FACULTY OF FORESTRY

Detailed Syllabus for the B.Sc. (Hons.) FORESTRY - 2016

DEPARTMENT-WISE DISTRIBUTION OF COURSES

1. Silviculture and Agroforestry (Safo)

Cat. No.	Title of the Course	Credit
Safo 1101	Introduction to Forestry	2+0
Safo 1102	Introduction to Agronomy and Horticulture	2+1
Safo 1103	Principles of Agroforestry	1+1
Safo 1204	Theory and Practice of Silviculture	2+1
Safo 2105	Forest Seed Technology	2+1
Safo 2106	Forest Mensuration	2+1
Safo 2207	Silviculture of Indian Trees	2+1
Safo 2208	Forest Nursery Technology	1+1
Safo 2209	Agroforestry Systems and Management	1+1
Safo 2210	Soil Biology & Fertility	2+1
Safo 3211	Plantation Forestry	2+1
	Total	**19+10=29**

2. Forest Biology and Tree Improvement (Fbti)

Cat. No.	Title of the Course	Credit
Fbti 1101	Dendrology	2+1
Fbti 1102	Plant Biochemistry	1+1
Fbti 1203	Plant Physiology	2+1
Fbti 1204	Plant Cytology and Genetics	2+1
Fbti 2105	Tree Improvement	2+1
Fbti 2206	Medicinal and Aromatic plants	1+1
Fbti 2207	Clonal Forestry	1+1
Fbti 3208	Forest Biotechnology	2+1
	Total	**13+8=21**

3. Natural Resource Management (Narm)

Cat. No.	Title of the Course	Credit
Narm 1201	Forest Survey & Engineering	2+1
Narm 2102	Environmental Studies and Disaster Management	1+1
Narm 2103	Forest Ecology	1+1
Narm 2104	Forest Entomology	1+1
Narm 2205	Forest Management	2+1
Narm 2206	Forest Pathology	1+1
Narm 3107	Forest Hydrology and Watershed Management	2+1
Narm 3108	Forest Protection	1+1
Narm 3209	Forest Policy and Law	2+0
Narm 3210	Geomatics	1+1
Narm 3211	Forest Inventory and Yield Prediction	1+1

Narm 4212	Recreation & Urban Forestry	1+1
Narm 4213	Restoration Ecology	1+1
	Total	**17+12=29**

4. Forest Products and Utilization (Fopu)

Cat. No.	Title of the Course	Credit
Fopu 1201	Wood Anatomy	2+1
Fopu 2102	Wood Science and Technology	2+1
Fopu 3103	Wood Products & Utilization	2+1
Fopu 3104	Non-Timber Forest Products	2+1
Fopu 3205	Logging and Ergonomics	1+1
Fopu 4206	Certification of Forest Products	2+0
	Total	**11+5=16**

5. Wildlife Sciences (Wild)

Cat. No.	Title of the Course	Credit
Wild 1201	Wildlife Biology	2+1
Wild 2102	Ornithology	2+1
Wild 2203	Herpetology	1+1
Wild 3104	Wildlife Management	1+1
Wild 3105	Anthropology and Tribal Welfare	2+0
Wild 3206	Fundamentals of Conservation Biology	1+1
	Total	**9+5=14**

6. Basic and Social Science(Bass)

Cat. No.	Title of the Course	Credit
Bass 1101	Information & Communication Technology	1+1
Bass 1102	Communication Skills & Personality Development	1+1
Bass 1103	Basic Mathematics	2+0
Bass 1104	Basic Economics	1+0
Bass 1105	Physical Education&Yoga Practice -I	0+1*
Bass 1106	NCC-I/NSS-I	0+1*
Bass 1207	Geology & Soils	1+1
Bass 1208	Climate Science	1+1
Bass 1209	Physical Education&Yoga Practice-II	0+1*
Bass 1210	NCC-II/NSS-II	0+1*
Bass 2111	Physical Education&Yoga Practice-III	0+1*
Bass 2112	NCC-III/NSS-III	0+1*
Bass 2213	Study Tour of State Forests	0+1*
Bass 3114	Statistical Methods & Experimental Designs	2+1
Bass 3215	Forestry Extension	1+1
Bass 4116	All India Study Tour	0+3*
Bass 4217	Agricultural Informatics	1+1
Bass 4218	Entrepreneurship Development & Business Management	1+1
Bass 4219	Forest Economics	1+1
	Total	**13+19=32**

STUDENT READY

Cat. No.	Title of the Course	Credit
Foel 3101 to 3109	Experiential Learning/Hands on Training - I	0+5
Foel 3201 to 3209	Experiential Learning/Hands on Training - II	0+5
Fowe 4101	Forestry Work Experience	0+20
Prwk 4201	Project Work& Dissertation	0+10
	Total	**0+40=40**

Class room credits = 131
Total non-credit courses = 10
Credits for Student Ready = 40
Grand total (including NC courses) = 181

SEMESTER-WISE DISTRIBUTION OF COURSES

Semester I

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Safo 1101	Introduction to Forestry	2+0
2.	Safo 1102	Introduction to Agronomy and Horticulture	2+1
3.	Safo 1103	Principles of Agroforestry	1+1
4.	Fbti 1101	Dendrology	2+1
5.	Fbti 1102	Plant Biochemistry	1+1
6.	Bass 1101	Information and Communication Technology	1+1
7.	Bass 1102	Communication Skills and Personality Development	1+1
8.	Bass 1103	Basic Mathematics	2+0
9.	Bass 1104	Basic Economics	1+0
10.	Bass 1105	Physical Education&Yoga Practice-I	0+1*
11.	Bass 1106	NCC-I/NSS-1	0+1*
		TOTAL	**13+8=21**

Semester II

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Safo 1204	Theory and Practice of Silviculture	2+1
2.	Fbti 1203	Plant Physiology	2+1
3.	Fbti 1204	Plant Cytology and Genetics	2+1
4.	Fopu 1201	Wood Anatomy	2+1
5.	Wild 1201	Wildlife Biology	2+1
6.	Narm 1201	Forest Survey & Engineering	2+1
7.	Bass 1207	Geology & Soils	1+1
8.	Bass 1208	Climate Science	1+1
9.	Bass 1209	Physical Education&Yoga Practice-II	0+1*
10.	Bass 1210	NCC-II/NSS-II	0+1*
		TOTAL	**14+10=24**

Semester III

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Safo 2105	Forest Seed Technology	2+1
2.	Safo 2106	Forest Mensuration	2+1
3.	Wild 2102	Ornithology	2+1
4.	Narm 2102	Environmental Studies and Disaster Management	1+1
5.	Narm 2103	Forest Ecology	1+1
6.	Narm 2104	Forest Entomology	1+1
7.	Fbti 2105	Tree Improvement	2+1
8.	Fopu 2102	Wood Science and Technology	2+1
9.	Bass 2111	Physical Education&Yoga Practice-III	0+1*
10.	Bass 2112	NCC-III/NSS-III	0+1*
		TOTAL	**13+10=23**

Semester IV

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Safo 2207	Silviculture of Indian Trees	2+1
2.	Safo 2208	Forest Nursery Technology	1+1
3.	Safo 2209	Agroforestry Systems and Management	1+1
4.	Safo 2210	Soil Biology & Fertility	2+1
5.	Narm 2205	Forest Management	2+1
6.	Narm 2206	Forest Pathology	1+1
7.	Wild 2203	Herpetology	1+1
8.	Fbti 2206	Medicinal and Aromatic plants	1+1
9.	Fbti 2207	Clonal Forestry	1+1
10.	Bass 2213	Study Tour of State Forests	0+1*
		TOTAL	**12+10=22**

Semester V

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Narm 3107	Forest Hydrology and Watershed Management	2+1
2.	Narm 3108	Forest Protection	1+1
3.	Wild 3104	Wildlife Management	1+1
4.	Wild 3105	Anthropology and Tribal Welfare	2+0
5.	Fopu 3103	Wood Products & Utilization	2+1
6.	Fopu 3104	Non-Timber Forest Products	2+1
7.	Bass 3114	Statistical Methods & Experimental Designs	2+1
8.	Foel 3101 to 3109	Experiential Learning/Hands on Training - I	0+5
		TOTAL	**12+11=23**

Semester VI

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Safo 3211	Plantation Forestry	2+1
2.	Wild 3206	Fundamentals of Conservation Biology	1+1
3.	Narm 3209	Forest Policy and Law	2+0
4.	Narm 3210	Geomatics	1+1
5.	Narm 3211	Forest Inventory and Yield Prediction.3	1+1
6.	Fbti 3208	Forest Biotechnology	2+1
7.	Fbti 3205	Logging and Ergonomics	1+1
8.	Bass 3215	Forestry Extension	1+1
9.	Foel 3201 to 3209	Experiential Learning/Hands on Training - II	0+5
		TOTAL	**11+12=23**

Semester VII

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Fowe 4101	Forestry Work Experience	0+20
2.	Bass 4116	All India Study Tour	0+3*
		TOTAL	**0+23**

Semester VIII

Sl. No.	Cat. No.	Title of the Course	Credit
1.	Narm 4212	Recreation & Urban Forestry	1+1
2.	Narm 4213	Restoration Ecology	1+1
3.	Fopu 4206	Certification of Forest Products	2+0
4.	Bass 4217	Agricultural Informatics	1+1
5.	Bass 4218	Entrepreneurship Development & Business Management	1+1
6.	Bass 4219	Forest Economics	1+1
7.	Prwk 4201	Project Work& Dissertation	0+10
		TOTAL	**7+15=22**

Class room credits = 131
Total non-credit courses = 10
Credits for Student Ready = 40
Grand total (including NC courses) = 181

Department of Silviculture and Agroforestry (Safo)

Safo 1101 Introduction to Forestry 2 (2+0)

Theory

Forests - definitions, role, benefits - direct and indirect. History of Forestry - definitions, divisions and interrelationships. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. Basic concepts on Forest types of India. Agroforestry - farm forestry, social forestry, joint forest management - concepts, programmes and objectives. Important acts and policies related to Indian forests. Global warming – climate change- forestry options for mitigation and adaptation - carbon sequestration. Important events/dates related to forests and environment - themes and philosophy.

Introduction to world forests – forest biomes- geographical distribution and their classification, factors influencing global forests distribution - productivity and increment of world forests. Forest resources and forestry practices in different eco-regions of the world. General problems of forest development and economy. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry.

Lecture Schedule

1 Forests - definitions and role
2-3 Benefit - direct and indirect.
4-5 History of Forestry
6-7 Forestry - definitions, divisions and interrelationships.
8-9 Classification of forests
10 Basic concepts on Forest types of India
11 Agroforestry systems – concepts, objectives and programmes
12-13 Farm forestry, urban forestry, social forestry, joint forest management - concepts, objectives and programmes
14-15 Important acts and policies related to Indian forests.
16-17 Global warming and climate change- GHG emissions- forestry options for mitigation and daptation - carbon sequestration/carbon conservation/carbon substitution- AR-CDM projects.
18-19 Biomes- Introductions to world forests - Geographical distribution of forests and their classification
20-21 Factors influencing global forest distribution - productivity potential and increment of world forests.
22-26 Forest resources and forestry practices in different eco-regions of the world. General problems of forest development and economy.
27-28 Forest based industries in the developed and developing countries.
29-30 Trade patterns of forest based raw materials.
31-32 Recent trends in forestry development in the world.
33-34 National and international organizations in forestry.
35-36 Important events/dates related to forests and environment-themes and philosophy.

Suggested readings

Beazley, M. (1981). The International Book of Forest. Mitchell Beazly Publishers, London.
Grebner, D.L., Bettinger, P and Siry, J.P. (2012). Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
Khanna, L.S. (1989). Principles and Practice of Silviculture. Khanna Bandhu, New Delhi, 473p.
Mather, A.S. (1990). Global forest resources. Belhaven, London.
Persson, R. (1992). World forest resources. Periodical experts, New Delhi.
Westoby, J. (1991). Introduction to World Forestry. Wiley, 240p.

Safo 1102Introduction to Agronomy and Horticulture 3 (2+1)

Theory

Agronomy, scope and its role in crop production-Major Field crops of India – classification, area, distribution and productivity of major Field crops. Farming and cropping systems – mono, sole and multiple cropping, relay, sequential and inter cropping. Tillage- definition- objectives – types of tillage- tillage implements – tilth - characteristics of good tilth - Soil productivity and fertility- Crop nutrition – nutrients –classification – Nutrient sources- organic manures – fertilizers – biofertilizers- Integrated Nutrient Management-Importance of water in plant growth- Soil properties influencing moisture availability – texture, structure and organic matter status-Irrigation and drainage. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed control-Classification of herbicides–Integrated weed management. Soil and its management-Definitions and importance of horticulture- Economic importance and classification of horticultural crops and their culture and nutritive value- area and production-exports and imports- fruit, vegetables, plantation and spice crops-soil and climate–principles-planning and layout- management of orchards- planting systems and planting densities-Principles and methods of pruning and training of fruit, plantation crops-use of growth regulators in horticulture crops-Horticultural zones of state and country.

Lecture schedule

1. Introduction to agriculture and agronomy, definition of agronomy and basic concepts - scope and its role in crop production
2. Major field crops of India – classification, area, distribution and productivity of major field crops.

3-6. Agronomy of major field crops – rice, pulses, tapioca and minor tubers, ground nut and sesame, fodder crops.

7. Farming and cropping systems – mono, sole and multiple cropping, relay, sequential and intercropping.

8-9. Tillage- definition- objectives – types of tillage- tillage implements – tilth - characteristics of good tilth- minimum tillage.

10-11. Soil productivity and fertility- crop nutrition – nutrients –classification.

12-14. Manures –organic manures, green manures, compost, vermicompost – Chemical fertilizers – biofertilizers- Integrated Nutrient Management.

15-17. Importance of water in plant growth- Soil properties influencing moisture availability – texture, structure and organic matter status- Soil moisture constants - Irrigation and drainage.

18-20. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed control-Classification of herbicides–Integrated weed management.

21-22. Introduction to Horticulture – economic importance and classification of horticultural crops and their culture and nutritive value.

23-24. Area, production and productivity of important tropical fruit, vegetables, plantation and spice crops - exports and imports.

25-29. Soil, climate requirements and cultural practices of major plantation, fruit, vegetable and spices crops in Kerala- coconut, areca nut, cocoa, cashew, rubber, cardamom, black pepper, mango, pineapple, banana, sapota, clove, nutmeg, ginger, turmeric, cowpea, etc.

30-31. Principles-planning and layout - management of orchards- planting systems and planting densities.

32-34. Principles and methods of pruning and training of fruit, plantation crops.

35-36. Use of growth regulators in horticulture crops.

Practical

Identification of field crop and tillage implements. Field exercise on the cultivation practices of important agronomic crops- Preparation of seed beds, identification of fertilizers and manures – mixing chemical fertilizers – calculating fertilizer requirements. Identification of green manure plants. Identification of important weeds of the region with particular reference to forest plantations. Preparation of weed herbarium. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides. Identification of horticultural crops-garden tools and implements. planning and layout of orchard and plantations. Nursery and field planting techniques on important plantation crops- techniques of digging and filling of pits for fruit and plantation crops-planting systems, training and pruning of orchard trees-preparation and application of regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits-bearing habits and maturity standards, harvesting, grading, packaging and storage.

Practical schedule

1. Major crops of India & Kerala- Collection of data on area, distribution and productivity.
2. Visit to the farm and identification of field crop and tillage implements.
3-5. Familiarization with field cultivation and cultural practices of important agronomic and horticultural crops- seed treatment-preparation of seed beds-out planting of important crops.
6. Visit to the laboratories and identification of fertilizers and manures - making fertilizer mixtures of different compositions.
7. Calculating fertilizer requirements for different crops.
8. Identification of green manure and green leaf manure plants.
9. Identification of important weeds in the forests and crop lands and preparation of weed herbarium.
10. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides.
11. Visiting college orchard and identification of horticultural crops, garden tools and implements.
12. Digging and filling of pits for fruit and plantation crops.
13. Field visit to plantations/spice gardens and studying about planting systems, training and pruning of orchard tree, harvesting, processing etc.
14. Preparation and application of growth regulators.
15. Layout of different irrigation systems.
16. Identification and management of nutritional disorder in major agricultural crops.
17. Bearing habits and maturity standards, harvesting, grading, packaging and storage of fruits.
18. Final practical examination

Suggested reading

Balasubramaniyan, P and Palaniappan, S.P. (2001). Principles and Practices of Agronomy. Agro Bios (India) Ltd., Jodhpur.

Bose, T.K. (1985). Fruits of India- Tropical and subtropical. Naya Prakash, Calcutta

Brady, N.C. and Well,R.R. (2002).The Nature and Properties of Soils (13th ed.). Pearson Education, Delhi.

