses of variance using

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various mating designs of forest trees. Estimation of population value with respect to quantitative/qualitative traits.Multivariate analysis.

Suggested Readings

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Objective

To provide the students knowledge about the genetic diversity in forest tree species, their distribution, assess and analysis law and methodology of *in-situ* and *ex-situ* conservation.

Forest biodiversity: concept, levels and measurement. Forest genetic diversity: Values, Services and threats.Levels of Genetic Variation in Forest Trees.Characteristics of Forest Genetic Diversity: Interspecific and Intraspecific diversity, Ecotypes, Subspecies, Population, Metapopulation, Provenance, Land race, Cline. Dynamics of forest genetic diversity: Genetic erosion, Population bottleneck, Genetic drift, Selection, Migration and Mutation.Genetic diversity in natural forests.Natural and induced genetic diversity in forest tree species.Biodiversity in forests of India (Tropical and Temperate Forests).Hotspots of forest genetic diversity Measurement of forest genetic diversity and diversity indices.Monitoring of forest genetic diversity: Documentation and evaluation.Climate change and forest genetic diversity.

Conservation Of Forest Genetic Diversity: *in situ* and *circa situ* conservation: Protected areas. Biosphere reserves. National parks. Sanctuaries, gene reserve forest and Community reserves ; *Ex Situ* Conservation: gene banks. Cryopreservation. Targeted Species-Based Approach.Intellectual property rights. The Biological Diversity Act. 2002, Quarantine laws and FGR exchange. Conservation efforts in India and worldwide.International conservation bodies: FAO, IUFRO, CIFOR, IUCN and WWF.

Practical

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

Suggested Readings

1.
FAO. 1985. *Forest Tree Improvement*. FAO Publ.

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

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

Fred W. Allendorf, Gordon H. Lulkart, Sally N. Aitken. 2012. *Conservation and the Genetics of Population*. 2nd Edition ISBN: 978-1- 118- 40857-5, Wiley E-Book.

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

Mahmut Caliskan. 2012 .*Genomics Diversity in Plants*. In Tech Publishers.

Mahmut Caliskan. 2012. *The Molecular Basis of Plants Genetics Diversity*. In Tech Publishers

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

Padmini Sudarsana, Madhugiri Nageswara-Rao and Jaya R. Soneji.2012. *Tropical Forest*. A free online edition of this book is available at *www.intechopen.com*

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

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

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

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

SEMESTER- IV

This semester will have following training programmes.

1. **Field Training (Attachment with State Forest Department for analysis of FGR & its distribution)**
   Specialization: Forest Genetic Resources (FGR)

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

2. Industrial Training

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

3. Computational skills

Introduction to computers and personal computers, basic concepts (H/W, S/W, Input & Output Devices) operating system(Introductionof open source and closed source), DOS and Windows XP/7/8, introduction of programming languages, BASIC languages concepts basic and programming techniques, MS Office, Win Word, Excel, Power Point, MS Access.Introduction of Statistical & Remote sensing softwares.Introduction to Multi-Media and its application.Introduction to Internet.

4. Student Report

B.FOREST MANAGEMENT

PAPER I. FOREST RESOURCE ANALYSIS **CR.4 (3+1)**

Objective

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

Theory

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

case, match splints, toys etc.

Minor forest products: edible products, fodder trees, shrub and grasses, bamboo and cane, medicinal and aromatic plants, oil seeds, gum & resins, fiber and flosses, spices and miscellaneous products e.g. Katha, latex, insecticides, soap nuts, etc.

Animal products from forest - lac, honey, silk, fur, skins, tusks etc. Dependency of villagers/ tribal on forest resources for different livelihood options.

Nature, scope and importance of forest resources in regional & national economy, nature, role and functions of forest based industries, reasons for resource degradation. Causes of low productivity of forest resources, remedial strategies, Trends in the production of important forest resources (wood and non-wood products). Government policies on forest resources.

Approaches to achievements under five year plans. Management strategies for improved production and consumption of forest resources.

Practical

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

Suggested Readings

Agricultural Production and Resource Use. Oxford Univ. Press.

