

**CBCS COURSE SYLLABUS  
FOR**

**B.Sc. FORESTRY**

(w. e. f. 2018-19)

Revised during 2019-20



**“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)

**Course Structure**  
**B.Sc. Forestry (4 -Year / 8- Semester) CBCS Program**

Semester	Course Opted	Course Code	Name of the course	Credit	Hour / week	Marks
I	Core-01	NR/FR/CR/01/01/L	Principles and Practices of Silviculture	4	4	100
	Core-01 Practical	NR/FR/CR/01/01/P		2	4	100
	Core-02	NR/FR/CR/01/02/L	Fundamentals of Soil Science	4	4	100
	Core-02 Practical	NR/FR/CR/01/02/P		2	4	100
	Generic Elective (GE)-01	NR/FR/GE/01/01/L	Basic Mathematics	5	5	100
	Generic Elective (GE)-01 Tutorial	NR/FR/GE/01/01/T		1	1	--
	Ability Enhancement Compulsory (CC-01)	NR/FR/CC/01/L	English Communication	4	4	100
	Extracurricular Activity (EC-01)	NR/FR/EC/01/01/P	ECA-Extracurricular activity Field visit/ NSS/ Swachhta/ Physical Education/ Plantation Activities	2	4	100
	<b>TOTAL</b>				<b>24</b>	<b>30</b>
	Core -03	NR/FR/CR/02/03/L	Forest Ecology and Biodiversity Conservation	4	4	100
	Core -03 Practical	NR/FR/CR/02/03/P		2	4	100
	Core -04	NR/FR/CR/02/04/L	Fundamentals of Wildlife	4	4	100
	Core -04 Practical	NR/FR/CR/02/04/P		2	4	100
	Generic Elective (GE)-02	NR/FR/GE/02/02/L	Introductory Botany	4	4	100
	Generic Elective (GE)- 02 Practical	NR/FR/GE/02/02/P		2	4	100
	Ability Enhancement Compulsory (CC-02)	NR/FR/CC/02/02/L	Environmental Studies	4	4	100
	Extracurricular Activity- (EC-02)	NR/FR/EC/02/02/P	ECA-Extracurricular activity/ Field visit/ NSS/ Swachhta/ vocational Training/ Sports/ Plantation activities	2	4	100
	<b>TOTAL</b>				<b>24</b>	<b>32</b>


  
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Semester	Course Opted	Course Code	Name of the course	Credit	Hour / week	Marks
III	Core -05	NR/FR/CR/03/05/L	Forest Mensuration	4	4	100
	Core -05 Practical	NR/FR/CR/03/05/P		2	4	100
	Core -06	NR/FR/CR/03/06/L	Cytogenetics and Plant Breeding	4	4	100
	Core -06 Practical	NR/FR/CR/03/06/P		2	4	100
	Core -07	NR/FR/CR/03/07/L	Forest Management	4	4	100
	Core -07 Practical	NR/FR/CR/03/07/P		2	4	100
	Generic Elective-(GE)-03	NR/FR/GE/03/03/L	Ethnobotany	4	4	100
	Generic Elective (GE-3) Practical	NR/FR/GE/03/03/P		2	4	100
	Skill Enhancement Course(SC-01)	NR/FR/SC/03/01/L	Nursery Practices and Plantation management	2	2	100
	Skill Enhancement Course(SC-01) Practical	NR/FR/SC/03/01/P		2	4	100
	<b>Total</b>				<b>28</b>	<b>38</b>
IV	Core -08	NR/FR/CR/04/08/L	Application of Remote Sensing and GIS in Forest and Watershed Management	4	4	100
	Core -08 Practical	NR/FR/CR/04/08/P		2	4	100
	Discipline Specific Elective (DSE) -1A	NR/FR/DS/04/1A/L	Fundamentals of Wood Science	4	4	100
	Discipline Specific Elective (DSE) -1A Practical	NR/FR/DS/04/1A/P		2	4	100
	Discipline Specific Elective (DSE) -1B	NR/FR/DS/04/1B/L	Nursery Management and Commercial Forestry			
	Discipline Specific Elective (DSE) -1B Practical	NR/FR/DS/04/1B /P				
	Generic Elective-(GE)-04	NR/FR/GE/04/04/L	Non Wood Forest Products and Utilization	4	4	100
	Generic Elective Practical(GE)-04	NR/FR/GE/04/04/P		2	4	100
	Skill Enhancement Course(SC-02)	NR/FR/SC/04/02/L	Forest Policy, Legislation & Environmental Act	2	2	100
	Skill	NR/FR/SC/04/02/P		2	4	100