De,G.C. (1989). Fundamentals of Agronomy. Oxford & IBH Publishing Co.,NewDelhi

Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. (2006). Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th ed.). Pearson Education,Delhi.

ICAR.(2006). Handbook of Agriculture, ICAR, NewDelhi.

Nair,P.K.R.(1979). Intensive multiple cropping with coconuts in India.Verlag Paul Pary, Berlin.

Palaniappan, S.P. (1988). Cropping systems in the tropics - Principles and management. Wiley Eastern Limited, NewDelhi
Reddy.T.Y and Reddy, G.H.S. (1995). Principles of Agronomy, Kalyani Publishers, Ludhiana.
Reddy.S.R.(1999).Principles of Agronomy, Kalyani Publishers, Ludhiana.
Sankaran, S. and Subbiah Mudaliar, V.T. (1991). Principles of Agronomy. The Bangalore Printing & Publishing Co., Bangalore.
Tisdale, S. L., W. L. Nelson, J. D. Beaton and J. L. Havlin. (1995). Soil feritility and fertilizers (5th ed). Macmillan Publishing Co., New York.

Safo 1103 Principles of Agroforestry 2 (1+1)

Theory

Overview of the Agriculture scenario – Paradigm shift in Agriculture development- impacts of green revolution – Agrobiodiversity – significance, threats and conservation strategies. Agroforestry – definition and scope – Social, ecological, and economic reasons for agroforestry. History of agroforestry. Components of Agroforestry- Provisioning and regulator services of agroforestry- Nutrient cycling, Soil improvement, Increased production and productivity, Microclimate amelioration and carbon sequestration – Tree-crop interaction in agroforestry– Definition, kind of interaction – Positive interactions- complementarity - compatibility - mutualism, commensalism - Negative interactions – allelopathy and competition-Interaction management - Aboveground and belowground interactions- Manipulation of density, space, crown and roots. Tree Management – structure and growth of trees, crown and root architecture, agroforestry practices to minimize negative interaction – coppicing, thinning, pollarding and pruning – crop planning and management –selection of suitable crops – management of nutrients, water and weeds – Classification of agroforestry systems – National Agroforestry Policy 2014—National and International organizations in Agroforestry.

Lecture Schedule

1. Overview of Indian Agriculture scenario – paradigm shifts in agricultural development of India – Impacts of green revolution
2. Agrobiodiversity – significance, threats and conservation strategies
3. Agroforestry – Definition, scope and history- Social, ecological, and economic reasons for agroforestry
4. Components of agroforestry- tree components- MPTs- crop components- animal components
5. Provisioning services of agroforestry- Tangible products from agroforestry- food fodder, fuel, nutritional

6-7. Ecosystem/regulatory services of agroforestry- Nutrient cycling, Soil improvement, Increasedproduction and productivity, Microclimate amelioration, carbon sequestration and climate change mitigation

8. Tree- crop interaction – Definition, kind of interaction-aboveground and belowground interactions and significance
9. Positive interactions - complementarity- compatibility - mutualism, commensalism
10. Negative interactions – Allelopathy and competition
11. Interaction management – management of aboveground and belowground interactions- manipulation of density, space, crown and roots
12. Tree Management – structure and growth of trees, crown and roots architecture
13. Agroforestry tree management practices to minimize negative interactions – cropping, thinning, pollarding and pruning
14. Crop management – Selection of suitable crops, spatial and temporal regulation, nutrients and weed management, irrigation management

15. Multipurpose tree species and their characteristics. Choice of species for agroforestry - criteria for selection of fodder trees, fuel wood and charcoal trees, food and medicinal uses, pulp wood and round wood used; multipurpose trees, nitrogen fixing trees.
16. Classification of agroforestry systems – structural, functional, ecological and socio-economic
17. National Agroforestry Policy 2014
18. National and international organizations in Agroforestry

Practical

Visit to social / Urban / Community forestry plantations and study their impact on socio – economic status of rural people- Traditional agroforestry systems in the country and visits to some of the local agroforestry systems. Agroforestry systems in different agroecological zones- their structural and functional features. Visit to on farm agroforestry models. Studies on fodder banks and live fences. Studies on light and below ground interactions in agroforestry systems- MPTs and Nitrogen fixing trees in agroforestry- Studies on allelopathy- Design & Diagnostics exercise in agroforestry- Land capability classification of various topographic regions- Visit to industrial plantations.

Practical Schedule

1-3. Visit to social / Urban / Community forestry plantations and study on their impact on socio – economic status of rural people
4-6 Diagnosis and design survey on agroforestry practices in various agroecological regions
7-9. Collect information on various traditional agroforestry systems in the country and visit some of the local agroforestry systems.
10-11 List out the major agroforestry systems in different agroecological zones in India and describe their structural and functional features.
12-13. Visit to on farm agroforestry models
14-15. Studies on fodder banks and live fences
16. Studies on photosynthetically active radiation (PAR) and below ground interactions in agroforestry systems
17. Compilation of information on MPTs and Nitrogen fixing trees used in agroforestry
18. Final practical examination

Suggested reading

Huxley, P. A. (1999). Tropical Agroforestry. Wiley: 384p.
Kumar, B.M. and Nair, P.K.R (eds). (2011). Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p
Nair, P.K.R, Rao MR, and Buck, L.E (eds), (2004). New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.
Nair, P.K.R. (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.
Pathak P.S. and Ram Newaj (eds.) (2003). Agroforestry: Potentials and Opportunities. Agrobios, Jodhpur.
Patra, A.(2013). Agroforestry: Principles and Practices, New India Publishing Agency, 260 p
Raj, A. J. and S. B. Lal (eds.) (2013). Agroforestry-Theory and Practice. Scientific Publishers (India), Jodhpur

Safo 1204 Theory and Practice of Silviculture 3 (2+1)

Theory

Definitions: Forests and Forestry- Silviculture objectives and scope of silviculture-relation with other branches of Forestry Silvics. Site factors - climatic, edaphic, physiographic, biotic and

their interactions. Trees and their distinguishing features, growth and development. Root growth- fine root/functional root production- Direct and indirect benefits- biophysical interactions- trees and buffering functions- C sequestration potential of forests. Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

Regeneration of forests – objectives - ecology of regeneration- natural, and artificial regeneration. Natural regeneration- seed production, seed dispersal, germination and establishment, requirement for natural regeneration, advance growth, coppice, root sucker, regeneration survey, natural regeneration supplemented by artificial regeneration. Artificial regeneration - object of artificial regeneration - advantages. Factors governing the choice of regeneration techniques. Tree planting- Sowing v/s planting different kinds of pits- tending and cultural operations- weeding- kinds of weeding- release operations- singling, cleaning– liberation cutting

Lecture schedule

1-2 Introduction - definition - forests, forestry, silvics, silviculture - principles vs practice, general considerations and framework of silviculture - objectives and scope of silviculture

3 Trees and their distinguishing features - Growth and development

4-6 Factors of site: Classification of climatic factors - role played by light, temperature, rainfall, snow, wind, humidity and evapotranspiration in relation to forest vegetation–

7-8 Influence of topography, configuration of land surface, altitude, slope, aspect on vegetation

9 Edaphic factors: Distribution of the species based on soil types and climate - reasons for teak, sal, deodar and spruces occupying different regions

10 Biotic factors-influence of plants, insects, wild animals, man and domestic animals on vegetation

11 Tolerance and crown classes - crown class differentiation

12-13 Growth of trees in general - height growth, diameter growth and volume production of trees- silvicultural control of tree growth- advantages and disadvantages of rapid growth

14 Silvicultural characteristics of stands- growth of stands - even-aged and uneven- aged

15-16 Silvicultural systems- introduction, definition, scope and classification-

17-18 Clear-felling system – kinds of clear felling systems- Clear-strip system and alternate strip system

19-20 Shelterwood system – types of sheterwood systems- uniform system - Group system - Shelterwood strip system and the Irregular shelterwood system

21 Selection system and its modifications- controversy, application

22 Accessory systems - two storied high forest system, high forest with reserves system, improvement felling.

23-24 Coppice systems- kinds of coppice systems- Simple coppice Coppice of two rotations system Shelterwood coppice system Coppice with standards system Coppice with reserves system Coppice with selection system

25 Regeneration of forests - objectives – ecology of regeneration- factors governing the choice ofregeneration techniques.

26-27 Natural regeneration - seed production, seed dispersal, germination and establishment.Requirements for natural regeneration

28 Natural regeneration from vegetative parts - advance growth, coppice, root sucker, layering

29 Artificial regeneration - object of artificial regeneration - advantages.

30 Choice of species - factors that govern - hardwoods, softwoods, fast growing exotic andindigenous species.
31-32 Sowing v/s planting - different kinds of sowing - preparation of planting material-stumppreparation -field planting
33-34 Tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning - fertilization in trees-plant protection and sanitation measures
35 Forest nutrition- fertilization in trees-methods
36 Plant protection and sanitation measures

Practical
Acquaintance with modern silvicultural tools. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised by forest department, Exercise on nursery practice- seed collection, seed pre-treatment- nursery stock preparation- field preparation-marking, alignment and stacking, pit making-planting, various tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning- fertilization in trees-plant protection and sanitation measures.

Practical schedule
1. Acquaintance with modern silvicultural tools.
2-5. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised byforest department
6-7. Exercise on nursery practice- seed collection, seed pre-treatment- nursery stock preparation
8-12. Field preparation- marking, stacking and alignment, pit making-planting
13-16. Various tending operations- weeding, cleaning, singling, pruning and thinning
17. Fertilization in trees-plant protection and sanitation measures
18. Final Practical Examination

Suggested reading
Evans, J. & John W. Turnbull . (2004). Plantation Forestry in the Tropics: The role, silviculture and use of planted forests for industrial, social, environmental and agroforestry purposes. OUP Oxford. 482p.
Khanna, L.S.(1989). Principles and Practice of Silviculture. Khanna Bandhu, 7 Tilak Marg, Dehra Dun
Nyland, R. D. (2016). Silviculture: Concepts and Applications, Third Edition. Waveland Press, 680 pages
Ram Parkash (1991). Theory and Practice of Silvicultural Systems International Books & Periodicals, Dehra Dun, 298 pages
Smith, D.M. (1986). Practice of Silviculture, Edn 8. New York, John Wiley.

Safo 2105 Forest Seed Technology 3 (2+1)

Theory
Importance of seed in present day forestry- seed and fruit development -pollination - seed dispersal. Planning seed collection- determining species, provenances, trees, stands, seed quantities, year of collection and dates for collection. Collection of immature fruits..Methods of seed collection. Fruit and seed handling - maintaining viability and identity- special precautions for recalcitrant seeds. Seed processing- operations prior to extraction- pre-cleaning, methods of extraction- operations after extraction- cleaning, grading and control of moisture level-factors affecting drying of orthodox seeds. Seed storage- definition- purpose, seeds-Harrington's rule of thumb, seed maturity- parental and annual effects. Storage condition and

ageing of seeds. Storage methods. Storage containers. Seed dormancy- classification of types of dormancy. Treatments for breaking exogenous and endogenous dormancy - morphological and physiological dormancy, treatments to overcome double dormancy. Seed dressing and pelleting. Seed testing - definition- ISTA rules. Sampling- seed weight- moisture- authenticity- seed health. Germination testing- germination equipment- conditions for selected species. Germination evaluation- germination testing in nursery. Indirect tests of viability. Deterioration of seed- deterioration vs. "vigour". Concepts of seed vigour- measurements of seed vigour and deterioration. Seed Act and seed law enforcement. Seed certification. Emerging trends in tropical seed technology.

Lecture schedule

1. Introduction - importance of seed in forestry
2. Pollination and fertilization - angiosperms vs. gymnosperms
3-4. Seed and fruit development - seed dispersal - seed germination.
5-6. Planning seed collection - collection of immature fruits - large-scale collection -provenance collection - single tree collection - single clone collection - collection for conservation.
7-8. Seed collection - choice of methods - year of collection and dates for collection - productivity in fruit collection.
9-10. Fruit and seed handling between collection and processing -maintaining viability and identity-special precautions for recalcitrant seeds.
11-12. Seed processing- operations prior to extraction- pre-cleaning, methods of extraction-Separation - tumbling - threshing etc.,
13-14. Operations after extraction -cleaning, grading and control of moisture level - equilibrium moisture content - factors affecting drying of orthodox seeds.
15-16. Seed storage - definition- purpose - natural longevity of tree seeds - Ewart's classification, Roberts classification - orthodox and recalcitrant seeds - Harrington's rule of thumb - seed maturity -parental and annual effects.
17-18. Storage condition and ageing of seeds - choice of storage methods -storage containers - use of desiccants in storage, seed shipment. Cryopreservation of recalcitrant seeds
19-20. Seed dormancy - classification - treatments designed to break exogenous dormancy
21-22. Treatments designed to break endogenous or embryo dormancy - treatments to overcome double dormancy.
23. Seed dressing and pelleting - uses - materials and methods.
24. Other types of pre-treatment - Pressure Vacuum (PREVAC) method - Incubation-Drying-Separation (IDS) method
25-26. Seed testing -definition- ISTA rules. Sampling- seed weight- moisture- authenticity- seed health.
27. Germination testing - germination equipment - germination conditions.
28. Germination evaluation - germination energy - germination Value.
29. Germination testing in nursery - calculations and interpretation of results.
30-31. Indirect tests of viability
32-33. Ecological aspects of germination. Deterioration of seed - theories of deterioration – accelerated ageing - deterioration vs "vigour".
34-35. Seed Act and seed law enforcement - role of seed testing laboratories under Seed Act., Seed certification standards - seed quality control - principle and procedure
36. Advances in Research and Technology in Handling of Tropical Forest Seed

Practical:

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test – evaluation and interpretation of results; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its

measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; 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.

Practical schedule

1-2. Morphological structure of seeds of economic trees
3-4. Visit to seed production areas and seed orchards.
5. Seed maturity test
6. Seed extraction techniques - cleaning, drying techniques - using different sieves
7-8. Visit to seed processing units - study of processing equipment - seed health - bagging and tagging.
9-10. Study of organisational set up of seed certification in India and Kerala.
11-14. Seed testing - sampling - purity - moisture and germination testing - seed evaluation - quick test of viability. Different methods of breaking seed dormancy
15-17. Visit to seed testing laboratory in Kerala and neighboring states- assessment of mechanical injury - seed health testing - storage containers.
18. Final Practical Examination

Suggested reading

Agrawal, R.L. (1996) Seed Technology. Oxford - IBH Publishing Co. New Delhi Agrobios

Ahuja PS, Mathur J, Lai N, Mathur A, Kukreja AK (1989). Towards developing artificial seeds by shoot bud encapsulation. In: Kukreja AK, Mthur A, Ahuja PS and Thakur RS (eds), Tissue culture and Biotechnology of medicinal and aromatic plants. Lucknow. India. CIMAP pp. 20-78

Carol C. Baskin and Jerry M. Baskin. 2000. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press; New edition

Chacko KC, Pandalai RC, Seethalakshmi KK, Mohanan C, Mathew G, Sasidharan N. (2002) Manual of seeds of Forest trees, Bamboos and Rattans. Kerala Forest Research Institute, Peechi, Thrissur, Kerala, India.

Chin, H.F. and Roberts, E.H. 1980. Recalcitrant crop seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia

Edwards, D. G. W. and Naithani (1999) .S. C Seed and nursery technology of forest trees.New Age International (P) Limited

Dharmaligam C., Sivasubramaniam K., Yadav Shiv K. **(**2007). A Dictionary of Seed technological Terms. Kalyani Publishers,

Dutta, M. and Saini, G.C. (2009). Forest tree improvement and seed technology International Book Distributors, Dehra Dun 302 p.

ISTA. (2016). International Rules for Seed Testing Rules., http://doi.org/10.15258/istarules.2016.i

Khullar, P., Thapliyal, R.C.;,Beniwal, B.S., Vashasya, R.K. and Sharma, A. (2003). Forest Seed. ICFRE Publication, Dehradun

Leadem, C.L. (1984) Quick tests for tree seed viability. BC Ministry of Forests, Reserach Branch. Land Management Handbook No. 18. 45 pp.

Ramamoorthy. K., K., Sivasubramaniam and A. Kannan (2006). Seed legislation in India, Agrobios

Schmidt, L. (2000) Guide to handling tropical and subtropical forest seed. Danida

Schmidt. L. (2007) Tropical forest seed. Springer New York. 409 p.

Willan, R.L. (1985) A guide to forest seed handling. FAO Forestry Paper 20/2

Safo 2106 Forest Mensuration3 (2+1)

Theory

Forest Mensuration - Definition and objectives - Scales of measurement- Units of measurements - Precision, bias and accuracy- Diameter and girth measurements- Breast height measurements instruments used- Measurement of height-Definitions- Methods of measurement of height-occular-non instrumental and instrumental methods- Sources of error in height measurements- leaning trees. Tree stem form-Metzgr's theory –form factor- types of form factor-form height for quotient-form class. Volume measurements of standing trees-logs-branch wood- formulae-involved Definitions - Volume tables preparation of volume tables-graphical method-regression method- Determination of growth of trees- Increment-CAI & MAI-increment percent-increment borer- Stump analysis- Stem analysis. Measurement of tree crops-objects-crop diameter-crop height-crop age-crop volume.