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

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

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

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

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

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

Rakshit, Swapan KumarForest Resource Management/ Today & Tomorrow's Printers and Publishers

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

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

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

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PAPER II. PRODUCTION MANAGEMENT IN NURSERY AND PLANTATION FORESTRY **CR.4 (3+1)**

Objective

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

Theory

Introduction to production theory, Production concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of resource allocation in nursery production, Resource combination and cost minimization: Resource allocation and enterprise combination.Derivation of cost andsupply functions from production functions, Managing risk and uncertainty in nursery and plantation forestry.

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis.Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period.

Market structure, Functions, Channels, Marketing efficiency and marketing problems of nursery and plantation forestry.

Practical

Exercises on marginal analysis in nursery production, Exercises on investment analysis. Exercises on marketing channels, costs, margin and price spread for different nursery and plantation crops.

Suggested Readings.

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

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

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

Makchau JP Makcham and L.R. Malcolm,Economy of Tropical Farm Management Cambride University Press.

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

Ransit swapan Kumar. 2007. *Forest Resource Managemen*.. Todays and Tomarrow printers and publishers New. Delhi.

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

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

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

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PAPER III. FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCESCR.4 (3+1)

Objective

To develop understanding of students about financial and marketing management tools as applied in forest resources.

Theory

Finance- definition, aims and objective; Goals of financial management, organization of finance in business firms; Working capital management; need, concepts and sources of working capital.Gross and net working capital; factors influencing working capital requirements.Importance and preparation of Financial Statements, Balance Sheet and Profit and Loss accounts. Sources of long term finance. Purpose and essentials of budgeting, important components of budget, preparation of budgets;

Market-concept, components and classification. Demand and supply and factors affecting the market. Simple market model and price determination: Market structure, conduct and performance. Market integration-meaning, types and effects of market integration.Marketing cost, margin and price spread-concepts and applications. Marketing efficiency- definition. IPRs and their implications in forestry.Marketing of wood andnon-wood forest products.

Practical

Library review of studies in marketing and trade of national and international timber and non timber forest products. Analysis of price and market data of forestry products.Exercises on analysis of demand and supply of important forest products. Exercises on marketing channels, costs, margins and price - spread of important forest products.Case studies based on visits to selected markets, marketing institutions and forest based industries.

Suggested Readings

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

FAO 1986.*Guidelines to Project Evaluation*.NatrajPubl.

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

Grebner D. Betthing P. Siryj .,2013 *Introduction to forestry and Natural Resource*. Elsvier Publisher.

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

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

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

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

Panda SC 2011. *Farm management and Agricultural Marketing* ,Kalyani Publishers.

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Shanley Alan R P. 2001 *Tapping the green Market: Management and Certification of Non- Timber Forest Products*. Amazon.

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

W.A. Lauscher, Introduction to forest Rewsource Economics.

PAPER IV. TREE BUSINESS MANAGEMENT **CR.4 (3+1)**

Objective

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

Theory

Tree Farm : concepts, present scenario, and business application. Relationship of farm sciences with other sciences.Types of tree Farm in India, nature, scope and function of farm business management. Principles involved in Tree farm management decision making. Law of diminishing returns, substitution law, cost and price principle, depreciation.Principles of farm planning and budgeting.Working out existing and alternative farm plans. Importance of farm records, types of physical and financial records, Farm business efficiency measures.Fundamentals of inventory.Management of special farm projects like, nursery, plantations Teak, Eucalyptus, Bamboo, Sissoo, and Terminalia, sericulture.Farm labour and its problems.Labour efficiency measurement, work allocation, raising labour productivity, staff control, work progress charts, Farm capital and its problems, Farm machinery and its working principle, Field assessment for species selection and growth analysis of tree in the farm.

Practical

Visit of agricultural farm, plantations. Calculation of fertilizers and compost quantity in different tree farms.Formulation of farm budget, Cost of production, maintenance of single and double entry system of account, preparation of farm records. Farm tools and its use in tree farm.

Suggested Readings:

Bamoul WJ &Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.

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

FAO 1986.*Guidelines to Project Evaluation*.NatrajPubl.