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	Enhancement Course(SC-02) Practical					
	<b>TOTAL</b>			<b>22</b>	<b>30</b>	<b>800</b>
<b>V</b>	Core -09	NR/FR/CR/05/09/L	Wildlife Management	4	4	100
	Core -09 Practical	NR/FR/CR/05/09/P		2	4	100
	Core- 10	NR/FR/CR/05/10/L	World forestry System	4	4	100
	Core- 10 Practical	NR/FR/CR/05/10/P		2	4	100
	Discipline Specific Elective (DSE)-2A	NR/FR/DS/05/2A/L	Wood Technology	4	4	100
	Discipline Specific Elective (DSE)-2A Practical	NR/FR/DS/05/2A/P		2	4	100
	Discipline Specific Elective (DSE)-2B	NR/FR/DS/05/2B/L	Forest Tree Seed Technology			
	Discipline Specific Elective (DSE)-2B Practical	NR/FR/DS/05/2B/P				
	Discipline Specific Elective DSE-3A	NR/FR/DS/05/3A/L	Meteorology and Crop Production	4	4	100
	Discipline Specific Elective DSE-3A Practical	NR/FR/DS/05/3A/P		2	4	100
	Discipline Specific Elective-(DSE-3B	NR/FR/DS/05/3B/L	Basic Concepts of Horticultural and Landscaping			
	Discipline Specific Elective-DSE-3B Practical	NR/FR/DS/05/3B/P				
	<b>TOTAL</b>			<b>24</b>	<b>32</b>	<b>800</b>
	<b>VI</b>	Core -11	NR/FR/CR/06/11/L	Forest Pathology and Entomology	4	4
Core -11 Practical		NR/FR/CR/06/11/P		2	4	100
Core -12		NR/FR/CR/06/12/L	Agroforestry	4	4	100
Core -12 Practical		NR/FR/CR/06/12/P		2	4	100
Discipline Specific Elective (DSE)-4A		NR/FR/DS/06/4A/L	Forest Economics	4	4	100


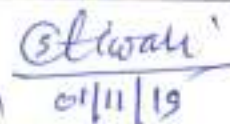
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	Discipline Specific Elective (DSE)-4A Practical	NR/FR/DS/06/4A/P		2	4	100
	Discipline Specific Elective (DSE)-4B	NR/FR/DS/06/4B/L	Forest Tree Improvement and Biotechnology			
	Discipline Specific Elective (DSE)-4B Practical	NR/FR/DS/06/4B/P				
	DSE-5A	NR/FR/DS/06/5A/L	Carbon forestry and global climate change	4	4	100
	Discipline Specific Elective (DSE)-5A Practical	NR/FR/DS/06/5A/P		2	4	100
	Discipline Specific Elective (DSE)-5B	NR/FR/DS/06/5B/L	Community Forestry			
	Discipline Specific Elective (DSE)-5B Practical	NR/FR/DS/06/5B/P				
	<b>TOTAL</b>			<b>24</b>	<b>32</b>	<b>800</b>
<b>VII</b>	Core -13	NR/FR/CR/07/13/L	Biostatistics	4	4	100
	Core -13 Practical	NR/FR/CR/07/13/P		2	4	100
	Core -14	NR/FR/CR/07/14/L	Forest Surveying and Engineering	4	4	100
	Core-14 Practical	NR/FR/CR/07/14/P		2	4	100
	Discipline Specific Elective-(DSE-6A)	NR/FR/DS/07/6A/L	Fundamentals of Extension Education	4	4	100
	Discipline Specific Elective-(DSE-6A) Practical	NR/FR/DS/07/6A/P		2	4	100
	Discipline Specific Elective-(DSE-6B)	NR/FR/DS/07/6B/L	Entrepreneurship Development			
	Discipline Specific Elective-(DSE-6B) Practical	NR/FR/DS/07/6B/P				
		<b>TOTAL</b>			<b>18</b>	<b>24</b>

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VIII	Core -15	NR/FR/CR/08/15/P	Socio economic Survey-Village attachment ( report writing, presentation, Viva-Voce)	200
	Core -16	NR/FR/CR/08/16/P	Forest operation Work Experience ( report writing, presentation, Viva-Voce)	200
	Core -17	NR/FR/CR/08/17/P	Forest Institute and Industrial visit (report writing, presentation, Viva-Voce)	200
	The nature of the course in VIII Semester is field based. Socio economic survey will be performed by the students in an assigned village. For exposure of forest operational work students will be attached with State Forest Department. Institute/ industrial training will be accomplished by the students through visits of nearby forest based Industries / Institutions.			
<b>TOTAL</b>		<b>18</b> (6 credits for each training segment)	<b>48 Hours/</b> <b>week for each</b> <b>training segment</b> <b>separately</b>	<b>600</b>
<b>GRAND TOTAL</b>		<b>182</b>		<b>6100</b>

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# SEMESTER – I

## PRINCIPLES AND PRACTICES OF SILVICULTURE (Core-01)

CR: 4 + 2

Definition, objective and scope of silviculture. Status of forest in India and their role. Forest types and their classification. Trees and their distinguishing features. Site factors and their interactions. Climatic factors and its role. Edaphic factors, Physiographic factors and its influences. Biotic factors- influence of plant insect, wild animals, man and domestic animals. Impact of controlled burning, grazing, influence of forest on vegetation. Microclimate and its effect.

Regeneration: Natural, artificial and factors affecting it. Regeneration Survey. Tending operation: Weeding, cleaning, thinning and improvement felling.