Lecture schedule

1-2 Forest Mensuration- Definition and objectives. Scales of measurement-Nominal scale, ordinalscale, interval scale and ratio scale-Units of measurements- Metric system and imperial systems-Precision, bias and accuracy

3. Individual tree measurements: Diameter and girth measurements- Places of measurement- Breast height measurement- Standard rules governing breast height measurements

4-5. Instruments used-Wooden scale-Callipers-Tape

6-7. Upper-stem diameter-Ruler- Wheeler Penta Prism Tree Calliper-Spiegel Relaskop

8. Bark-Measurement of bark thickness-Calculation of bark thickness-Swedish bark gauge

9. Measurement of height-Definitions-Total height-Bole height-Commercial bole Height-Crown length- Crown height-

10. Methods of measurement of height-ocular-non instrumental and instrumental- Shadow method- Single pole method.

11-12. Instrumental method-Based on geometric principles-Christens Hypsometer-Smythies Hypsometer-Modified Smythies Hypsometer-

13-14 Trigonometric principles-Tangent method and sine method-observation in level and slopingground

15-16. Instruments- Brandis hypsometer-Abney's level-Topographic Abney's level- Haga altimeter Relaskop Clinometer- Blumeleiss Hypsometer-Laser Hypsometer

17-18. Sources of error in height measurements- height measurements of leaning trees

19-20. Tree stem form-Metzger's theory – methods of studying tree form – form factor-types of formfactor-form height-form quotient-form class

21-23 Volume measurements of trees-objects- Calculation of volume of logs- Smalian's formula-Huber's formula-Prismoidal or Newton's formula- Quarter girth formula. Definitions-Commercial volume-standard stem timber volume-standard stem small timber volume

24. Volume of standing trees-ocular-partly ocular-direct and indirect measurements

25. Measurement of branch wood-solid volume- stacked volume

26-27 Volume tables-classification of volume tables-preparation of volume tables-graphical method-regression method

28-29. Determination of growth of trees-Increment-classification of increment relationship between CAI & MAI- increment percent-various formulae-increment borer-

30-31 Stump analysis

33-33 Stem analysis.

34-36 Measurement of tree crops-crop diameter-crop height-crop age-crop volume

Practical

Determination of pace length- Measurements of diameter-girth and basal area of trees using Calipers, Tape, Ruler, Penta Prism Tree Caliper etc. Measurement of height using non

instrumental method- Preparation and use of simple height measuring instruments- Christens Hypsometer-Smithies Hypsometer- Modified Smithies Hypsometer-Measurement of tree height using instrumental methods-Abneys level- Haga altimeter- Relaskop- Clinometer- Blumeleiss Hypsometer-Laser Hypsometer- Volume determination of standing and felled trees. Exercise on Stump analysis. Exercise on stem analysis-Annual ring counting using ring borer. Preparation of volume tables- local volume table.

Practical Schedule

1-2 Determination of pace length- Measurements of diameter-girth and basal area of trees usingCalipers, Tape, Ruler, Penta Prism Tree Calliper etc.
3-4 Measurement of height using non instrumental methods
5-8 Preparation and use of simple height measuring instruments- Christens Hypsometer-Smithies Hypsometer- Modified Smithies Hypsometer
9-10 Measurement of tree height using instrumental methods- Abneys level- Haga altimeter-Relaskop- Clinometer- Blumeleiss Hypsometer-Laser Hypsometer
11 Volume determination of standing and felled trees.
12-13 Exercise on Stump analysis
14-15 Exercise on Stem analysis
16. Annual ring counting using ring borer.
17. Preparation of volume tables- local volume table.
18. Final Practical examination

Suggested reading

Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition). KhannaBandhu. Dehra Dun. 364 pp.
Husch, B., Beers, T.W. and Kershaw, J. J.A. (2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.
Laar, V. A. and Akca, A. (2007). Forest Mensuration. Managing Forest Ecosystems. Vol.13).Springer.384pp.
Matthews,R. W. and Mackie, E. D. (2006). Forest mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.
West, P.W. (2009). Tree and Forest Measurement (2nd edition). Springer. 192pp.

Safo 2207 Silviculture of Indian Trees 3 (2+1)

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices pest and diseases and economic importance of the following tree species of India. Broadleaved species: *Tectona grandis*, *Shorea robusta, Dalbergia latifolia, Dalbergia sissoo, Anogeissus spp, Terminalia spp., Santalum album, Swietenia macrophylla, Albizia spp, Pterocarpus marsupium, Gmelina arborea, Pterocarpus santalinus, Azadirachta indica, Hopea parviflora, Lagerstroemia microcarpa,* Bamboos, reeds and rattan, *Quercus* spp. Conifers: *Abies pindrow, Picea smithiana, Cedrus deodara, Pinus roxburghii, Pinus wallichiana.* Fast growing MPTs: Tropical pines, *Eucalyptus spp, Casuarina equisetifolia, Leucaena leucocephala, Ailanthus triphysa, Grevillea robusta, Pongamia pinnata, Melia dubia, Acacia spp, Populus spp*. *Emblica officinalis Atrocarpus sp.*

Lecture schedule

1. *Tectona grandis* – origin, general description - general value - economic importance, distribution and habitat
2 *Tectona grandis* - silvicultural characteristics - climate - physiographic factors - geology – rock and soil

3-4. *Tectona grandis* - phenology - important diseases and pests, silvicultural systems – regenerationmethods, nursery – site preparation- field planting- establishment - tending – stand management practices- thinning cycle- site quality evaluation, growing stock assessment, extraction

5. *Shorea robusta* – origin, general description - general value - economic importance, distribution and habitat

6 *Shorea robusta* - silvicultural characteristics - climate - physiographic factors – edaphic factors

7-8. *Shorea robusta* - phenology, important diseases and pests, silvicultural systems – regenerationmethods, nursery – site preparation- field planting- establishment - tending – stand management practices, growing stock assessment, extraction

9-10 *Dalbergia latifolia* and *Dalbergia sissoo* origin, general description - general value - economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic and edaphic factors, phenology, diseases and pests, silvicultural systems- regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

11-12 *Swietenia macrophylla*- origin, general description - general value – economic importance, distribution and habitat, silvicultural characteristics - climate - physiographic factors - geology – rock and soil- phenology, diseases and pests, silvicultural systems – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

13-14 *Artocarpus heterophyllus and A. hirsutus* origin, general description - general value – economic importance, distribution and habitat, silvicultural characteristics - climate - physiographic factors - geology – rock and soil- phenology, diseases and pests, silvicultural systems – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

15-16 Bamboos, Reeds and Rattan – Description of different species- economic importance, distribution and habitat- silvicultural characteristics- climate - physiographic and edaphic factors - phenology, diseases and pests, silvicultural systems – regeneration- methods – site preparation- field planting- establishment - tending – clump management practices, extraction- felling rules

17 *Ailanthus triphysa* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices and extraction

18 *Santalum album* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

19-20 *Terminalia paniculata, T. tomentosa* and *T. bllerica* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

21-22 *Pterocarpus marsupium, Pterocarpus santalinus* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

23 *Hopea parviflora, Lagerstroemia microcarpa* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

24 *Azadirachta indica* - origin, general description - general value – economic importance, distribution and habitat- silvicultural characteristics - climate - physiographic factors – edaphic factors- phenology - diseases and pests, silvicultural system – regeneration- methods nursery – site preparation- field planting- establishment - tending – stand management practices- extraction

25-26 *Anogeissus latifolia, Emblica officinalis, Pongamia pinnata, Melia dubia* –distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices.

27-28 *Albizia spp* – distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices.

29-30 *Leucaena leucocephala, Grevillea robusta, Melia dubia*– distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices.

31-32 Eucalypts, *Casuarina equisetifolia*– distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices

33-34 Tropical pines, *Pinus wallichiana, Pinus roxburgii, Cedrus deodara, Abies pindrow, Picea smithiana* - distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices

35-36 *Acacia mangium, Acacic auriculiformis*, wattles, *Populus spp*- distribution and habitat- economic importance- silvicultural characteristics – locality factors- phenology - diseases and pests, silvicultural system – regeneration- methods- propagation and field planting- tending and management practices

Practical

Study the morphological description and field identification characteristics of trees, seeds and seedlings. Phenology, Collection of seeds. Planting and stand management practices of *Tectona grandis, Dalbergia latifolia, Santalum album, Swietenia macrophylla,* eucalypts, acacias, bamboos, fast growing MPTs etc.

Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicing and pollarding, etc. Visit various problem areas and study on species suitability. Visit forest plantations and other woodlots. Study the planting density and stand management regimes for various end uses such as timber, pulpwood, plywood, cottage industries etc.

Practical schedule

1. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Tectona grandis*
2. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Shorea robusta*
3. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Dalbergia latifolia,D. sissoo*

4. Morphological description and identification of species, seeds and seedlings, planting and standmanagement practices of *Swietenia mahagony,Santalum album*.
5. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of bamboos, reeds and rattan
6. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Terminalia spp, Pterocarpus marsupium*
7. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Hopea parviflora, Lagerstroemia lanceolata*
8. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Azadirachta indica, Anogeissus latifolia*
9. Morphological description and identification of trees, seeds and seedlings,
planting and stand management practices of *Pongamia pinnata, Ailanthus triphysa, Leucaena leucocephala, Grevillea robusta, Melia dubia*
10. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Albizia spp.*
11. Morphological description and identification of trees, seeds and seedlings,
planting and stand management practices of , Eucalypts, *Casuarina equisetifolia*
12. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of tropical pines, *Pinus wallichiana, Pinus roxburgii, Cedrus deodara, Abispindrew, Pecia smithiana*
13. Morphological description and identification of trees, seeds and seedlings, planting and standmanagement practices of *Acacia mangium, Acacic auriculiformis,* Wattles, *Populus* spp.
14. Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicingand pollarding, etc
15-17. Visit to various plantations and forest areas to familiarise with species and study their silvicultural characters.
18. Final practical examination

Suggested reading

Bebarta. K.C. (1999). Teak: Ecology, Silviculture, Management and profitability, IBD, Dehra Dun

Champion, H.G. and Griffith, A.L.. (1989). Manual for General Silviculture for India, EBD Educational

ICFRE booklets on tree species

Kadambi, K. (1993). Silviculture and Management of teak. Nataraj Publishers, Dehra Dun. p. 137.

Lamprecht H (1989). Silviculture in the Tropics. GTZ, GmBH, FRG

Luna, R. K. (1996). Plantation trees. International Book Distributors, Dehradun 975p. 8. Smith, D.M., Forest

Renuka, C., Pandalai, R.C. and Mohanan, C. (2002) Nursery and silvicultural techniques for rattan, Kerala Forest research Institute.

Seethalakshmi, K.K. and Kumar, M. (1998). Bamboos of India- a compendium. BIC India, Kerala Forest Research Institute, Peechi and International Network for Bamboo and Rattan, New Delhi, India, 342 pp

Troup, R.S. (1975). Silviculture of Indian Trees, Vol. 1-4, Revised and Enlarged Edition, Forest Research Institute and Colleges, Dehra Dun.

Safo 2208 Forest Nursery Technology 2 (1+1)

Theory

Introduction - scope for nursery technology. Nursery establishment - site selection – planning, and layout of nursery area. Bare root nursery techniques - types of nursery beds, preparation of beds, fumigation. Pre-sowing treatments. Methods of seed sowing and mulching, seed size

and position of sowing, seedling growth and development, pricking. Watering methods, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, and packaging. Storing and transportation. Containerized nursery technique - advantages, disadvantages - root deformations - container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerized stock, field handling of containerized stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages, conditions/practices affecting early survival and early growth. Methods for field handling and planting bare-root stock. Type and size of containers. Merits and demerits of containerized nursery. Preparation of ingredient mixture. Nursery practices that influence seedling uniformity, diameter/height and size of root system. Study of important nursery pests and diseases and their control measures. Nursery practices for important tree species. Target seedling concept. Emerging trends in tropical forest nursery management.

Lecture schedule

1.Introduction - scope for nursery technology.
2. Nursery establishment - site selection – planning, and layout of nursery area.
3. Types of nursery, types of nursery beds, preparation of beds, fumigation.
4. Pre-sowing treatments. Methods of seed sowing and mulching, seed size and position of sowing
5. Seedling growth and development, pricking.
6. Irrigation methods in nursery, weeding, hoeing,
7. Rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading
8. Pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation.
9. Containerised nursery technique - advantages, disadvantages – Type and size of containers
10. Root deformations - container designs and types/root trainers and rooting media.
11. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock,
12. Planting techniques for containerized stock and bare-root seedlings: advantages, disadvantages
13. Conditions/practices affecting early survival and early growth. Methods for field handling, Preparation of ingredient mixture.
14. Nursery practices that influence seedling uniformity, diameter/height and size of root system.
15-16. Study of important nursery pests and diseases and their control measures.
17. Nursery practices for important tree species.
18 .Target seedling concept- emerging trends in in tropical forest nursery management

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 forest nurseries.

Practical schedule

1-2. Preparation of production and planning schedule for bare root and containerized nurseries.
3-4. Nursery site and bed preparation.

5. Pre-sowing treatments.
6-7. Sowing methods of small, medium, and large sized seeds.
8-9. Pricking and transplanting of pricked out stock within nursery in transplant beds.
10-11. Intermediate nursery management operations.
12-13. Preparation of ingredient mixture-vermi-compost- coir pith compost.
14. Filling of containers.
15-16. Visit to Central nurseries and study the management practices.
17. Familiarization with important nursery pests and diseases and their control measures
18. Final Practical examination

Suggested reading

Duryea ML, Landis TD (2004) Forest nursery manual: production of bareroot seedlings. Martinus Nijhoff/Dr W Junk Publ, The Hague. http://dx.doi.org/10.1007/978-94-009-6110-4

Evans J and Turnbull W.J. (2004) Plantation forestry in the tropics. Oxford University Press - Oxford. 482p.

Kumar, V. (2006) Nursery and plantation practices in forestry. Scientific publication. Jodhpur.

May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. (1985). Southern Pine Nursery Handbook, USDA Forest Service, Southern Region, Cooperative Forestry

Napier, I. and Robbins, M. (1989) Forest seed and nursery practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu

Prakash, R. Chaudhari, D.C. and Negi, S.S. (1990) Propagation practices of important Indian trees. International Book Distributors, Dehra Dun.

Prakash, R. Chaudhari, D.C. and Negi, S.S. (1998) Plantation and NurseryTechniques of Forest Trees. International Book Distributors, Dehra Dun.

Singh V and Lavania S.K. (2003) Forest tree seeds and nursery management. Bishan Singh Mahendra Pal Singh , Dehra Dun

Wilkinson KM, Landis TD, Haase DL, Daley BF, Dumroese R.K. (2014). Tropical Nursery Manual: a Guide to Starting and Operating a Nursery for Native and Traditional Plants. Agric Handbk 732. US Dept Agric Forest Serv, Washington, DC

Safo 2209 Agroforestry systems and Management 2 (1+1)

Theory

Land use and land capability classification- prospects of agroforestry as a land use practice in India. Classification of agroforestry systems – structural, functional, agroecological, socio-economic and physiognomic basis. Agrosilvicultural systems – Improved fallows in shifting cultivation – soil dynamics in shifting cultivation – Taungya systems – Alley cropping – structural and functional attributes. Multipurpose trees and shrubs on farmlands, agricultural fields- Plantation crop combinations- commercial crops under shade of planted trees and natural forests- Windbreaks & Shelterbelts. Silvopastoral systems – protein banks, Live fence of fodder trees and hedges, trees and shrubs in pastures. Pastoral silviculture systems- grassland and tree management in the humid, arid and semi- arid regions. Agrosilvopastoral systems – tropical home gardens –structural and functional attributes. Other systems – apiculture, sericulture and mixed woodlots. Industrial agroforestry- agroforestry practices for wasteland reclamation- agroforestry practices for salt affected soils, wetlands and waterlogged areas. Ecosystem services from agroforestry- Soil fertility improvement and water conservation through agroforestry. Climate change mitigation and adaption through agroforestry- carbon sequestration –CDM-LULUCF-REDD+- activities- Socio-economic analysis of various agroforestry systems- evaluation of direct and ecosystem services.