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

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

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

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

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

Panda SC 2011. *Farm management and Agricultural Marketing* ,Kalyani Publishers

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

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PAPER V. FOREST MANAGEMENT FOR ENVIRONMENT CONSERVATION CR.4 (3+1)

Objective

To develop understanding and management skills of the student with special reference to Environment conservation

Theory

Definition, concept and principle of sustainable forest management. Problems in modern forest management, ITTO's principles, Montreal Process, SFM within the context of climate change. Sustainable energy and NTFP management. Sustainable harvesting, Gender sensitization in SFM, Process flow for women involvement SFM.Concept of participatory development. Participatory management and key elements of processes for planning and implementation, monitoring and evaluation.Concept of PRA &RRA ,techniques& tools of PRA. Importance of PRA, problems in PRA. RRA applications. Watershed Management: Concept, Scope, importance and Principles of watershed management. Application of Remote sensing & GIS for sustainable forest management.Criteria and Indicators of SFM, Bhopal India Process. CAMPA, JFM, Assistant natural regeneration. Forest Certification. Concept of tree outside forest.

Practical

Practice of participatory rural appraisal technique.Preparation of micro plan for sustainable forest management.Resource survey and preparation of resource map.Exercises on designing training program for sustainable forest management.Reading of watershed map: Region/Basin /Catchment/Watershed preparation of classification chart.Writing news items, success stories, leaflets, and folders for the SFM.Visual interpretation of imageries and preparation of land use land class classification.Digitization of raster data.

Suggested Readings:

Bhattacharya, P et al. 2008. *Joint Forest Management in India in 2 Vols.* Today's and tomorrow Printers and Publishers.

Lal J.B. 2011. *Farm Management Classical Approach to current imperatives*, Natraj Publication.

Neela Mukherjee. *Participatory Appraisal of Natural resources*, Concept publishing company new Delhi.

Osmoston.*Management of forest* . International Book Distributors.

S.K. Gupta. *Aspects of sustainability of JFM*.,Bishen Singh Mahendrapal Singh.

Sen Rajkumar2012. *Forest Management and Sustainable Development.* Today's and tomorrow Printers and Publishers.

Suresh Sachdeva,M.L.Mourya. *Management concept practices*, Y.K. Publishers *Agra*

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SEMESTER- IV

This semester will have following training programmes.

1. Field Training (Attachment with State Forest Department for analysis of Forest Management patterns & Management techniques)

Specialization: Forest management

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

2. Industrial Training

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

3. Computational skills

Introduction to computers and personal computers, basic concepts (H/W, S/W, Input & Output Devices) operating system (Introduction of open source and closed source), DOS and Windows XP/7/8, introduction of programming languages, BASIC languages concepts basic and programming techniques, MS Office, Win Word, Excel, Power Point, MS Access.Introduction of Statistical & Remote sensing softwares.Introduction to Multi-Media and its application.Introduction to Internet.

4. Student Project

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Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$\text{SGPA } (Si) = \sum(Ci \times Gi) / \sum Ci$$

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$\text{CGPA} = \sum(Ci \times Si) / \sum Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of Computation of SGPA and CGPA and Format for Transcripts

i. Computation of SGPA and CGPA

Illustration **for SGPA**

Course	Credit	Grade letter	Grade point	Credit Point (Credit x Grade)
Course 1	3	A	8	3 X 8 = 24
Course 2	4	B+	7	4 X 7 = 28
Course 3	3	B	6	3 X 6 = 18
Course 4	3	O	10	3 X 10 = 30
Course 5	3	C	5	3 X 5 = 15
Course 6	4	B	6	4 X 6 = 24
	20			139

Thus, SGPA =139/20 =6.95

Illustration **for CGPA**

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Credit : 20 SGPA:6.9	Credit : 22 SGPA:7.8	Credit : 25 SGPA: 5.6	Credit : 26 SGPA:6.0	Credit : 26 SGPA:6.3	Credit : 25 SGPA: 8.0

Thus, **CGPA** = $\dfrac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$ **= 6.73**

ii. Transcript (Format): Based on the above recommendations on Letter grades, grade points and SGPA and CCPA, the HEIs may issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.