### PRACTICAL

Acquaintance with various technical terms. Study of forest composition. Recording the observations on phenological characteristics of different tree species. Study of site factors. Study of the natural regeneration, afforestation and reforestation success. Lay outting of nursery bed and soil preparation, types of 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.

## FUNDAMENTALS OF SOIL SCIENCE (Core-02)

CR: 4 + 2

Composition of earth's crust, soil as natural medium for plant growth, major components of soil, Soil minerals formation. Weathering of rocks and minerals-weathering factor, physical-Chemical-biological weathering and procedure of soil formation. Physical properties-bulk density, soil porosity, soil structure, soil consistency, plasticity. Soil organic matters and litter decomposition, pH, nutrient availability and absorption, soil buffering capacity, Soil water forms- soil moisture, wilting point- field capacity- moisture, water holding capacity, Soil orders- land capability classification. Problem of soils: salted, permeable, flooded and sandy soils.

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Forest soils Vs cultivated soils. 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. Forest soil environment-distribution of various microorganisms, rhizosphere and phyllosphere concept. Mineral Transformation-carbon cycle, N<sub>2</sub>-cycle, P-cycle, S-cycle. Bio-fertilizers –their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia - non-legume symbiosis, asymbiotic and associative N<sub>2</sub> fixation. Mycorrhiza: types, biology and importance with specific relevance to tree seed crops.

### 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 the forest soil profile. 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<sub>2</sub>- evolution method, preparation and inoculation technique for mycorrhiza and biofertilizers.

### Suggested Readings:

1. Armonson, K.A. Forest Soils, (1977). IBD Publisher, Dehradun.
2. Gale, M.R. Forest Soil Research, (2006). IBD Publisher, Dehradun.
3. Brady, N.C and Weil, R.R. (2009). Nature and properties of Soil. Printice Hall of India.
4. Biswas, T.D. and S.K. Mukherjee (2001). Text book of soil Science. Tata Mc. Grew Hill, Publishing 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.
9. Havlin J.L. and Tisdale S.L. (2013). Soil fertility and Fertilizers. Amazon.com
10. Halvin J and Pearson (2005). Soil fertility and fertilizers: An introduction to nutrient management. Printice Hall of India.
11. Biswas, T.D. and S.K. Mukherjee (1992). Text book soil fertility. Tata Mc. Grew Hill, Publishing Co., New Delhi.
12. Black, C.A. (1993). Soil fertility evaluation and control, Lewis publishers, London.
13. Kanwar, J.S. (1976). Soil Fertility – Theory and practice ICAR publication, New Delhi.

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## BASIC MATHEMATICS (GE-01)

CR: 6

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 numbers, cube root of unity. Arithmetic progression, geometrical progression, binomial theorem for positive index. Measurement of an angle in radian and degree and its problems, trigonometric ratio and its problems related to them, addition, subtraction and product formula, Height and distance. Coordinate of point, distance between two points, coordinate of a point dividing the line joining two points in  $m:n$  ratios, mid-point, centroid, area of a triangle and quadrilateral. Matrices: addition, subtraction, multiplication of matrices, transpose adjoint and inverse of a matrix. Determinants and its properties. Measure of central tendency, Measure of dispersion and correlation. Surface Areas and Volumes: Introduction, Surface area of a Combination of Solids, Volume of a Combination of Solids, Conversion of solid from one shape to another, Frustum of a Cone.

### Suggested Books:

1. Agrawal, R. S. (2012) Elementary Mathematics. Kalyani Publishers, New Delhi.
2. NCERT, Elementary Mathematics.
3. Hall and Knight: Higher Algebra, Book place, New Delhi.

## ENGLISH COMMUNICATION (CC-01)

CR: 4

Introduction: Theory of Communication, Types and modes of Communication. Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business, Barriers and Strategies, Intra-personal, Inter-personal and Group communication, Speaking Skills: Monologue, Dialogue, Group Discussion, Effective Communication/ Mis- Communication, Interview, Public Speech. Reading and Understanding: Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa), Literary/Knowledge Texts. Writing Skills: Documenting, Report Writing, Making notes, Letter writing

### Suggested Readings:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr Brati Biswas

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## SEMESTER – II

### FOREST ECOLOGY AND BIODIVERSITY CONSERVATION (Core-03)

CR: 4 + 2

Concept of ecology, levels of biological organization, Ecosystem structure and function. Population ecology and its importance in forest management, plant community structure, Ecological succession, Biodiversity; conservation measurement of diversity and diversity indices. Biodiversity hotspots and biogeographic zones of India. Principles of conservation, Conservation – efforts in India and worldwide. Rangeland ecology, importance of rangeland, Indian rangelands status and management. Rangeland inventory, rangeland improvement.

#### PRACTICAL

Study of Forest composition; Phytosociological study. Measurement of diversity of plants in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems. Identification of grasses. Rangeland inventory making. Determination of carrying capacity of rangelands, Indicator of heavy grazing.