Lecture schedule

1. Land use – definition - land capability classification and planning- prospects of agroforestry as a landuse practice for India
2. Classification of agroforestry systems – structural, functional, agroecological, socio-economicand physiognomic basis
3. Agrosilvicultural systems – Improved fallows in shifting cultivation – soil dynamics in shiftingcultivation – strategies and initiatives for controlling shifting cultivation
4. Taungya systems – definition, types, practices in India, management of taungyas – merits anddemerits – latest developments in taungya system

5-6. Alley cropping – definition, history – structural and functional attributes, soil management, choice of species- establishment and management – advantages and disadvantages

7. Multipurpose trees and shrubs on farmlands, agricultural fields- Plantation crop combination. Commercial crops under shade of planted trees and natural forests.
8. Windbreaks & Shelterbelts – definition, characteristics, benefits - planning and designing – selection of species
9. Silvopastoral systems –intensive and Extensive, Protein banks, Live fence of fodder trees and hedges, trees and shrubs in pastures
10. Pastoral silviculture systems- grassland and tree management in the humid, arid and semiarid. Regions- various systems

11-12. Agrosilvopastoral systems – Tropical home gardens – definition, distribution, biodiversityaspects, structural and functional attributes – management of homegardens-integrated farming.

13. Other systems – Apiculture, sericulture and mixed woodlots
14. Agroforestry practices for wasteland reclamation- salt affected soils, bio saline agroforestry – Agroforestry practices for wetlands and waterlogged areas- biodrainage through agroforestry
15. Industrial agroforestry- concept- farmer-industry- market linkage- success stories.
16. Ecosystem services from agroforestry- soil fertility improvement and water conservation through agroforestry – microclimate amelioration- carbon sequestration
17. Climate change mitigation and adaption through agroforestry- carbon sequestration- CDM-LULUCF-REDD+ activities
18. Socio-economic analysis of various agroforestry systems- evaluation of direct and ecosystem services

Practical

Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes. Assessment of standing stock of tree species in various agroforestry systems such as homegardens. Survey of agroforestry practices in local/adjoining areas. Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices- agrosilviculture systems, silvopastoral systems, pastoral silviculture systems, agrosilvopastoral systems, shelterbelts and windbreaks, live fences; fodder trees and protein banks. Exercise on Diagnosis and Design of agroforestry systems and practices. Assessment of productivity of tree crop combinations. Studying resource partitioning in agroforestry systems - water, light and nutrients. Analysis of soil and plant samples for organic carbon N, P and K.

Practicalschedule

1. Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes.
2. Assessment of standing stock of tree species in various agroforestry systems Survey of agroforestry practices in local/adjoining areas.

Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices:

3. Agrosilviculture systems
4. Silvopastoral systems
5. Pastoral silviculture systems

6-7. Agrosilvopastoral systems

8-9.Shelterbelts and windbreaks, live fences; fodder trees and protein banks

10-11. Exercise on Diagnosis and Design of agroforestry systems and practices

12-13. Assessment of productivity of tree crop combinations

14-15. Studying resource partitioning in agroforestry systems - water, light and nutrients

16-17. Socio-economic evaluation of various agroforestry systems- evaluation of ecosystems services.

18. Final Practical examination

Suggested reading

Batish,D.R., Kohli, R.K., Jose,S. and Singh, H.P. (2007). Ecological Basis of Agroforestry. CRC Press. 400p. Huxley, PA 1983 (ed). *Plant Research and Agroforestry*, ICRAF, Nairobi, Kenya.

Huxley, P.A. (1999). Tropical Agroforestry. Wiley: 384p.

Kumar, B. and Nair, P.K.R. (eds). (2006). Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Volume 3 in the Book Series "Advances in Agroforestry". Springer Science, the Netherlands

Kumar, B.M. and Nair, P.K.R. (2004). The enigma of tropical homegardens. 2004. Agroforestry Systems. 61: 135–152.

Montagnini, F and Mark S Ashton, M.S (eds). (2000). The Silvicultural Basis For Agroforestry Systems. CRCNair, PKR, Rao MR, and Buck LE (eds). 2004. *New Vistas in Agroforestry*: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.

Nair, PKR (1993). An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Nair, P.K.R., Kumar, B.M. and Vimala D. N. (2009). Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.

Pathak P.S. and Ram Newaj (eds.) (2003). Agroforestry: Potentials and Opportunities. Agrobios, Jodhpur.

Safo 2210 Soil Biology & Fertility 3 (2+1)

Theory

Introduction - forest soils vs. cultivated soils, special features of forest soils, forest soil formation and vegetation development. Pedogenic processes – Podzolization and Laterization. Properties of soils under different forest ecosystems. Forest floor – stratification – types of humus. 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. Forest soil - biology-distribution of various microorganisms in soil ecosystem and their interaction effects. Role of microorganisms in soil fertility. Mineral transformations-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 N2 fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur, and micronutrients. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere

concept. Fertility management of forest soils. Integrated nutrient management in plantation forestry.

Lecture schedule

1. Introduction: soils-definition –importance as a medium for plant growth. Forest soils-definition-forest soils vs cultivated soils.

2-4. Special features of forest soils. Forest soil formation and vegetation development-pedogenic processes- podzolization, laterization, melanization.

5-7. Properties of soils under different forest ecosystems.

8-9. Forest floor: Definition –stratification in forest floor-humus layers-mor and mull humus-forest litter-properties of forest floor-physical and chemical. Altering the forest floor.

10-13. Essential nutrient elements- occurrence, availability and their function. Nitrogen,Phosphorous, Potassium, Calcium, Magnesium and Sulphur. Micronutrients.

14-15. Diagnosis of nutrient deficiencies-visual symptoms.

16-18. Soil fertility evaluation methods-soil analysis, tracer methods, leaf analysis and plant analysis.

19-21. Macro and micronutrient fertilizers and their uses. Fertilizer sources – Nitrogen, Phosphate and Potassium fertilizers-micronutrient fertilizers-application of fertilizers.

22-25. Forest soil biology-kinds of organisms and their functions in soils-soil fauna, microflora-rhizosphere and microbial activity

26-27. Role of microorganisms in soil fertility, bacteria, fungi and actinomycetes, biofertilizers

28-29. Nutrient cycling in forest soils. Geochemical nutrient cycling-nutrient inputs, nutrient outputs-Biological nutrient cycling-uptake by trees, retention and distribution, internal transfer-silvicultural implications

30-31. Carbon cycle-organic matter decomposition-role of microbes, termites, ants, earth worms, types of humus-significance of C/N ratio-factors affecting soil organic matter and nitrogen.

32. Nitrogen cycle in forest soils-atmospheric nitrogen, plant and animal organic nitrogen, mineralization and immobilization –ammonification, nitrification and denitrification-biological N fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis,

33. Phosphorous cycle-inorganic and organic forms of P-availability problems in soils-microbial transformations of P.

34. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorous and micro-nutrients, Rhizosphere and phyllosphere concept.

35-36. Fertility management of forest soils-constraints-soil compaction-erosion-second rotation productivity decline-harvest removals-nutrient budgets- Integrated nutrient management in plantation forestry.

Practical

Study of forest soil profile; Estimation of pH and EC –Organic carbon – available N, P, K, Ca, Mg, S and micronutrients – Determination of CEC and exchangeable cations; Interpretation of soil and plant analysis data for fertilizer recommendation. 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; Estimation of nitrification rate in soil; Isolation of legume bacteria and Azotobacter; Preparation and inoculation techniques for mycorrhizae and biofertilizers.

Practical schedule

1. Study of forest soil profile
2. Collection and preparation of soil samples for analysis
3. Determination of pH of soil
4. Determination of electrical conductivity of soil

5. Estimation of organic carbon by Walkley and Black method
6. Determination of available nitrogen in soil
7. Determination of available phosphorus in soil
8. Determination of available potassium in soil
9. Preparation and interpretation of soil test reports
10. Collection and preparation of plant samples for analysis
11. Dry ashing of plant material
12. Wet digestion of plant material - Preparation of diacid and triacid extracts
13. Determination of P in the plant material
14. Determination of K in the plant material
15. Determination of total nitrogen in plant material
16. Interpretation of soil and plant analysis data for fertilizer recommendation
17. Preparation and inoculation techniques for mycorrhizae and biofertilizers
18. Final practical examination

Suggested reading

Biswas, T. D. and S. K. Mukherjee (1992). Text book soil fertility. Tata Mc. Grew Hill, Publishing Co., New Delhi.

Brady, N.C. and Weil, R.R. (2002) .The nature and properties of soils, Prentice Hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi.

Burges, A. and Raw, F. (1967). Soil Biology. Acad. Press, New York

Gupta, P,K. (2007). Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur

Mengel, K. and Kirkby, E.A. (1987). Principles of Plant Nutrition. International Potash Institute, New York.

Prasad, R. and Power, J.F. (1997). Soil Fertility Management for Sustainable Agriculture. CRC Press.

Pritchett and Fisher, R.F. (1987). Properties and Management of Forest Soils. John Wiley, Publication. Switzerland, pp. 687.

Tisdale, S. L., W. L. Nelson, J. D. Beaton and J. L. Havlin. (1995). Soil feritility and fertilizers (5^{th}ed). Macmillan Publishing Co., New York.

Wild, A. (1988). Soil Condition and plant growth. 11th ed, ELBS, London.

Yawalkar K.S., Agarwal, J.P. and Bokde, S. (2000). Manures and Fertilizers. Agri-Horti

Young, A. (1989). Agroforestry for Soil Conservation. CAB International, U.K.

Safo 3211 Plantation Forestry 3 (2+1)

Theory

Plantations-definition and scope. History of plantations, Development of plantation forestry, Plantation organization and structure, Land and plantation development. Plantation planning-National and regional planning-project appraisal and project implementation– feasibility studies. Plantation silviculture - Choice of species- Plantation establishment- Plantation maintenance- Nutrition in plantations- use of fertilizers- Major pest and disease in plantations-sanitation and control measures. Dynamics of stand growth- CCF-MCA- stand density management in plantations- Thinning regimes- improvement fellings, Site quality evaluation, stand basal area- site index concept in plantation forestry- plantation productivity assessment-growing stock assessment- MAI, sustainability of plantations. Plantation records- plantation journal. Industrial plantations- paper and pulp wood- match wood, plywood plantations-Plantations yielding NTFPs- Energy plantation- high density short rotation plantations- petro crops- TBOs. Avenue plantations- Plantations as potential carbon sinks carbon sinks- Economic factors in plantation development- social and cultural considerations

Lecture schedule

1-2. Plantations-definition and scope - importance of plantation forestry - present status – nationaland international scenarios.
3-4 Historical aspects- trends in the spread of man-made forests in the tropics; early history of teakand other tropical plantations.
5-6. Planning plantation enterprise- National and regional planning-project appraisal and projectimplementation-plantation journal.
7-8. Plantation organization and structure- plantation characteristics; species composition; age classdistribution; stocking; silvicultural system, plantation design, schematic representation of plantation activities.
9-10. Species choice, concept of fast growth-exotics vs. indigenous- traditional vs. intensive forestmanagement.
11. Plantation establishment- Site preparation– boundary demarcation- ground preparation-leveling- contour terracing- alignment and staking
12-13. Planting- planting stock preparation, planting layout, planting pattern; spacing; general planting rules protection of newly planted seedlings-Plantation maintenance- seedling mortality; weed control; cleaning; singling; re-spacing.
14. Dynamics of stand growth- pattern of growth of individual trees; physiological and silviculturalbasis of stand development.
15-16. CCF-MCA- Site quality evaluation- stand basal area, site index concepts in plantation forestry- plantation productivity assessment- growing stock assessment- MAI of different plantations-
17-18. Stand density management in plantations- Thinning- concept of thinning; thinning schedules; kinds of thinning; silvicultural regimes; software tools for modelling thinning regimes. Pruning- need for pruning, timing and intensity of pruning.
19-20. Nutrition in plantations - nutrient deficiencies; symptoms of deficiency; use of fertilizers
21. Factors influencing forest product quality and value. Effects of rotation length on product quality. Ways of choosing rotation length, risks.
22-23. Final crop stocking. Effects of final crop stocking on crop dimensions, interaction with rotationlength. Site occupancy, biomass production.
24-25. Sustainability of plantations - fast growing plantations-myths and reality. Second rotation decline mensurational evidence of the productivity of successive tree crops
26-28. Industrial plantations- paper and pulp wood- match wood plantation- plywood plantation- NTFPplantation- tannin, resin and turpentine plantations, Energy plantation - high-density short rotation plantations- petrocrops - TBOs.
29-30. Strip plantation-road side plantation - canal plantation- railway line plantation.
31. Clonal plantations- development and management of clonal plantation
32-33. Economic factors of plantation development- finance- unit cost calculation- cost benefit analysis labour- infrastructure, economic marketing social and cultural effects.
34-35. Plantations as potential carbon sinks- concepts Sequestration, C Substitution and C Conservation functions; LULUCF and REDD concepts, AR-CDM concepts
36. Modern concepts in plantation forestry- mechanization in plantation development.

Practical

Study the tools and materials for plantation establishment- Visit small and large plantations-study their management and functioning- Exposure to plantation project preparation-economic evaluation and feasibility studies of plantation projects. Study of planting operations-study of tending techniques- Planting methods and techniques for different types of plantations including energy plantations, canal bank plantations - pulp wood plantations- study of Forest Development Corporation plantations-road side plantations plantation planning-Plantation journal- Choice of species for plantations-economic considerations in plantation-Study of Government vs. private plantations.

Practical schedule

1. Study the tools and materials for plantation establishment
2-4. Staking and alignment- lay out-Site preparation
5. Stump planting-planting of root trainer plants
6. Visits to commercial and belt plantations and familiarization with their management
7. Exercise on plantation project development
8. Planting methods and techniques- study of tending techniques
9-11. Production technology of teak, mahogany, ailanthus, casuarina, eucalyptus
12. Study of industrial plantation-pulp wood plantations
13. Study of energy plantation, canal-side strip plantation
14. Visit to mechanised plantation operation sites.
15. Study of Forest Development Corporation plantations-road side plantations
16. Exercise on plantation planning- Plantation records, plantation journal
17. Choice of species for plantations-economic considerations in plantation Development-assessment of productivity
18. Final Practical examination

Suggested reading

Bowen, G.D., E. K. S. Nambiar, E.K.S (1984). Nutrition on Plantation Forests. Academic Press, Nature - 516 pages

Evans, J. and Turnbull, J.W. (2004). Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.

Krishnapillay, B. (2000). Silviculture and Management of teak plantations. Unasylva. 201 (51): 14-21p

Nambiar, E.K.S., Cossalter, C and Tiarks.A. (1998). Site Management and Productivity in Tropical Plantation Forests. Workshop Proceedings, South Africa.

Nambiar, E.K.S. and Brown, A.G. (1997). Management of Soil, Nutrients and Water in Tropical PlantationForests. Australian Centre for Internat. Agricultural Research. 571p.

Nyland, R.D. (2016). Silviculture: Concepts and Applications, Third Edition. Waveland Press, 680 pages

Suzuki, K., Ishii, K., Sakurai, S. and Sasaki, S. (2006). Plantation Forestry in the Tropics. Springer Tokyo.

Department of Forest Biology and Tree Improvement (Fbti)

Fbti 1101 Dendrology 3 (2+1)

Theory

Introduction- importance and scope of dendrology, Principles and systems of plant classification systems. Detailed study of Benthamand Hooker natural system, its advantages and disadvantages. Plant Nomenclature–objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees. Characteristics of blaze, bark colour, exudations etc. Morphology of leaf, different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

Detailed study of the families- diagnose the features-floral variations–distribution and economic importance-systematic position as per Bentham &Hooker System of classification - Magnoliaceae, Annonaceae, Clusiaceae, Dipterocarpaceae, Malvaceae, Sterculiaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardiaceae, Fabaceae, Rhizophoraceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae, Bignoniaceae, Lamiaceae, Lauraceae, Euphorbiaceae, Orchidaceae, Palmae and Poaceae. Brief description of the families- Bombacaceae, Santalaceae, Casuarinaceae.

Lecture schedule

1. Introduction – importance and scope of dendrology, Principles and systems of plan t classification systems.
2. Detailed study of Bentham and Hooker natural system,its advantages and disadvantages.
3. Plant Nomenclature –objectives, principles and International Code of Botanical Nomenclature.
4-5. Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees.
6. Characteristics of blaze, bark colour, exudations etc.Morphology of leaf, different types of leaves, colour of young and old leaves in some species as (regular) features of identification.
7. Reproductive morphology of plants with reference to description and identification of reproductive parts.
8-9. Detailed study of the families- diagnose the features-floral variations–distribution and economic importance-systematic position as per Bentham &Hooker System of classification- Magnoliaceae
10. Annonaceae
11. Clusiaceae
12. Dipterocarpaceae
13. Malvaceae
14. Sterculiaceae
15. Tiliaceae
16. Rutaceae
17. Meliaceae
18. Sapindaceae
19. Anacardiaceae
20. Fabaceae
22. Rhizophoraceae
23. Combretaceae
24. Myrtaceae

25. Rubiaceae
26. Sapotaceae
27. Apocyanaceae
28. Bignoniaceae
29. Lamiaceae
30. Lauraceae
31. Euphorbiaceae
32. Orchidaceae
33. Arecaceaeand Poaceae.
34.-36. Brief description of the families-Bombacaceae, Santalaceae, Casuarinaceae

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. General study of herbarium. Dissection of flowers-making sketches-construction of floral diagrams of one species of the following families:Annonaceae and Guttiferae, Dipterocarpaceae and Malvaceae, Sterculiaceae and Tiliaceae, Rutaceae and Meliaceae, Sapindaceae and Anacardiaceae, Fabaceae - Papilionaceae- Mimosae– Caesalpiniaceae, Rhizophoraceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae and Bignoniaceae, Lamiaceae, Euphorbiaceae, Santalaceae and Casuarinaceae, Orchidaceae, Poaceaeand Pinaceae.