#### 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. Kumar and Asija. Biodiversity – Principles and conservation. Published by Updesh Purohit for Agrobios, Jodhpur, India.
5. Ashok Malik (2008) Dynamics of forest ecosystems. Today and Tomorrow publishers, New Delhi.
6. Vijendra Das, LD (1998). Forage crops. International Book Distributors, Dehradun.
7. Singh, J. S., Singh, S. P. and Gupta, S. R. 2014. Ecology environmental science and conservation. S. Chand publication.

### FUNDAMENTALS OF WILDLIFE (Core-04)

CR: 4 + 2

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

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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 food chain, food web, ecological pyramids, habitat, ecological niche, carrying capacity, density, prey-predator relations and population dynamics.

### PRACTICAL

Identification and study of wildlife in a nearby zoo. Bird watching. Observe and prepare the list of butterfly in the campus. Preparation of inventory of an area.

### 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.

## INTRODUCTORY BOTANY (GE-02)

CR: 4 + 2

Introduction to Botany and general classification of plants. Morphology of different parts of typical flowering plant. 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 in a flowering plant. Importance of plants in relation to environment.

Water relation in plants. Absorption of water, ascents of sap. Stomata, structure, mechanism of opening and closing of stomata, guttation, transpiration, factors affecting transpiration.. Photosynthesis, its importance and factors affecting it. Photorespiration. Mechanism of Respiration and factors affecting it. Phyto hormones and their role in plant growth.

### PRACTICAL

Morphological studies of root, stem, leaf and flowers. Studies of permanent slides of histology and anatomy. General survey of the local vegetation. A field trip during the semester. Osmosis- endo and

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exo-osmosis demonstration, Plasmolysis- demonstration, Transpiration rate, Measuring the rate of photosynthesis in plant species.

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

## ENVIRONMENTAL STUDIES (CC-02)

CR: 4

Introduction to environmental studies, Multidisciplinary nature of environmental studies, Scope and importance, Concept of sustainability and sustainable development. Ecosystems: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Natural Resources: Renewable and Non-renewable Resources, Land resources and land use change, Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining. Dam building impact on environment, forests, biodiversity and tribal populations. Water: Use and over exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs and case studies. Biodiversity and

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Conservation: Levels of biological diversity, genetic, species and ecosystem diversity. Biogeographic zones of India. Biodiversity patterns, global biodiversity, hot spots. India as a mega biodiversity nation. Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man wildlife conflicts, biological invasions. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational values. Environmental Pollution: types, causes, effects and controls of air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial wastes. Pollution case studies. Environmental Policies and Practices. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act, Air Prevention & Control of Pollution Act, Water Prevention and control of Pollution Act, Wildlife Protection Act, Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment, Human population growth: Impacts on environment, human health and welfare, Resettlement and rehabilitation of project affected persons and case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, silent valley, Bishnois of Rajasthan. Environmental ethics: role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case and studies (e.g., CNG vehicles in Delhi). Field work: Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems-pond, river etc.

#### Suggested Readings:

1. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
2. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36--37.
3. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
4. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.

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## SEMESTER – III

### FOREST MENSURATION (Core-05)

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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. Height measurements - direct and indirect methods. Height measuring instruments, errors in height measurement. Tree form and method of studying forms. Measurement of cross sectional area, basal 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, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees. Tree growth measurements, objectives of increment, determination of increment, stump analysis, stem analysis and increment boring. Measurement of volume and yield of plantation area/stand. Forest inventory.

#### PRACTICAL

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

#### Suggested Readings:

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

### CYTOGENETICS AND PLANT BREEDING (Core-06)

CR: 4 + 2

Plant cell: its structure and function. Cell reproduction, mitosis, meiosis and its significance. Nucleus chloroplast and mitochondria. Chromosome its structure and function. Chromosomal aberration. Polyploidy.

Linkage and crossing over. Mendel's principles of heredity. Deviation from mendelian inheritance, pleiotropy, threshold characters, co-dominance, chromosome theory of inheritance, gene interaction, multiple alleles. Sex determination-theories, sex linked inheritance and characters. Cytoplasmic

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inheritance and maternal effects. Chemical basis of heredity. Structure of DNA and its replication, RNA: its structure and function. Mutation and its classification.

Plant breeding its aim and objectives, modes of reproduction, methods of breeding, selection types and importance.

## PRACTICAL

Preparation of slide showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Testing the viability and germination of pollen grains. Solving the problems based on Mendelian laws, floral morphology.

### Suggested Readings:

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

## FOREST MANAGEMENT (Core-07)

CR: 4 + 2

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. Definition, Scope and classification of Silviculture System Clear felling systems Shelter wood system Selection system Accessory systems. Coppice system. Choice of silviculture system. Culm selection system in Bamboo. 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 uneven 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 uneven aged forest crop. Working Plan: definition,

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objects and necessity, preparation of working plan. Joint forest management: concept and methodology. Criteria and Indicator for sustainable forest management.

### PRACTICAL

Visit to forest department and courts to observe working procedures. Study of working plans of the forests. Learning of preparation of working plan for one of the area. Estimation of MAI and CAI, Fixation of rotation for species. Perform a survey of forest area & chalk out a plan for Silviculture management. Study of vegetation features in G.G.V. campus. Drawing of silvicultural treatment map.

### Suggested Readings:

1. Ram Prakash. Forest management, (2006) IBD Publication, Dehradun
2. Osmaston, F.C. Management of Forests, (1984) IBD Publication, Dehradun
3. J B Lal (2007).Forest Management: Classical Approach and Current Imperatives. Natraj publishers, Dehra Dun.
4. Ram Prakash and L.S. Khanna (1991) Theory and Practice of Silvicultural systems. International Book Distributors, Dehra Dun.
5. Khanna, L. S. (1984) Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun. P. 476.
6. Champman, G.W. and Allan, T.G. (1978) Establishment Techniques for Forest Plantation F.A.O Forestry Paper No.8. F.A.O Rome
7. David M. Smith. (1989) The Practice of silviculture. IBD Educational Pvt. Ltd. Dehradun, India.

### ETHNOFORESTRY (GE-03)

CR: 4 + 2

Forest and tribes- their relationship, Major tribes in India and Chhattisgarh. Forest ecosystem and cottage industries. Role of tribes in forest protection, development and conservation. Tribal welfare and social forestry, Tribal and co-operative movements. History of tribal welfare and administration, forest & tribes, Seed and biofuels, Herbal medicines in ethnomedical practices, Edible wild fruits, Wild mushrooms, Natural dyes, Tasar cultivation, Economic uses of grasses, Non wood forest products. Ethnoforestry & sustainable management.

### 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 of medicinal plants. Harvesting, drying, grading, storage and processing techniques. Study of plants parts used in drugs preparation. Visit to nearby MPCA/ nursery/ ayurvedic pharmacies. Study the tribal races of India. Study the important medicinal plant used by traditional healers.

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1. Tiwari, S C (2010) Ethnobotany: The Future of Indian Forestry. Bishen Singh Mahendra Pal Singh, Dehradun.
2. Vinod M. Mhaiske, Vinayak K Patil and Satish S Narkhede (2016). Forest Tribology and Anthropology. Scientific Publishers, Delhi.
3. R.K. Sinha (1996) Ethnobotany : the renaissance of Traditional Herbal Medicines. Ina shree publishers.
4. C.M. Cottan (1996) Ethnobotany: Principles & Applications. John Wiley and Sons Ltd.
5. V.P. Agrawal (2002) Forest in India. Oxford and IBH publishers.
6. Ashok Ranjan Basu & S. Nijhavan (1985) Tribal Development Administration in India. Mittal publications.

## NURSERY PRACTICES AND PLANTATION MANAGEMENT (SC-01)

**CR: 2 + 2**

Nursery, introduction, objectives and scope, types of nursery, choosing nursery site, design and layout of the nursery, preparation of nursery beds, producing plant from seed, seed handling, dormancy and treatments, methods of sowing, time and season, potting mixtures, transplanting of young seedlings, plant containers, compost and mulches, nutrient and soil management, disease and pest control, sale and marketing.

Plantation: traditional and high tech plantation, layout of nursery design, different types of pits, site selection, calculation of plant requirement, pit filling, nutrient and pest management, post plant care, tree architects.

### Practical

Site selection and its assessment, preparation of different types of nursery bed, study of plant containers, seed treatment, seed sowing, preparation of potting mixtures, application of mulches, application of weedicides, Compost preparation, Tools and instruments, nursery record. Assessment of plantation site, visit of nursery and plantations, pruning methods in newly and old plantations, fertilizer and weed management practices. Marketing management of nursery grown seedlings.

Suggested Readings:

1. Keats C Hall. 2003 Manual on nursery practice. Forest Department, Jamaica. E book
2. Pawar Pankaj 2007. Practical Manual of plantation forestry. Scientific publisher, Jodhpur
3. Sharma and Singh NP. 2011. Soil and orchard management. Daya Publishing House, Delhi
4. Luna RK. 2006. Plantation forestry in India. International book distributor, Dehradun India.

## SEMESTER – IV

### APPLICATION OF REMOTE SENSING AND GIS IN FOREST AND WATERSHED MANAGEMENT (Core-08) CR: 4 + 2

Introduction of Remote Sensing, World Satellite system, Energy sources and radiation principals. EMR and Spectrum concept, Atmospheric windows. Interaction of EMR with Earth surface features, spectral signatures. SAR Interferometry, Fraction of absorbed photosynthetically active radiation. Basics of GIS, components, application and advantages. GIS software used. Data Image Processing concept, Data analysis, data output in GIS. Global Navigation Satellite System concept, Basic information on vegetation indices (RVI, NDVI, PVI, SAVI and LAI), different vegetation parameters for Watershed Management, Plant species specification, DEM creation and Soil mapping methods, Topographical character analysis concept in forest and watershed. Conceptual knowledge of use of remote sensing in Water cycle (precipitation, soil moisture, snow, evapotranspiration) system. Riparian zonation, Land cover data, its derivation and classification scheme for Integrated Watershed Management.

#### PRACTICAL

Acquaintance with GIS software and imageries: map reading of SOI toposheets, Image processing, georeferencing, digitizing, sub setting, mosaicing and feature identification, GPS survey and point location, unsupervised and supervised classification of images for forest type and watershed area. Forest and watershed land use/land cover classification, field visit for ground data collection and truthing.