Practical schedule

Dissection of flowers-making sketches-understanding the construction of floral diagrams of one species of the following families:

1. Annonaceae and Clusiaceae
2. Dipterocarpaceae and Malvaceae
3. Sterculiaceae and Tiliaceae
4. Rutaceae and Meliaceae
5. Sapindaceae and Anacardiaceae
6-7. Fabaceae
8. Combretaceae
9. Myrtaceae
10. Rubiaceae and Sapotaceae
11. Apocyanaceae
12. Bignoniaceae,
13. Lamiaceae
14. Euphorbiaceae
15. Santalaceae
16. Casuarinaceae
17. Orchidaceae, Arecaceae and Poaceae
18. Final Practical Examination

Suggested reading

Bor N. L. (2009). Manual of Indian Forest Botany. International Book Distributors; Reprint of Oxford UP.

Brandis. D. Revised by R. D. Jakarti (2010). Indian Trees. Dehra Dun.

Charles McCann. (1966). 100 Beautiful Trees of India. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)

Eric A. Bourdo Jr. (2001). The Illustrated Books of Trees. A Visual Guide to 250 species. Salamander Books Pvt. Ltd. London. (Available online PDF)

Father H. Santapau. (1966). Common Trees. (Available online PDF at http://www.arvindguptatoys.com/arvindgupta/santapau.pdf)

Fyson, F. P. (1877). The flora of the Nilgiri and Pulney Hill-tops. Government of India.
Gamble, J. S. (1915). Flora of the Presidency of Madras Vol-1 to 3. Adlard and Sons. Ltd. London.
Hardin, W., Harrar, E. S., and White, F. M. (1995). Textbook of Dendrology (8th Edition). McGraw-Hill Companies, London 30
Jain S. K. and R. R. Rao. (1977). Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers. New Delhi
Lawrence, G.H.M. (1967). Taxonomy of Vascular Plants. Oxford & IBH, New Delhi.
Mishra. S. R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd. New Delhi.
Naqshi, R. (1993). An Introduction to Botanical Nomenclature. Scientific Publishers. Jodhpur.
Pandey S. N. and S. P. Mishra. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
Parker, R. N. (1933). Forty Common Indian Trees and How to know them. (Available online PDF)
Pascal, J. P. and Ramesh, B. R. (1987). A field key to the trees and lianas of the evergreen forests of the Western Ghats (India). FIP, Pondicherry.
Pradip Krishnen (2013). Jungle Trees of Central India. Published by Penguin Books India Pvt. Ltd. New Delhi.
Randhawa, M. S. (1957). Flowering Trees in India. Sree Saraswati Press Ltd. Kolkatta.
Sahni, K. C. (2000). The Book of Indian Trees. Bombay Natural History Society. Mumbai.
Singh, G. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Fbti 1102 Plant Biochemistry 2 (1+1)

Theory

Chemistry of carbohydrates–classification, mono, di and polysaccharides, anomerism, epimerism, mutarotation, configuration of sugars and inversion. Chemistry of lipids–classification, simple lipids and phosphor lipids. Fatty acids and fat constants, lipids of chloroplast, membranelipids. Chemistry of amino acids, peptides and proteins, classification, levels of protein structure. Chemistry of nucleic acids–bases, sugars, Nucleosides and nucleotides. Structure and function of RNA and DNA. Enzymes –classification, enzyme kinetics, enzyme inhibition, allosteric enzymes, lysozymes, coenzymes. Metabolism of carbohydrates–glycolysis, TCA cycle, HMP shunt, glyoxylic acid cycle, electron transport chain. Lipids metabolism–beta oxidation and fatty acid biosynthesis. Photosynthesis –light reaction, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3 and C4 plants, CO_2 fixation, regulation of photosynthesis. Plant hormones and their mode of action.

Lecture schedule

1. Chemistry of carbohydrates–classification, mono, di and polysaccharides
2. Anomerism, epimerism, mutarotation,
3. Configuration of sugars and inversion.

4-5.Chemistry of lipids–classification, simple lipids and phosphor lipids.

6. Fatty acids and fat constants, lipids of chloroplast, membrane lipids.
7. Chemistry of amino acids, peptides and proteins, classification, levels of protein structure.
8. Chemistry of nucleic acids–bases, sugars, Nucleosides and nucleotides.
9. Structure and function of RNA and DNA.

10-12. Enzymes –classification, enzyme kinetics, enzyme inhibition, allosteric enzymes, lysozymes, coenzymes.

13. Metabolism of carbohydrates–glycolysis,
14. TCA cycle, HMP shunt, glyoxylic acid cycle, electron transport chain.
15. Lipids metabolism–beta oxidation and fatty acid biosynthesis.

16. Photosynthesis –light reaction, dark reaction, Hill's reaction, photorespiration, C4 pathway. C3 and C4 plants, CO_2 fixation, regulation of photosynthesis.
17-18. Plant hormones and their mode of action.

Practical
Qualitative tests for carbohydrates, Quantitative estimation of reducing sugars by DNS method, Quantitative test for total carbohydrates by Anthrone reagent, Qualitative tests for lipids, Determination of Saponification number of oils/fats, Determination of Iodine number of fatty acids, Qualitative tests for proteins/amino acids, Estimation of protein by Lowry's method, Determination of Michaelis constant of enzymes, Estimation of RNA

Practical schedule
1. Qualitative tests for carbohydrates
2-3. Quantitative estimation of reducing sugars by DNS method
4. Quantitative test for total carbohydrates byAnthrone reagent
5-6. Qualitative tests for lipids
7-8. Determination of Saponification number of oils/fats
9-10. Determination of Iodine number of fatty acids
11-12. Qualitative tests for proteins/amino acids
13-14. Estimation of protein by Lowry's method
15-16. Determination of Michaelis constant of enzymes
17. Estimation of RNA
18. Final practical exam

Suggested reading
Conn, E. E. and Stumpf, P.K. (2006). Outlines of Biochemistry, Vth edition. Wiley India (P) Ltd., New Delhi
Nelson, L.D. and Cox, M.M. (2013) Lehninger Principles of Biochemistry. VIth edition. Mc Millan Learning.
Robert, C. B. (1987). Modern concepts in Biochemistry. Allynand BaconInc. London
Salisbury, F. B. and Ross, C. W. (2004). Plant Physiology. Thomson Asia Ptd., Ltd. Singapore.
Taiz, L. and Zeiger, E. (2010) Plant Physiology. Vth edition Sinauer Associates, Inc., Massachusetts
William, H. E. and Daphne, C. E. (2005). Biochemistry and Molecular Biology, Oxford University Press.

Fbti 1203 Plant Physiology 3 (2+1)

Theory
Introduction to tree physiology. Photosynthesis - C3, C4 and CAM plants - Photorespiration - Factors affecting photosynthesis. Respiration - energetics of dark respiration. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency. Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Forest Biomes. Light interactions models of forest canopies - Sun plants and shade plants - shade tolerance. Temperature - temperature influence on forest development - energy budgets - low and high temperature - Physiological adaptations for high temperature - chilling injury. Water stress - Mechanism of drought tolerance and drought resistances - Physiological basis of drought avoidance and tolerance. Water relations of forest trees – Transpiration from forest canopies – Evapotranspiration models of forest stands - Water use efficiency. Salinity stress its effects on tree growth. Resistance to salinity. Forest

and microclimate. Carbon balance and dry matter production in forest trees - Dry matter production and partitioning – source/ sink - . GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S.

Lecture schedule:

1-3. Introduction to tree physiology - Distinction between plant physiology and crop physiology

4-7. Physiological functions and processes in tree- Photosynthesis, Light reaction, Dark reaction - C3, C4 and CAM plants and its pathways of carbon fixation Photorespiration Energetics of photosynthesis and photorespiration - Factors affecting photosynthesis

8-10. Physiological functions and processes in tree - Respiration, - glycolysis - TCA cycle – fermentation - Electron transfer and energetics of dark respiration - Photosynthetic efficiency and respiratory losses

11-12. Physiological functions and processes in tree – Plant-water relations, Concept of water potential - Absorption of water, ascent of sap and water balance

13-14. Stomatal physiology - transpiration gas exchange - porometry - stomatal conductance – resistance

15-17. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency

18-19. Plant growth regulators – occurrence, biosynthesis, mode of action and physiological roles of auxins, cytokinins, gibberellins, ABA and ethylene

20-21. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis - basic principles Components of growth analysis

22-23. Forest biomes – classification

24. Canopy architecture. Light interactions models of forest canopies - Sun plants and shade plants - shade tolerance

25-26. Temperature - temperature influence on forest development - energy budgets Temperature influence - low and high temperature - Physiological adaptations for high temperature - low temperature - chilling injury

27-28. Water stress - Mechanism of drought tolerance and drought resistances - Physiological basis of drought avoidance and tolerance.

29-30. Water relations of forest trees – Transpiration from forest canopies – Evapotranspiration models of forest stands - Water use efficiency.

31. Salinity stresses its effects on tree growth. Resistance to salinity - Calcicoles and calcifuges.

32. Forest and microclimate

33-34. Carbon balance and dry matter production in forest trees - Dry matter production and partitioning – source/ sink - GPP and NPP of forest stands

35-36. Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S.

Practical

Preparation of solutions. C3 and C4 leaf anatomy. Estimation of transpiration using porometer. Estimation of photosynthesis using IRGA. Extraction and estimation of chlorophyll in plants. Estimation of stomatal index.Demonstration of plasmolysis. Estimation of water potential in plants using Plant water status console. Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, LAR- specific leaf area and leaf weight ratio - LAI - CGR – LAD etc… Measurement of moisture stress tolerance parameters in trees - membrane stability, chlorophyll stability, proline content, wax and cuticle thickness. Measurement of relative water content, leaf water potential, osmotic potential. Measurements of stomatal resistance/stomatal conductance under varying stress condition. Observation on tree architecture of important species

Practical schedule

1. Preparation of solutions.

2. C_3 and C_4 leaf anatomy.
3. Estimation of transpiration using porometer.
4. Measurement of radiation using lux meter and quantum sensor.
5. Estimation of photosynthesis using IRGA.
6. Extraction and estimation of chlorophyll in plants, use of SPAD
7. Estimation of stomatal frequency and index.
8. Demonstration of plasmolysis.
9. Estimation of water potential in plants using Plant water status console.
10. Estimation of leaf area of plants.
11. Plant growth analysis – RGR, NAR, LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc.
12. Estimation of LAI using canopy analyser.
13-15. Measurement of moisture stress tolerance parameters in trees - membrane stability, chlorophyll stability, proline content, wax and cuticle thickness.
16. Measurement of relative water content, leaf water potential, osmotic potential.
17. Measurements of stomatal resistance/stomatal conductance under varying stress condition. Observation on tree architecture of important species.
18. Final practical examination.

Suggested reading

Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. John Wiley and sons. New York

Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Science & Business Media, New York

Lambers, H., Chapin, F.S. and Pons,T.L. (2008). Plant Physiological Ecology. IInd edition. Springer Scientific & Business Media inc. New York.

Landsberg , J. and Sands, P. (2011). Physiological Ecology of Forest Production. Principles, Processes and Models. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Management. Academic Press Inc., London.

Nobel, P. S. (2005). Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, Amsterdam

Pallardy, S.G. (2008) Physiology of woody plants. IIIrd edition. Elsevier Inc. Amsterdam

Salisbury, F. B. and Ross, C. W. (2004) . Plant Physiology. Thomson Asia Ptd. Ltd. Singapore.

Taiz, L. and Zeiger, E. (2010) Plant Physiology. 5th edition. Sinauer Associates, Inc., Massachusetts

Fbti 1204 Plant Cytology and Genetics 3 (2+1)

Theory

History of genetics. Pre-Mendelian concepts – preformation – pangenesis. Mendels principles of inheritance – segregation – independent assortment. Cell – structure and functions. Cell organelles. Cell reproduction – mitosis – meiosis and its significance. Gametogenesis and syngamy in plants. Chromosome theory of inheritance. Evidences for chromosome as bearers of genes. Modification to Mendelian inheritance – multiple alleles – codominance – gene interaction – epistasis –pleotrophy – polygenic inheritance – penetrance and expressivity – cytoplasmic inheritance. Linkage and crossing over– cytological consequence of crossing over. Detection of linkage and linkage maps. Sex determination – theories. Sex-linked and other sex-related inheritance. Evidence to prove DNA as genetic material.

Structure of DNA and its replication. Chromosomes – its structure and function. Chromosomal aberrations-numerical and structural. RNA its structure function and types. Cytology of polyploids. Molecular structure of gene. Gene action – protein synthesis. Gene expression and

their functions. Mutation, its classification and uses. Methods of inducing mutations and CIB technique.

Lecture schedule

1. Introduction – history – importance of genetics and cytogenetics.
2-3. Pre-Mendelian concepts of genetics – preformation and epigenesis – pangenesis and inheritance of acquired characters – germplasm theory.
4. Experiments of Mendel – Mendelian laws of inheritance – segregation and independent assortment.
5. Cell – structure and function – cell organelles.
6. Cell reproduction – mitosis and meiosis – significance of the two.
7. Behaviour of chromosome in meiosis – chromosome pairing - crossing over, exchange of segments etc. – theories of crossing over – pachytene analysis.
8. Gametogenesis and syngamy in plants.
9. Relation between chromosomes and genes during gamete production – chromosome theory of inheritance.
10. Modification to Mendelian inheritance – incomplete dominance, over dominance, codominance, multiple alleles, gene interaction, epistasis, maternal inheritance.
11. Polygenic inheritance – pleotrophy – penetrance and expressivity.
12. Linkage and crossing over – detection of linkage – calculation of percentage recombination and distance between two genes – preparation of linkage map.
13. Sex determination in plants – theories of sex determination.
14. Sex-related inheritance - Sex linked, sex influenced and sex limited characters.
15. Evidences to prove that DNA is the genetic material. DNA – chemical properties, physical model of Watson and Crick.
16. Replication of DNA. Difference between DNA and RNA
17. RNA its structure, function and types.
18. Chromosomes – significance of its number and structure
19. Physical structure, karyotype and ideogram
20. Ultrastructure of chromosomes-Folded fibre model.
21. Numerical and structural changes in chromosomes – different types of polyploids, their origin and significance
22-23. Cytology of polyploids. Different types of aneuploids, their origin and significance.
24. Chemistry of chromosomes – molecular model of chromosome
25. Solenoid model.
26. Gene – structure and function.
27. Gene as a unit of inheritance, central dogma of life.
28. Genetic code and its characteristics.
29-30. Protein biosynthesis – transcription and translation, different types of RNA in protein synthesis.
31. Fine structure of gene.
32. Gene expression and their functions.
33. Mutation – spontaneous mutations, their origin and significance.
34. Methods of inducing mutations and CIB technique.
35-36. Induced mutations – physical and chemical mutagens- Importance of induced mutations.

Practical

Study of fixatives and stains. Preparation of slides showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Working out problems related to monohybrid cross, dihybrid cross,independent assortment, linkage, gene mapping, probability and chi-square, multiple alleles etc.

Practical schedule

1-3. Study the principles and preparation of fixatives and stains.
4-8. Preparation of slides for the study of mitosis.
9-11.Preparation of slides for the study of meiosis.
11-17.Working out problems related to monohybid cross, dihybid cross, independent assortment, linkage, gene mapping, probability and chi-square, multiple alleles etc.
18. Final practical examination.

Suggested reading:

Fletcher, H. and Hickey, I. (2012). Genetics (4th ed.). Garland Science, Taylor & Francis, U. K. 371p
Garner, E. J., Simmons, M. J. and Sunstad, P. D. (2008). Principles of Genetics (8th edn.) Wiley India (P.) Ltd., Daryaganj, New Delhi.
Gupta, P. K. (1999). Cytogenetics Rastogi Publishers, Meerut
Strickberger, M. W. (1996). Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi
Tamarin, R. (2002). Principles of Genetics (7th Ed). Tata McGraw-Hill Education.
Timothy L. White, T.L., Adams, W.T. and Neale, D.B. (2007). Forest Genetics, CABI Publishing, Oxfordshire, UK FB

Fbti 2105 Tree Improvement 3 (2+1)

Theory

Introduction – history and development of tree improvement – its relation to other disciplines of forestry. Reproduction in forest trees. Anthesis and pollination – their importance in tree breeding. Incompatibility and sterility. Quantitative inheritance. Relevance in forestry. Genetic, environmental and interaction components of varitation - heritability and genetic advance. Genetic basis of tree breeding. Natural variability in trees – types and importance.- forces that change variability. Exotic forestry. Provenance testing. Selection- seed production areas–seed orchards. Progeny trial and improvement of seed orchards. Combining ability and genetic gain – Hybridization in trees – back cross breeding, heterosis breeding. Breeding for resistance to insect pest's diseases, air pollution and for wood properties. Conservation of forest tree germplasm. Recent techniques in tree improvement. Mutation breeding; Ploidy breeding. Breeding objectives and concepts of breeding in self pollinated cross pollinated and vegetative propagated crops. Breeding of important tree species. Breeding procedures for development of hybrids, / varieties of various crops. DUS testing, Concepts of Geographical indications. Artificial hybrids in trees-crossing in trees-problems and perspectives-crossing hybrids and hybrid breakdown. Hybrid nomenclature in trees- Future of hybrid in applied tree improvement.

Lecture Schedule

1. Tree breeding- introduction - history – its relation with other disciplines of forestry
2. Prospects of tree improvement – special problems associated with tree improvement
3. Reproductive systems in plants – self and cross pollinated species of forest trees
4. Anthesis, pollination and their importance in tree breeding
5. Incompatibility – sterility – significance – mechanisms to prevent self-pollination
6. Genetic basis of tree breeding
7. Quantitative inheritance
8. Components of phenotypic variance – genetic, environment and interaction components
9. Additive and dominant gene action – Heritability - its significance in tree improvement
10. Natural Variability – provenance and seed source – variation between and within stands – between and within trees
11. Ecotypes and clines.

12. Factors affecting variation – mutation, selection, migration, genetic drift
13. Exotic forestry – problems and prospects
14. Selection as a method of breeding – selection of species
15. Provenance testing – range wide and limited range tests – origin of land race
16. Selection from even aged stand - mass selection – comparison tree method
17. Candidate tree – plus tree – elite tree. Selection and genetic gain
18. Selection from uneven aged stand- mother tree selection – regression selection.
19. Seed production area – immediate seed requirement
20. Seed orchard – seedling/ clonal seed orchard – long term seed requirements
21. Genetic testing – need and methods
22. Combining ability – general and specific combining abilities – breeding value – applications.
23. Advance generation selection –Pedigree selection – family and with-in family selection
24. Multi-trait selection – tandem, independent culling and index selection methods
25. Recurrent selection – simple recurrent selection
26. Indirect selection – marker aided selection
27. Hybridization as a method of tree breeding – applications
28. Heterosis breeding, back cross breeding
29. Breeding for disease, pests, and pollution and wood properties.
30. Polyploidy breeding
31. Mutation breeding
32-33.Breeding objectives and concepts of breeding in self-pollinated cross pollinated and vegetative propagated crops
34. Breeding of important tree species. DUS testing
35-36. Artificial hybrids in trees-crossing in trees-problems and perspectives-crossing hybrids and hybrid breakdown. Hybrid nomenclature in trees- Future of hybrid in applied tree improvement.

Practical

Floral biology and phenological observations in some important species. Pollen morphology. Estimation of pollen sterility and viability. Emasculation and hybridization in forest tree species. Different breeding methods – flow chart. Recording observations in provenance trial. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus tree selection – recording data – design and observation in teak, eucalyptus seed orchard.

Practical schedule

1 – 4. Floral biology and phenological observations in some important species.
5 – 6. Estimation of pollen sterility.
7 – 8. Pollen viability studies.
9 – 10. Technique of emasculation in self and cross pollinated crops.
11 – 12. Estimation of genetic advance.
12 – 13. Estimation of heritability, GCA and SCA.
14 – 16. Visit to seed orchards.
18. Final practical examination.

Suggested reading:

Bedell P. E. (2007). Tree Breeding for Genetic Improvement of Tropical Tree Species, Allied Publishers Pvt Ltd., Mumbai.

Surendran, C., Sehgal, R.N. and Parmathma, M. (Eds.) (2003). A text book of Forest Tree Breeding. ICAR, New Delhi.

White, T.L., Adams, W.T. and Neale, D.B. (2007). Forest Genetics, CABI Publishing, Oxfordshire, UK.

Wright, J. (2012). Introduction to Forest Genetics. Elsevier, Amsterdam
Zobel, B. and Talbert, J. (2003). Applied Forest Tree Improvement. Blackburn Press. New Jersey

Fbti 2206 Medicinal And Aromatic Plants 2 (1+1)

Theory:

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, jasmine, patchouli and geranium - botany, climate and soil requirements, planting cultural and manurial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and respective states- history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like Atropa, Cinchona, Rauwolfia, Sandal, Acorus, Digitalis, Strychnos, Aconitum, Neem, Senna, Dioscorea, Costus, Solanum etc. Conservation and regeneration of medicinal plants and trees in the forests like *Gmelina arborea, Terminalia chebula*, *T. bellerica*, *Phyllanthus emblica*, neem. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia*, *Sterospermum colais*, *Plumbago zylanica*, *Tinospora cordifolia, Kaemferia glanga*, *Indigofera tinctoria*. Conservation packages for the medicinal plants collected in wild. Role of NGO's in the conservation of the medicinal plants. Definition and scope of ethno botany. Ethnomethodology- definition origin-theory and methods.

Lecture Schedule

1**.** Definition - role of medicinal and aromatic plants in Indian economy –
2. Important essential oil yielding plants in India - botany, climate and soil requirements, planting cultural and manurial practices - harvesting, curing and extraction of essential oils
3. Detailed study of lemon grass, citronella,
4. Palmarosa, vetiver
5. Japanese mint, eucalyptus
6. Jasmine,
7. Patchouli and geranium –
8. Medicinal plants in India and respective states- history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants : Atropa, Cinchona
9. Rauwolfia, Acorus
10. Sandal, Strychnos, Aconitum
11. Digitalis, Neem, Senna
12. Dioscorea, Costus, Solanum etc.
13. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia*
14. *Sterospermum colais*, *Plumbago zylanica*
15. *Tinospora cordifolia, Kaemferia glanga*, *Indigofera tinctoria*.
16. Conservation packages for the medicinal plants collected in wild. Role of NGO's in the conservation of the medicinal plants.
17-18. Definition and scope of ethno botany. Ethnomethodology- definition origin-theory and methods.

Practical:

Visit to botanical and medicinal garden, Visit to different tribal area to study their ethno-botanical uses. Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Practical schedule

1. Visit to botanical and medicinal garden.
2-4. Visit to different tribal area to study their ethno-botanical uses.
5-10. Identification of medicinal and aromatic plants – propagation techniques.
11-12. Harvesting and oil extraction of aromatic plants.
13-15. Field visit, collection and preparation of herbarium.
16-17. Visiting commercial units of medicinal plants.
18. Final Practical examination.

Suggested reading:

Atul, C. K. and Kapur, B. K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.

Chopra, R. N., Nayar, S. L. and Chopra, I. C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.

Chopra, A. K. Khanna, D.R., Prasad, G., Malik, D.S. and Bhutiani, R. (2007). Medicinal Plants: Conservation, Cultivation and Utilization. Daya Publishing House, New Delhi.

EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction Processes. Engineers India Research Institute, Nai Sarak, Delhi,

Gunther, E. (1975). The essential oils. Robert, K. Krieger Pub. Co., New York.

Jain, S. K. (2010). Manual of Ethnobotany (2nd Ed). Scientific Publishers, India,

Khan, I. A. and Khanum, A. (2005). Medicinal and Aromatic Plants of India; Herbal Wealth for Human Health (1st Ed). Ukaaz Publications, Hyderabad.

Muralia, S. (2006).Medicinal and aromatic plants (1st Ed).Neha Publishers & Distributors, New Delhi

Fbti 2207 Clonal Forestry 2(1+1)

Theory

Clonal Forestry – definition - Basic concepts in clonal forestry –operational use – advantages of clonal forestry- constraints – Selection of CPTs – Propagation methods- auto and hetero propagation methods – rooting of cutting, grafting, layering, budding- micro-clonal propagation methods – Factors controlling propagation . Plant growth substances – Auxins – cytokinins – gibberellins – ethylene – preparation of powder and liquid formulations – Applications in clonal multiplication. Propagation structures – types of Green house – Polytunnels – Mist Chambers – Shade house – Mini garden – Concepts – Method of establishment – Hedge garden - Management of mini and hedge clonal garden – Clonal Multiplication Area (CMA) – Clonal Testing Area (CTA) – Designs of clonal evaluation – Amplified clonal test – Clonal plantation establishment- management strategies – Problem and constraints in clonal forestry – Tophophysis – Plagiotorphic and orthotrophic response – Tophophysis – Cyclophysis – Periphysis

Lecture schedule

1. Clonal forestry – Basic concepts in clonal forestry
2. Scope – Limitations – Operational use – Number of clones – Clonal Deployment.
3. Potting media – Types – Physical and chemical properties – Organic and inorganic components – Vermiculite – Perlite – Styrofoam
4. Plant growth substances – Auxins – Cytokinins –
5. Plant growth substances - Gibberllins – Other chemicals – Their role in clonal propagation
6. Propagation methods – Rooting of cuttings – Types – Preparation of cuttings and treatment – Factors
7. Propagation Methods Grafting – Layering – Budding- Different methods
8. Micro propagation – methods – advantages and disadvantages

9. Propagation structures – Green house – Mist chambers – Green house glazing materials – Glass – Flexible and rigid plastics – Performance and cost factors.
10. Establishment of hardening chamber/shade house– Sanitation – Care- Maintenance.
11. Design and structure of Green house and Shade house – Sanitation – Care – Maintenance
12. Hardwares in clonal propagation – Root trainers –Types – Advantages and Disadvantages – Tools and equipment's – Grafting machines
13. Clonal multiplication area – Establishment – Maintenance – Mass multiplication – Hardening– Grading – Quality Standards.
14. Miniclonal garden – Establishment – Care and management – Irrigation and Fertigation management
15. Clonal testing area – Establishment – Care – Maintenance – Evaluation –
16. Design of CTA – Amplified clonal test.

17-18. Problems and constraints in clonal forestry – Abnormal growth – Plagiotorphic and orthotrophic response – Tophophysis – Cyclophysis – Periphysis

Practical

Clonal nursery – Study of propagation methods –- Propagation Chambers – Mist chamber – Green house – Cost of establishment – Root trainer technology – Establishment of low cost polytunnels – Cost of establishment and management – Establishment of CMA and CTA – Clonal evaluation – Visit to clonal forests

Practical schedule

1. Design and layout of clonal nursery-requirement of facilities and equipments
2. Study of propagation methods – Exercise with rooting of cutting- Teak-Rosewood- Melia
3. Mini Clonal multiplication – Mini garden and mass multiplication – exercise with tree species
4. Propagation method – Exercise with grafting of trees species
5. Clonal hedge management – Juvenility induction – Pruning and other management practices
6. Exercise with layering of different species-sandal
7. Study of propagation chambers – Mist chamber – Green house – Cost of establishment
8. Establishment of low cost poly tunnels
9. Root trainer technology – Exercise with propagation using root trainers
10. Cost of establishment and management of propagation chambers
11. Establishment of CMA for tree species
12. CTA – Establishment – Care and maintenance

13-15. Clonal evaluation – design of establishment-Problems using biometric approaches

16. Visit to clonal forests
17. Economics of clonal forestry
18. Final Practical Examination.

Suggested reference

Ahuja, M.R. and Libby, W.J. (Eds.) (1993). Clonal Forestry I- Genetics and Biotechnology. Springer- Verlag., Berlin

Ahuja, M.R. and Libby, W.J. (Eds.)(1993) Clonal Forestry II: Conservation and Application. Springer- Verlag., Berlin

Hartman, H.T., D.E. Kester, F.T. Davies and R.L. Geneve. (2010). Hartmann & Kester's Plant Propagation: Principles and Practices. Prentice- Hall of India Pvt. Ltd., New Delhi.

Parthiban K.T., Paramathma, M., Neelakantan, K.S. (2004). Clonal Forestry. TNAU Publications, Coimbatore.

Surendran, C., K.T. Parthiban, K. Vanagamudi and S. Balaji. (2000). Vegetative propagation of trees- Principles and Practices. .FC&RI Publication, Mettupalayam.

Zobel, B. and J. Talbert. (1991). Applied Forest Tree Improvement. John Wiley and Sons, New York.

Fbti 3208 Forest Biotechnology 3(2+1)

Theory

Concepts and history of Plant Biotechnology: Scope and importance in tree improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of in-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above *in-vitro* culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids,. Applications in tree improvement. Secondary metabolite production. Conservation of germplasm through tissue culture techniques Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants. their applications , achievements and biosafety regulations, Blotting techniques – DNA finger printing and bar coding – DNA based markers – RFLP, AFLP, RAPD, SSR , VNTRS,CAPS, SNPs, ESTs and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in tree improvement. Bio-safety rules and regulations – Intellectual Property Rights – concepts, trade related aspects. Protection of plant and animal genetic resources, biological materials, gene patenting.

Lecture schedule

1. Introduction to plant biotechnology – scope in tree improvement
2. History and development of plant tissue culture and genetic engineering
3.Concept of totipotency and morphogenesis – differentiation, dedifferentiation and organogenesis
4-5. Nutritional requirements of in vitro culture
6. Different methods of plant tissue culture
7.Scope of plant tissue culture in agriculture and forestry: micropropagation –different routs
8.Haploid plant production – pollen, anther and ovule culture
9-10. Overcoming incompatibility and distant hybridization: *in vitro* fertilization and embryo culture
10.Somaclonal variation – definition, reasons and applications, *in vitro* mutagenesis
11.Protoplast isolation, culture and fusion, cybrids
12.Secondary metabolite production under *in vitro* conditions
13. Somatic embryogenesis, synthetic seed production technique and applications
14.Conservation of germplasm through tissue culture techniques
15.Factors affecting *in vitro* culture
16-17. Plant genetic engineering – principles and general strategy
18.Restriction enzymes and their mode of action
19.Artificial synthesis of gene – gene library, cDNA library
20.Cloning vectors in RDT – plasmids, phages, cosmids, single stranded DNA phages, BACs, YACs etc.
21. Gene cloning – general strategies and enzymes
22.Gene transfer in plants – direct methods
23-24. Indirect method of gene transfer – *Agrobacterium tumifaciens*, Ti plasmid, T-DNA transfer and integration
25-26. Production of transgenic plants – screening of transformants – GUS assay, PCR, RTPCR, southern blotting and northern blotting, electrophoresis, autoradiography
27-28. Genetic finger printing – different methods – RAPD, RFLP, AFLP, SSR, VNTRS,CAPS, SNPs, ESTs and DNA Probes
29. Marker assisted selection, mapping of QTL and molecular breeding, achievements and future prospects
30. Scope of biotechnology in forest tree improvement

31-32. Bio-safety rules and regulations – rules related to GM crops-research, development, field trials, and commercial cultivation.
33-34. Intellectual Property Rights – concepts, trade related aspects. IPR and international trade - WTO, WIPO, GATT, TRIPS.
35-36. Protection of plant and animal genetic resources, biological materials, gene patenting.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis technique

Practical schedule

1. Requirements for Plant Tissue Culture Laboratory.
2. Media components and preparation of stock solutions. Preparation and sterilization of media.
3-5. Aseptic manipulation and inoculation of axillary bud of various forest tree species.
6-7. Callus induction and plant regeneration.
8-9. Anther culture.
10-11. Embryo culture.
12. Somatic embryogenesis and synthetic seed production.
13. Hardening / Acclimatization of regenerated plants.
14. Demonstration of isolation of protoplast.
15. Demonstration of gene transfer technique.
16. Demonstration of Confirmation of Genetic transformation.
17. Demonstration of gel-electrophoresis technique.
18. Final practical examination.

Suggested reading

Bajaj, Y. P. S. (Ed) (1988). Biotechnology in Agriculture and Forestry. Springer-Verlag, Berlin.

Bajaj, Y. P. S. (Ed) (1989). Biotechnology in Agriculture and Forestry - Trees 2. Springer-Verlag, Berlin.

Bajaj, Y. P. S. (Ed) (1991). Biotechnology in Agriculture and Forestry - Trees 3. Springer-Verlag, Berlin.

Bajaj, Y. P. S. (Ed) (1996). Biotechnology in Agriculture and Forestry - Trees 4. Springer-Verlag, Berlin.