#### Suggested Readings:

1. M. Anji Reddy (1998). Textbook of Remote Sensing and GIS
2. Curran, P.J. (1985) Principles of Remote Sensing, Long man Group Ltd., England
3. Janssen, L.F.(2000) Principles of Remote Sensing, ITC. Edl. Text Book Series II. The Netherlands
4. Rolf A.de By. (2000) Principles of Geographical Information Systems. ITC. Edl. Text Book Series I. The Netherlands
5. Sabins, F.F. (1978) Remote Sensing-Principles and Interpretation. W.H.Freeman and Co., San Francisco.
6. Sharma, M.K.(1986) Remote Sensing and Forest Surveys, International Book Distributors, Dehra Dun

### FUNDAMENTALS OF WOOD SCIENCE (DSE-1A)

CR: 4 + 2

Introduction to Wood. 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, 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

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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 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 wood rays and their types Study of non-porous woods, their physical and anatomical description Study of cell inclusions in wood. Estimation of moisture content and density of wood.

### 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.

## NURSERY MANAGEMENT AND COMMERCIAL FORESTRY (DSE-1B)

CR: 4 + 2

Propagation concept of plants, 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, *Pinus roxburghii*. Broad leaved species: *Tectona grandis*, *Shorea robusta*.

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*Acacia nilotica*, *Dalbergia sissoo*, *D. latifolia*, *Eucalyptus spp.* *Albizzia lebbeck*, *Albizzia procera*, *Azadirachta 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. Preparation of ingredient mixture. Filling of containers. Visit to different nurseries. Study of morphology and phenology of tree species growing in the area. To study quality characters of nursery planting stock.

#### **Suggested Readings:**

1. Kumar, V. (1999) Nursery and plantation practices in forestry. Scientific publication. Jodhpur.
2. Chaturvedi, A.N. (1994) Technology of forest nurseries, Khanna Bandhu, Dehradun.
3. Duryea, M. L. and Landis, T.D. (1984) Forest nursery manual: Production of bare root seedlings. Martinus Nijhoff. The Hague.
4. F.A.O (1978) Establishment techniques for plantations, F.A. O. Publication, Rome, Italy.
5. Kumar, V. (1999) Nursery and plantation practices in Forestry. Scientific Publication. Jodhpur.

### **NON WOOD FOREST PRODUCTS AND UTILIZATION (GE-04) CR: 4 + 2**

Introduction of Non Wood Forest Products (NWFP) importance and scopes, Canes and bamboos. Medicinal plants. Gums and resins, important gum yielding plants. Resins and Oleoresins, their formation in plants and its uses, Tendu leaves- sources, collection and processing. Sericulture and lac culture, Sustainable management of NTFP through community involvement, Dependency of forest dwellers on NTFP in economy. 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 canes and bamboos and their sources. Study of gums and resins and their collection. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, Visit to nearby extraction units. Visit of sericulture and lac cultivation farms. Tendu patta area and interaction with forest dwellers to study the economy of rural people.

#### **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 Tomorrow publishers.
3. Mehta T (2012) A handbook of forest utilization. Today and Tomorrow publishers.
4. Gupta, T. and Guleria, A. (1982) Non-wood forest products in India: Economic potential. Oxford and IBH Publication, New Delhi. 147 p.

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## FOREST POLICY LEGILATION AND ENVIRONMENTAL ACT (SC-02) CR:

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Origin of Forestry- Historical background and introduction of forest policies of India namely 1894, 1952 and 1988 to protect the Indian Trees. Indian forest Act 1927, Tendu patta (Vyapar Viniyaman) Adhiniyam 1964, Transit Rules 1961, Forest conservation Act 1980, 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. Natral Publishers, Dehra Dun.
2. Forest Policy (1988), Government of India Publication, Delhi.
3. Indian Forest Acts with short Notes (1975), Allahabad Law Agency, Allahabad.
4. Podder Erai (2011) Forestlaw and policy in India. Today and Tommorrow publishers.
5. Khanna, L.S., Wildlife (Protection) Act 1972 as amended upto date with commentary, Khanna Bandu, Dehra Dun.
6. Negi, S.S. (1985), Forest Law. Natraj Publication, Dehra Dun.

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## SEMESTER – V

### WILDLIFE MANAGEMENT (Core-09)

CR: 4 + 2

Definition of wildlife, free living, captive, domesticated and feral animals. Zoogeographic regions and biomes of the world. Status and distribution of wildlife in India. Scientific and common names of common, rare, endangered and threatened species of mammals, birds and reptiles in India. Agencies involved in wildlife conservation, Govt. and NGO's. Justification of wildlife conservation, uses, values and negative impact of wildlife. Biological basis and history of wildlife management. Basic requirements of wildlife –food, water, cover and space, limiting factors. Wildlife ecology, Prey-predator relations and population dynamics. Zoning, 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. Wildlife (Protection) Act, 1972. Protected areas –Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Conservation: Meaning, principles and strategies, in-situ and ex-situ conservation, conserving biodiversity.