Dhawan, V. (2012) Applications of Biotechnology in Forestry and Horticulture. Springer US, New York

Guptha, P. K. (2000). Elements of Biotechnology. Rastogi publications, Meerut.

Kumar, A. and Sopory, S. K. (2008) Recent Advances in Plant Biotechnology and Its Applications. I. K. International Pvt Ltd, New Delhi

Punia, M. S. (1998). Plant Biotechnology and Molecular Biology. A laboratory manual. Scientific Publishers, Jodhpur.

Thieman, W. J. and Palladino, M. A. (2009). Introduction to Biotechnology, Second Edition. Pearson Benjamin Cummings, San Francisco.

DEPARTMENT OF NATURAL RESOURCE MANAGEMENT (Narm)

Narm 1201 Forest Survey & Engineering 3 (2+1)

Theory

Forest survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain on sloppy grounds, chaining across obstacles; cross staff surveying, Areas of irregularly bounded fields- different methods; Simpson's, trapezoidal rule, Average ordinate method; compass surveying, chain and compass traversing, magnetic and true bearing, prismatic compass, local attraction. Computation of interior angles and balancing of closed traverse. Plane table surveying; Leveling: terms used types of level. Theodolite and its uses. Contour surveying. Buildings materials- types, strength and characteristics, site selection for building construction, forest roads- alignment, construction and drainage; retaining walls, breast wall, water ways and culverts; bridges-types, selection of site, simple wooden beam bridge, check dams, spurs, farm ponds, earth dams.

Lecture schedule

1. Introduction–uses of surveys–principles of surveying–scope of surveying in forestry.
2. Measurement of distances – direct measurement – instruments used- chain surveying – types of chains and accessories.
3-4.Areas of irregularly bounded fields- different methods; Simpson's, trapezoidal rule, average ordinate method.
5-6.Methods of recording and plotting- chain and compass traversing – measuring angles.
7.Bearing of lines – true meridian – magnetic meridian – arbitrary meridian.
8. Designation of bearings – calculation of angles from bearings.
9-10. Local attraction- correction of local attraction- methods.
11. Plotting a traverse survey – different methods
12-13. Closing error – and its graphical adjustments.
14.Plane table surveying– accessories– advantages and disadvantages of plane table surveying.
15.Methods of plane tabling–radiation, intersection and traversing–Application in forestry.
16.Leveling – terminology –types of leveling- leveling instruments – types of accessories.
17.Principles of leveling.
18-20. Reduction of levels – collimation method and rise and fall method.
21-25. Forest roads – types – design – cross section- alignment-Levelling (Profile and cross section) – drainage.
26-29. Quantity calculation.
30-32. Retaining walls– embankments – road maintenance – wooden bridges check dams, Spurs, farm roads, earth dams.
33-36. Theodolite surveying – study of instruments, terminology – measurement of horizontal and vertical angle

Practical

Chain surveying, compass traversing; plane table surveying, leveling, calculations of earth work for construction of forest; roads & earth dams; alignment of forest roads; preparation building plans; design of water ways; design of simple wooden beam bridge; design of retaining walls. Design of check dams.

Practical schedule

1. Study of chain survey instruments.
2. Chain survey of an area.

3. Cross Staff surveying
4. Problems on Simpson's and Trapezoidal rule.
5. Study of angle measuring instruments.
6. Chain and compass traversing.
7. Study of plane table and accessories.
8-9. Plane table surveying of an area.
10. Study of leveling instruments.
11-12. Estimation of reduced level.
13. Theodolite surveying
14. Computation of areas – problems.
15. Visits to construction sites and understanding different stages of construction and details of reinforcements.
16. Problems of estimating and costing – M book reading.
17. Preparation of road estimate and earth work calculations. Problems on road estimating
18. Final practical examination

Suggested reading

Kanetkar, T.P. and Kulkarni, S.V. (2010). 24th edition. Surveying and levelling. Vidyarthi Griha Prakashan, Pune.
Masani, N.J. (2006). Forest Engineering - without tears (2nd edition). Natraj Publishers, Dehra Dun.
Murthy, V.V.N. (2011).6th edition. Land and water management engineering. Kalyani Publishers, New Delhi.
Parkash, R. (1983). Forest Surveying, International Book Distributors.
Punmia, B.G. (2005). 16th edition. Surveying Vol I. Laxmi Publishers, New Delhi.
Sahani, P.B. (1979). Text Book of Surveying Vol. I & II. Oxford and IBH, New Delhi.

Narm 2102 Environmental Studies and Disaster Management 2 (1+1)

Theory

Environmental studies Definition, scope and importance, Natural Resources, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Ecosystems-Concept of an ecosystem, Structure and function of an ecosystem, Biodiversity and its conservation, Value, Environmental Pollution, Solid Waste Management, Social Issues, Environmental ethics, Wasteland reclamation, Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Issues involved in enforcement of environmental legislation. Public awareness, Environment and human health, Natural Disasters, Climatic change, Man Made Disasters, Disaster Management.

Lecture schedule

1. Multidisciplinary nature of environmental studies Definition, scope and importance-Natural Resources: Renewable and non-renewable resources Natural resources and associated problems.
2-3. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
4. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
5. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

6. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
7. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.
8-9. Environmental Pollution: definition, cause, effects and control measures of Air pollution Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards - Solid Waste Management: causes, effects and control measures of urban and industrial wastes.
10. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies- Environment and human health: Human Rights, Value Education, HIV/AIDS.
11-12. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.
13-14. Natural Disasters- Meaning and nature of natural disasters, their types and effects - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves
15-16. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.
17. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction.
18. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response

Practical

Field work: Rapid environmental appraisal of problem areas - Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, Study and documentation of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Practical Schedule:

1-5. Rapid environmental appraisal of problem areas- collection of basic data on climate, soil, water quality – social and economic impact etc.
6- 8. Visit to a local area and field work to document environmental assets river/ forest/ grassland/ hill/ mountain, v
9-10. Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural
11-12. Study and documentation of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.
13- 17. Visit to disaster sites to study the impact- assessment of environmental, social and economic impact of natural disasters.
18. Final practical examination

Suggested reading:

Gupta, H.K. (2003). Disaster Management. Indian National Science Academy. Orient Blackswan.
Hodgkinson, P.E. and Stewart, M. (1991). Coping with catastrophe. Handbook of Disaster Management. Routledge.
Sharma, V.K. (2001). Disaster Management. National Centre for Disaster Management, India.

Narm 2103 Forest Ecology 2 (1+1)

Theory

Historical development of ecology as a science, Levels of biological organization, Forest types of India-Champion and Seth; Forests of W. Ghats- Meher Homji-Forest ecosystem - abiotic and biotic components and their interaction, Nutrient cycling, global production decomposition-trophic levels, food webs, ecological pyramids and energy flow, Population ecology - definition, population dynamics and carrying capacity, Community ecology- species interactions, ecological succession, terminology, basic concepts, theories of succession- climax vegetation types, forest management and succession, Population dynamics– community dynamics- Qualitative and quantitative analysis of communities- Measurement of diversity.

Lecture Schedule

1. Historical development of Ecology - scope of ecology, approaches.

2-3. Classification of Forest types- Major forest types of India by Champion Seth. Major forests types of Western Ghats by Meher Homji.

4-5. The ecosystem -concept and structure of ecosystems- classification of ecosystems. Trophic structure and ecological pyramids, complexity theory, and the concept of carrying capacity.

6-7. Nature and stability of ecosystems, examples, and Energy in ecological cycle - fundamental concepts - the entropy law- energy partitioning, and optimization.

8-9. Concept of productivity, food chains, food webs and trophic levels and methods for estimating primary productivity- Global production and decomposition.

10-11. Biogeochemical cycles - nutrient cycling, pathways and nutrient budgets.

12-13. Auteoclogy - Population dynamics, Population structure, Population in communities - types of interactions.

14. Communities in geographical gradients- association vs. continuum concepts, ecotones, edge effect, and ordination techniques - Concepts of habitat, ecological niche, guild and species diversity.

15-16. Community dynamics - succession, pioneer, and climax communities - Succession theories.

17-18. Qualitative analyses of communities – Raunkiers system of classification – Structural analysis of communities – species area curve method – transect and quadrate - density- abundance - frequency- dominance and IVI - Diversity -–Measurement of diversity - diversity indices

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition - 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.

Practical schedule

1. Study the world map of climatic regions and vegetation
2. Study the map of India showing climatic regions and vegetation

3-6. Phyto-sociological analysis. Vegetation sampling - line transect method -quadrant method, species area curve- profile diagram

7-10. Field visits to study vegetation changes along environmental gradients

11-17. Field visits to study different ecosystem types

18. Final Practical Examination

Suggested reading

Frankel, O.H., Brown, A.H.D. and Burdon, J.J. (1995). The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p.

Michael, P. (1984). Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p.

Misra, K.C. (1974). Manual of Plant Ecology. Oxford &IBH Pub Co. New Delhi etc. 491p

Montagnini, F. and Jordan, C.F. (2005). Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.

Odum, E.P. (1983). Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p.

Pascal, (1980). Wet evergreen forests of Western Ghats. FIP.

Sagwal, S.S. (1995). Forest Ecology of India. Pioneer Publishers, India. 368p.

Narm 2104 Forest Entomology 2 (1+1)

Theory

History and importance of Forest Entomology in India. Classification of insect pests of forests: types of damages and symptoms. Principles and techniques of Integrated Pest Management in forests: Mechanical, physical, silvicultural, legal, biological and chemical. Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest (*Tectona, Dalbergia* sp., *Albizia* sp., Sandal, *Gmelina*, *Terminalia*, deodar, sal, pines etc); Plantation forest species (eucalyptus, bamboo, Ailanthus). Insect pests of freshly felled trees, finished timbers and their management. Insects of commercial value-honey bees and apiculture; silk- worms and sericulture, lac insect and lac culture.

Lecture schedule

1. History and importance of Forest Entomology in India.
2-3. Classification of forest pests: types of damages and symptoms.
4. Principles and techniques of Integrated Pest Management in forests
5. Mechanical, physical and silvicultural management methods
6. Biological management of insect pests
7. Chemical management of insect pests
8-11. Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest (*Tectona grandis, Dalbergialatifolia.*, *Albizia* sp., Sandal, *Gmelina arborea*, *Terminalia* sp., deodar, sal, pines etc).
12-14. Insect pests of major plantation forest species (eucalypts, bamboo, *Ailanthus*).
15. Insect pests of freshly felled trees and finished timbers and their management.
16-18. Insects of commercial value-honey bees and apiculture; silk- worms and sericulture, lac insect and lac culture.

Practical

Types of damages caused by insect pests. Insect pests of forest seeds; forest nurseries; standing trees; freshly felled trees and finished products. Visit to forest nurseries and plantations. Studies on various species of bees; silkworms and lac insect. Insecticides and their formulations, plant protection appliances.

Practical schedule

1-2. Types of damages caused by insect pests.
3-9 Identifying major insect pests of forest seeds, forest nurseries, standing trees, freshly felled trees and finished products.
10-12. Visit to forest nurseries and plantations to identify pests and understand their management options in actual field condition.
13-15. Understanding various species of bees; silkworms and lac insect.

16-17. Insecticides and their formulations, use of plant protection appliances.
18. Final Practical Exam

Suggested Reading

Beason CFC (1941) The Ecology and Control of Forest Insects of India and adjoining countries. Govt. of India, New Delhi.

BerrymanA.A(1986). Forest insects-Principles and practices of population management. Plenum Press, New York & London

David J.H. (1988). Ecological approach to pest management. The Guilford Press, London

Graham S.A and Knight F.B (1965) Principles of Forest Entomology. Mc Graw-Hill, New York.

Mathews G.A (1984). Pest Management. Longman, London.

Nair, M. R. G. K. (1975) Insects and mites of crops in India ICAR, New Delhi. p 404

Nayar K.K, Ananthakrishnan T.N and David B.V. (1985) General and applied Entomology. Tata McGraw-Hill Publishing co. Ltd. New Delhi.

Nair, K.S.S., Sharma, T.K. and Varma, R.V. (Eds) (1996). Impact of diseases and insect pests in tropical forests. Kerala Forest Research Institute, Peechi, Thrissur, Kerala.

Nair, K. S. S. (2007). Tropical forest insect pests – ecology, impact and management. Cambridge Univ. Press, UK.p 393

Vasantharaj D. B. (2001) Elements of Economic Entomology. Popular offset, Chennai.

Wang Haojie, Varma, R.V. and Xutiansen (1998). Insect pest of bamboos in Asia. ISBN, New Delhi

Narm 2205 Forest Management 3 (2+1)

Theory

Definition, scope, objective and principles of forest management, organization of state forests sustained yield-definition, principles and limitations.Sustainable forest management-criteria and indicators-Increasing and progressive yields-Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation.Normal forest-definitions basic factors of normality.Factors governing the yield and growth of forest stands-Working plan-preparations-objectives and uses-forest maps and their uses.Joint forest management-concept and principles- Modern tools in forest management. Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry-Forests and man- Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups-.Social Forestry- definition –NCA report of 1976- need and purpose-Social Forestry for – fodder production – fuel wood – leaf manure –timber production. Integrated rural development approach – with proper marketing facility – employment generation in raising, tending and harvesting of tree crops. Place of social forestry in the national forest policy of India-role of forest department-Gender dimensions in FM, Introduction to the concept of SFM and multiple use forest management

Lecture Schedule

1. Introduction to forest management – scope, importance and objectives – Principles of Forest Management

2-4. History of forest management in the state and in the country- Gender dimensions in FM

5-9. Forest Organization – Ecological classification– Functional classification– Legal classification– administrative classification (national and state level)- Silvicultural and territorial classification

10-12. Sustained yield– importance and definitions–Advantages of sustained yield -Sustainable forest management-criteria and indicators-Increasing and progressive yields- Rotation – definition – importance in modern forestry – different kinds of rotations
13-15. Factors affecting length of rotations – Increment percentage – methods of computation of increment-
16-17. Normal forests – regular and irregular forests – Factors governing normality – unique features
18-19. Increment – definition- CAI-MAI-Pressler's formula-Schnieder's formula-Increment percent-rate of growth- quality and price increment- determination of increment
20-23. Distribution of age gradation and age classes- The growing stock- concept and definition- methods of determination- Normal Growing Stock concept – estimation in clear felling system, uniform regular shelterwood system and selection system - real and theoretical growing stock- relationship between growing stock and yield
24. Forest maps – Different types – methods of preparation and uses
25-28. Working Plan –definition and importance – Methods of preparation of working plans and their uses-NWPC 2014.
29. Community forest- scope and relevance-developing community support- conflict management and decision making - consensus decision making-gender dimensions.
30-31. Principles of community involvement and participation - transparency and meaningful involvement-management and operational plans-Certification issues.
32. Evolution of the concept of Social Forests- NCA Report 1976-Social Forestry in India-success and failures-case studies-farm forestry
33-35. Co-management practices in forestry-concept, regulations and organizational aspects. Micro plan preparation- JFM/PFM - discussion of case studies pertaining to problems and prospects of JFM.National Schemes pertinent to Community Forestry-Conservation of biodiversity outside forest areas-concept.
36. Introduction to SFM and multiple use forest management.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan.

Practical schedule

1-3. Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber.
4-6. Visit to forest department to study forest organizational set up, study forest range administration-territorial, wildlife, and forest depots.
7-8. Visit to forest plantation- Working Plan field exercises. .
9. Field visit to JFM operational areas.
10-13. Visit to Working Plan Division- field exercises for data collection for working plan in natural forest
14-16. Exercise on assessment of growing stock and stock mapping.
17. Visit to Kerala Forest Development Corporation and study organizational and management procedures
18. Final practical examination

Suggestedreading

Balakathiresan, S. (1986).Essentials of Forest Management, Nataraj Publishers, Dehra Dun.
Bhattacharya, P., Kandya, A.K. and Krishnakumar (2008). Joint Forest Management in India, Aavishkar Publisher, Jaipur.
Desai,V.(1991).Forest Management in India–Issues and Problems. Himalaya Pub. House, Bombay.
Edmunds, D and Wollenberg, E. (2003). Essentials of Forest Management, Natraj Publishers, Dehra Dun.
National Working Plan Code (2014). MoEF, NewDelhi.
Osmaston, F.C. (1984). The management of Forests, International Book distributors, Dehra Dun, India, 384 p.
Prakash, R. (1986).Forest Management, International Book distributors, Dehra Dun, India, 256p.
Recknagel, A.B. and Bentley, J. (1985). Forest Management. International Book distributors,Dehra Dun, India, 269p.