#### PRACTICAL

Visits of wildlife sanctuary/ Tiger reserve. Bird watching, observe the butterfly population in the campus, Preparation of inventory of an area. Direct and indirect methods of studying food habits and behavior of different wildlife.

#### 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.

### WORLD FORESTRY SYSTEMS (Core-10)

CR: 4 + 2

Geographical distribution of world forest and their classification. International and National Forestry Organizations. 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

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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.

### **PRACTICAL**

Plot the different biomes of the world 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.

### **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.

## **WOOD TECHNOLOGY (DSE-2A)**

**CR: 4 + 2**

Wood- macroscopic and microscopic features, wood as raw material, Merits and demerits of wood as raw material. 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 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. Manufacture, properties and uses of composite wood- plywood, fiber board, particle board and hard board. Improved wood-definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood, production of wood molasses, alcohol and yeast. Nano Forestry:- definition, concept, scope, application and Techniques, Elemental composition of wood through nano particle. Significance of nano forestry.

### **PRACTICAL**

Preliminary idea regarding conversion and saw milling. 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.

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### Suggested Readings:

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

### FOREST TREE SEED TECHNOLOGY (DSE-2B)

CR: 4 + 2

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 break down dormancy, determining optimal harvest maturity indices. Seed collection methods- equipments and planning, seed processing, seed extraction, drawing, cleaning, grading, treating, bagging, leveling and storage. Storage of Orthodox, recalcitrant seeds and fumigation and seed treatment. Seed cryopreservation, seed quality testing, purity, viability, moisture, vigor and seed certification. Quality seed production technology- seed orchard, selection of seed tree, plus tree and elite tree.

### PRACTICAL

Identification of seed tree species, seed maturity test, germination test, seed vigor and its measurement, visit to seed production areas and seed orchards.

### Suggested readings:

1. Ram Prasad and A K Kandya (1995). Handling of Forestry seeds in India, Natraj Publication, Dehradun
2. Agrwal, P K and M Dadlani (1987). Techniques in seed scien and technology, South Asian Publishers , Delhi
3. Agrawal, R L (1996), Seed Technology, Oxford and IBM Publishing Co., New Delhi
4. Nema, M P (1987). Principle of Seed Certification and Technology, Elite Publishers
5. Renuga Devi, J NV Manumani (2011). A handbook of seed testing, Agrivos publication

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## METEOROLOGY AND CROP PRODUCTION (DSE-3A)

CR: 4 + 2

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 sowing, 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.

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## BASIC CONCEPTS OF HORTICULTURE AND LAND SCAPING (DSE-3B)

CR: 4 + 2

Horticulture: definition, component and importance, 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. Vegetative propagation techniques- budding, grafting, cutting, IPM in horticulture. Principles and methods of pruning and training of fruit crops, Use of growth regulators in horticulture, weed management, cropping systems, intercropping, multi-storeyed cropping, Tree based cropping system.

### 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, 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 Acquaaah (2002) Horticulture - Principles and Practices. Jain book Agency.

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## SEMESTER – VI

### FOREST PATHOLOGY AND ENTOMOLOGY (Core-11)

CR: 4 + 2

Relation of plant pathology with forest pathology and other sciences, classification of tree diseases. General characteristics and reproduction of plant pathogens: fungi, bacteria, viruses. Important characters of ascomycetes and basidiomycetes, Dissemination and survival of plant pathogens. Concept of tree disease and types of wood decay.

Definition, importance and scope of Forest Entomology. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests.

Symptoms, etiology and control of diseases/disorders and insect pests of important tree species (Teak, *Dalbergia*, *Eucalyptus*, Sal, and *Acacia*) Fungicides, methods of their application. Principles and techniques of Integrated Pest Management in forests.

Symptoms, etiology and management of diseases of important tree species like Teak, *Dalbergia sp.*, *Acacia spp.*, Sal, Pines, Deodar, Eucalyptus. Types of wood decay, Principles of disease management, Fungicides and their use in nurseries and plantation.

#### 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 Symptom, sign and diagnosis of tree disease.

Study of different types of insects and their collection. 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. 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 distributors, Dehra Dun.
4. Gupta, V.K. and N.K. Sharma. (1988). Tree Protection. Indian Society of Tree Scientists, Solan.
5. Herrick, G.W. (1988). Insect Enemies of Trees. Pioneer Publishers, Jaipur.
6. Paul D Menan (2003) Tree and disease concept. Prentice hall Inc.
7. Satha T V (2009) A textbook of forest entomology. Today and tomorrow publishers.

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8. Brues, T.C., A.L. Melander and E.M. Carpenta, (1954) Classification of Insects, Cambridge Man, USA.
9. Richards, O.N. and R.G. Davies (1977) Imm's General Textbook of Entomology, 10th ED. Chapman and Hall.

### AGROFORESTRY (Core-12)

CR: 4 + 2

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, pruning, 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.

## FOREST ECONOMICS (DSE-4A)

CR: 4 + 2

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 taking 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.

## FOREST TREE IMPROVEMENT AND BIOTECHNOLOGY (DSE-4B)

CR: 4 + 2

Reproduction in trees. 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, Genetic, environmental and phenotypic expression of trees.

Plus tree selection, progeny trials. Forest Genetic Resources and its Conservation.

Plant tissue culture - culture media and its formation, cell/tissue culture, haploid culture, basics of Genetic Engineering- Vectors: plasmid, bacteriophage and cosmids. Genetic code. Genetic Engineering, Methods of gene transfer: direct and indirect genetic engineering, gene cloning and polymerase chain reaction. Recombinant DNA Technology, Role of Genetic Engineering in Forest Tree Improvement

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## PRACTICAL:

Floral biology & phenological observations in some important species. Estimation of pollen viability. Different breeding methods flowchart. Species and provenance selection techniques. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Exercise in plus tree selection. 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, and callus culture.

### 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. Lars Schmidt (2000) Guide to Handling of tropical and sub-tropical forest seeds. Danida Forest Seed Centre, Denmark.
4. Zobel, B.J. and Talbert, J. (1984) Applied Forest Tree Improvement. John Wiley & Sons, New York.
5. FAO. (1985) Forest Tree Improvement, FAO Publication, Rome, Italy.
6. Fins, L., Friedman, S.T. and Brotschol, J.V. (1992) Handbook of Quantitative Forest Genetics, Klumer Academy, Dordrach, London.
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 Tommorrow publishers, New Delhi
9. Wright, J.W. (1976) Introduction to Forest Genetics. Academic Press, New York.
10. White, T.M. and G.R. Hodges. (1989) Predicting breeding values with application in forest improvement. Kluwar Publishing, Netherlands.
11. Wright, J.W. (1976) Introduction to forest genetics. Academic Press, New York. 463 p.
12. Zobel, B.J. and J. Talbert. (1984) Applied forest tree improvement. John Wiley & Sons, New York.

## CARBON FORESTRY AND GLOBAL CLIMATE CHANGE (DSE-5A)

### CR: 4 + 2

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, Bio Soil – a new forest soil survey, Trees and Forests as collectors of carbon. Forest operations effects on carbon flux.

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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. Global Climate Change: Science and Politics, Earth reservoirs: the basics, Climate change adaptation and mitigation. Mechanisms (CDM and REDD+), natural GHG effects, climate change: models, theories, facts and politics, Multilateral Agreements on Climate Change

### 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. Biodiversity, migration and climate change assessment in different forest areas

### 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](http://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

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Introduction to the history and evolution of community forestry, Linkage between community forestry and natural resource management, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, forest conflicts: wildlife and human conflicts, peoples movement in forest conservation like Chipko Movement, Gender dimension of forest management, tribals and forests, community management and sustainable livelihood strategies, forests and food security, eco-tourism and community development, Forest rights, customary rights of people, community participation, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals and non-tribals.

**Practical**

Case study of tribal's rehabilitation from National parks, dams. Study of role of community in ecotourism. Study of challenges faced by community for managing forest. Study of scared groove. Various techniques of improving community participation.

**Suggested readings:**

1. Annamalai R. 1999. Participatory Learning Action and Microplanning for JFM. Dean SFRC, Coimbatore.
2. FAO. 1978. Forestry for Local Community Development. FAO Publ.
3. Shah SA. 1988. Forestry for People. ICAR.
4. Tiwari KM. 1988. Social Forestry and Rural Development. International Book Distr.
5. Vyas GPD. 1999. Community Forestry. Agrobios.

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## SEMESTER – VII

### BIostatISTICS (Core-13)

CR: 4 + 2

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).

#### PRACTICAL

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

#### Suggested Readings:

1. Kenneth N.Berk(1998). Introductory Statistics.www.amazon.com
2. Arora P N (2003) Biostatistics.Himalayan publishers.
3. Marcello Pagano and Kimberlee Gauvreau (2008) Principles of Biostatistics.Jhon and Wiley sons ltd.

### FOREST SURVEYING AND ENGINEERING (Core-14)

CR: 4 + 2

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

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

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

### Suggested Readings:

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

## FUNDAMENTALS OF EXTENSION EDUCATION (DSE-6A)

CR: 4 + 2

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 the 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.

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### Suggested Readings:

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

### ENTREPRENEURSHIP DEVELOPMENT (DSE-6B)

CR: 4 + 2

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

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

### Suggested Readings:

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

## SEMESTER - VIII

### ❖ SOCIO-ECONOMIC SURVEY- VILLAGE ATTACHMENT (Core-15)

CR: 06

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.

### ❖ FORESTRY OPERATIONS (WORKING EXPERIENCE) (Core-16)

CR: 06

Visit to modern forest nurseries, Herbal garden and watersheds. Study the felling and logging operations, timber 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.

### ❖ FOREST INSTITUTES AND INDUSTRIAL VISIT/ TRAINING (Core-17)

CR: 06

- Study the nature of forest based industries
- Raw material- Collection and processing of raw material.
- Production and management process.
- Marketing and financial management.
- Visits of nearby forestry institutions/ organizations

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