Narm 2206 Forest Pathology 2 (1+1)

Importance of forest pathology, land marks-Fungi, Definition, nutrition, reproduction and classification - Causes and symptoms -, losses due to forest tree diseases, root diseases (wilt, root-rot), stem diseases, heart rots, stem blisters, rusts, cankers, pink diseases, gummosis and foliar diseases (rust, powdery mildew, leaf spot, needle blight etc.), Diseasesof *Tectona grandis, Casuarina equisetifolia, Bamboos, Mahogany, Gmelina arborea, Dalbergia latifolia , Bombax ceiba, Acacia auriculiformis, A.mangium,Pinus roxburghii, Grevillea robusta*- etiology, symptoms, mode of spread, epidemiology and management including chemical, biological, cultural and silvicultural practices. Nursery diseases of above tree species - their management - chemical, biological, cultural practices.Pathogens affecting timber - Timber decay, white fibrous rot, white pocket rot, brown cuboidal rot, dry rot - their management. Beneficial fungi of forests -Mycorrhizal association of forest trees, their importance in disease management - Edible mushroom from forests and their ecology differentiating characters of edible and poisonous mushrooms. Disease due to physiological causes.

Lecture Schedule

1-2. Introduction - importance of forest pathology - land marks losses due to forest tree diseases- Principles of forest pathology - general account- Definition of general phytopathological terms, infection, pathogenesis, virulence etiology etc.
3. Causes of forest diseases - physiological and pathological General symptoms of forest tree diseases
4-5. Fungi - definition - general morphological characters of fungi -Reproduction of fungi - sexual and asexual- Classification of fungi
6-9. Principles of control of forest diseases - plant quarantine- Cultural control of forest diseases - Chemical control of forest diseases- Biological and silvicultural methods of control of forest diseases- concept of IDM
10-15. Diseases of - symptoms, etiology, mode of spread, epidemiology and management practices of important nursery-seedling-plantation- root, stem and foliage diseases of important tree crops –*Tectona grandis,, Ailanthus triphysa, Santalum album, Casuarina equisetifolia, Cassia fistula, Bamboos, Swietenia macrphylla, Gmelina arborea, Dalbergia latifolia , Bombax ceiba, Acacia auriculiformis, A.mangium, Terminalias* and *Grevillea robusta*
16. Pathogen affecting timber – symptoms-Different types of timber ecology-Management of pathogen causing timber decay
17. Beneficial micro and macro fungi of forest – mycorrhiza -Different mycorrhizal association - its role in disease management

18. Ecological and economic importance of polypore, Edible fungi of forest, their ecology, mushroom cultivation

Practical:
Observation of symptoms in laboratory and in forests - examination of scrapings host-parasite relationships causal organisms of above forest diseases. Examination of cultures of important pathogens. Students will submit a collection of minimum 15 diseased specimens of important forest trees visit to nurseries and plantations.

Practical schedule
1. Study of morphological characters of fungi
2. Reproduction in fungi- microscopic observation of sexual and asexual reproductive structures in fungi
3. Familiarisation of general symptoms of forest diseases-field visit
4. Familiarisation of physiological diseases of forest trees- field visit
5. Familiarisation of common fungicides
6. Preparation of Bordeaux mixture, Bordeaux paste, chest nut compound etc
7-15. Study of symptoms, causal organisms, host parasite relationship of representative disease of *Tectona grandis, Santalum album, Casuarina equisetifolia,, Bamboos, Swietenia macrphylla, Ailanthus triphysa Gmelina arborea, Dalbergia latifolia, Acacia auriculiformis, A.mangium, & Grevillea robusta* and soft wood sps.
16. Mycorrhiza- detection of mycorrhizal association in forest plant by visual and microscopic methods
17. Mushrooms-familiarisation of edible and poisonous mushroom-Mushroom cultivation
18.Final practical examination

Suggested reading:

Agrios, G.N. (2006). Plant Pathology.5th edition, Elsevier Academic press., California, USA, 922 p.

Bakshi, B.K. (1976), Forest Pathology; Principles and Practices in Forestry. Pub. Comptroller of Publications, New Delhi. 400 p.

Boyce, J.S. (1961). Forest Pathology, 3rd edition. McGraw-Hill, New York, 572 p.

Devasahayam, H.L. and Henry, L.D.C. (2009).Illustrated Plant Pathology- Basic Concepts.New India Publishing Agency, New Delhi, 470p.

Dube, H.C. (2015). An introduction to Fungi, 4th edition, Scientific publishers, New Delhi, India, 603 p.

Leelavathy, K.M. and Ganesh, P.N. (2000).Polypores of Kerala. Daya Publishing house, New Delhi, India, 166p.

Mohanan, C. (2011). Macro fungi of Kerala, KFRI, Peechi. 597 p.

Narm 3107 Forest Hydrology and Watershed Management 3 (2+1)

Theory
Importance and scope of Hydrology. Definitions- Hydrological cycle. Energy and water balance equations-precipitation- rain and snow hydrology. Interception, infiltration, evaporation and transpiration- paired water sheds, surface water, run off processes and hydrograph. Soil water energy concept, movement, availability and measurement. Watershed management- an approach for sustainable productivity-principles and practices- Methods for water conservation-water harvesting techniques. Role of trees in water conservation- natural terracing- species suitability- Recharging of water springs. Forest treatment and water yield. Application of GIS in watershed delineation.

Lecture Schedule

1-2. Introduction and scope of hydrology
3-4. Hydrological cycle
5-6. Water and energy cycles, energy balance and water balance
7. Atmospheric moisture and precipitation – uplift mechanisms and forms-Definition and history of watershed management
8. Land capability classification
9-10. Drainage basin morphology
11-12. Watershed management- an approach for sustainable productivity- principles and practices
13-14. Precipitation measurement in forested watersheds- problems, storm analysis, calculating precipitation on area basis, infiltration
15. Interception and factors affecting it
16-17. Sub-surface water- classification of weathered mantle, water in the soil, water content measurement,
18-19. Energy of water in the soil, relation between water content and energy, soil water movement, soil water terminology
20-21. Infiltration and percolation-factors affecting, measurement
22. Ground water- definitions, forest and ground water
23-24. Evapotranspiration- evaporation as process, conditions necessary to sustain evaporation
25. Transpiration- plant water energy status, factors affecting and measurement.
26-27. Estimating evapotranspiration- watershed balance, lysimetry, paired watersheds, soil moisture plots and meteorological approaches, effects of forest cutting on water yield
28. Surface water, stream flow and hydrograph
29-30. Erosion and sedimentation in relation to forests.
31-33. Forest treatment and water yield, Forests and water quality, management for erosion control. Methods for water conservation- water harvesting techniques.
34. Role of trees in water conservation- natural terracing- species suitability. Recharging of water springs.
35-36. Application of GIS in watershed delineation

Practical

Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Visit to forest watersheds to study the effect of forest treatment on hydrological properties. Assessment of the impact of watershed treatments such as afforestation/restocking, assisted regeneration etc. on the watershed functioning- field layout- regeneration assessment- interpretation of results.

Practical schedule

1-3. Study of various hydrological equipment
4. Measurement and analysis of rainfall data
5-6. Estimation of runoff using rational formula
7. Preparation, use and analysis of hydrograph
8-10. Measurement of evaporation by different methods
11-12. Determination of soil moisture content
13. Measurement of infiltration using ring infiltrometer
14-15. Study of different water harvesting structures
16. Visit to various forest watersheds to study the effect of forest treatment on hydrological properties

17. Assessment of the impact of watershed treatments such as afforestation/ restocking assisted regeneration etc. on the watershed functioning- field layout regeneration assessment-interpretation of results
18. Final practical examination

Suggested reading

Bennet, H. H. (1955). 2nd edition. Elements of Soil conservation. McGraw Hill Book Co. Inc. New York.

Dhruva Narayana, V. V. (1993). Soil and Water Conservation Research in India, ICAR, New Delhi.

Dhruva Narayana, V. V., G. Sastry and U. S. Patnaik. (1997). Watershed Management. Indian Council of Agricultural Research, New Delhi, 176 p.

Singh, G., Joshi, P.B., Sastry, G., Venkataraman, C. (1999). Manual of Soil and Water Conservation. Oxford IBH Publishing Co. New Delhi.

Hamilton, L. S. (1983). Tropical Forested Watersheds: hydrologic and soils response to major uses or conversions. International Book Distributors, Dehra Dun.

Hamilton, L.S. (ed.). (1983). Forest and Watershed Development and Conservation in Asia and the Pacific. International Book Distributors, Dehra Dun.

Hewlett, J.D. and Nutter, W.L. (1969). An Outline of Forest Hydrology. University of Georgia Press, Athens 132p.

Hudson, N. (1981). Soil Conservation. BT Batsford Limited, London 324 p.

Lal, R. (2000). Integrated Watershed Management in the Global Ecosystem. CRC Press, London.

Michael, A.M. (2008). Irrigation theory and practice, Vikas Publishing House Pvt Ltd. 768p.

Morgan, R.P.C. (2005). 3rd edition. Soil Erosion and Conservation. English Language Book Society, Longman, London.

Murthy, V.N.N. (2011). 6th edition. Land and Water Management Engineering, Kalyani Publishers, New Delhi.

Rama Rao, M.S.V. (1974). Revised edition. Soil Conservation in India, ICAR, New Delhi.

Riedl, O. and Zachar, D. (1984). Forest Amelioration. Elsevier, Amsterdam.

Sutterlund, D.R. (1992). 2nd illustrated edition. Wildland Watershed Management, The Ronald Press Company, New York.

Seshagiri Rao, K. V. (2014). Watersheds, Comprehensive Development. B. S. Publications, Hyderabad.

USDA (1961). A Manual on Conservation of Soil and Water. Oxford and IBH Publishing Company.

Narm 3108 Forest Protection 2 (1+1)

Introduction – importance of protection in Indian forestry – classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires – fire prevention activity – fire suppression – fire-fighting equipment – fire control policy and objectives. Fire fighting in other countries. Injury to forest due to man, lopping – cutting for fuel wood – Encroachment-different types, control of encroachment- illegal felling of trees- method of control legislation. Major Forest weeds and their management, management of woody climbers, parasites and epiphytes-Forest Health-introduction to the concept and its importance.

Lecture Schedule:

1. Introduction– Importance of protection in Indian forestry– classification of injurious agencies
2. Forest fires – causes – classification and characteristics – fire in various forest

ecosystems – natural and man-made – impact of fire on forest ecosystem.
3. Fire management – prevention and suppression – various strategies
4. Tools for fire fighting
5. Fire-fighting in other countries – integration and co-operation of forest dwellers and nearby communities.
6. Extension activities – modern methods of fire control
7-8. Removal of timber and non-timber resources by man
9. Illegal felling and fuel wood collection – lopping – collection of non-timberproduce
10-11. Encroachment – extent and causes – historical reasons – shifting cultivation and other faulty, land-uses – impact on the ecosystem
12-13. Wildlife poaching – gravity of situation – strategies for prevention – India and abroad
14. Legal aspect – agencies, commissions and characters
15. Grazing and browsing of domestic animals and wild animals-Impact of grazing on forest ecosystem
16. Hazards to wildlife – steps for checking and prevention – carrying capacity concept
17. Parasitic plants-weeds, invasive and alien species-control strategies-effectiveness.
18. Forest Health-introduction to the concept and its importance.

Practical:
Visit to forest areas with fire damages, Studying fire registers as records, studying encroachment- problems caused due to disturbance-visit to illegally felled areas- Visit to fire station, Study and acquaint with machinery used for fire control, identification of weeds, parasites and epiphytes.

Practical schedule:

1-3. Understanding the impacts of forest fire and its management issues in a forested environment- Studying fire registers, records, reporting methods.
4-8. Visit to encroached areas-Booking an encroachment in a forest ecosystems- Studying encroachment- estimation of loss due to disturbance.
9-10.Studying management strategies to deal with cases of illicit felling-Detection and booking illicit felling.
11-13.Studying management strategies to deal with cases of poaching-Detection and booking the offence.
14-15. Management strategies of unwanted plants by silvicultural, physical, chemical and mechanical means- Understanding and managing invasive alien plant species-plant protection chemicals.
16-17. Visit to fire station-facilities and functions of a fire and rescue station-Study and acquaintwith machinery used for fire control.
18. Final practical exam.

Suggested reading
Brown, A.A and K.P. Davis. (1973). Forest fire control and use.McGraw Hill Book Co. New York.
Fuller, M. (1991). Forest fires. Wiley Nature Editions, New York.
Hal, R.B. (1990). Principles and Procedure of Range Management. International Book distributors, Dehra Dun.
Khanna, L.S. (1988). Forest Protection. Khanna Bandhu, Dehra Dun.

Narm 3209 Forest Policy and Law 2 (2+0)

Theory

National forest policies-scope and importance- comparative analysis of all forest policies - Indian judicial system- Legal definitions, application of penal code to forests, general principles of criminal law, legal principles of punishment, criminal procedure code, the law of evidence and the Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act, 1927 general provisions, Code of Civil procedure, 1908. Forest (Conservation) Act, 1980. Brief description about other major forest laws of regional, national and international significance like Wildlife Protection Act 1972 and its amendments, EFL Act 2003 etc. Detailed study of KFA 1961. Biological Diversity bill 2002-discussion of court verdicts on issues of utmost importance to conservation.

Lecture Schedule

1-4. History of forest management in the state and in the country, Definition of National Forest Policies
5-6. 1894 Forest policies in India
7-8. 1952 NFP
9. NCA report of 1976
10-12. NFP of 1988
13. History of forest legislation in India
14-20. Indian Forest Act, 1927, Kerala Forest Act, 1961, Kerala Private Forests (Vesting and Assignment Act), 1971
21. Kerala Preservation of Trees Act, 1986; Prevention of Cruelty to Animals Act, 1960
22-23. Forest (Conservation) Act, 1980 and rules 1981, Environment (Protection) Act, 1986 and amendments
24-25. Constitutional Provision for Safeguarding the Environment, Indian Penal Code, 1860 – Sections Relevant to Natural Resource Management, The Code of Criminal Procedure, 1974 – Sections Relevant to Natural Resource Management
26. Environmental Impact Assessment Notification, 1994 and amendments
27. The National Environment Tribunal Act, 1995
28-30. International Treaties Relevant to Conservation of Natural Resources
31. The Biological Diversity Bill, 2000
32. National Wildlife Action Plan
33-36. Discussion of court verdicts on issues of utmost importance to conservation, WPA, 1972 and amendments, EFL 2003, ROFR Act 2006,

Suggested reading

Baden Powell, B.H. (2002). Manual of Jurisprudence for Forest Officers.Materials, and Statutes, Oxford University Press.

Dutta, R. and Yadav, B. (2012). Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India.

Forest Laws of Kerala, (1975). Ganesh Publications, Kochi.

Handbook of Environment, Forest and Wildlife Protection laws in India (1998). Natraj Publishers, Dehra Dun.

Joy, P. P. (2012). Set up your criminal practice. Swamy Law House, Ernakulam.

Roy P Thomas. (2011). Manual of forest laws in Kerala 3rd Edition. Em tee en Publications.

Shetty, B. J. (1985). A Manual of Law for Forest Officers, Sharda Press, Mangalore.

Divan, S.and Rosencranz, A. (2001). Environmental Law and Policy in India. **Cases.**

Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths, Wadhwa, Nagpur.

Varghese, M. I. (2012). Treatise on Forest Laws of Kerala. Swamy Law house, Ernakulam.

Narm 3210 Geomatics 2 (1+1)

Theory

Remote sensing - classification based on source: Active and passive remote sensing; Aerial and space remote sensing; Interaction of electromagnetic radiation with atmosphere and earth surface; Aerial photographs – types; Photo interpretation - Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme; Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery-NDVI; Forest cover monitoring and damage assessment; Microwave remote sensing. Introduction to GIS. Differences between GIS and conventional cartography. Spatial and non-spatial data- Integration of attribute data with spatial data. Spatial data - Raster and Vector data-Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection-Toposheet and Map reading. Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, GLONASS, QZSS, Compass, IRNSS etc., GAGAN

Lecture schedule

1. Introduction to remote sensing – history - Principles of RS - Remote sensing as a tool for resource survey
2. Geographic Coordinate systems- Map projections
3-4. Active and passive type of remote sensing – Electromagnetic Radiation, energy sources and radiation principles- Fundamentals of radiometry- Physical basis of Signatures.
5. Spectral reflectance characteristics of vegetation, soil and water.
6-7. Remote sensors- platforms-Introduction to aerial platforms-photography- Types of aerial photographs.
8. Use of aerial photographs in forest management - forest cover types, insect and disease surveys, growing stock assessment, timber sale and recreation and wildlife management.
9. Satellite remote sensing - introduction, spectral bands.Satellite based sensors, Landsat TM, ETM, NOAA, Aster, SPOT, Hyperion, Indian Remote Sensing Programme etc.
10. Thermal Remote sensing - thermal sensors and scanners- Hyperspectral remote sensing
11. Introduction to microwave remote sensing - polarization, SLAR, synthetic aperture radar.
12-13. GIS:Introduction to GIS- principles and concepts of GIS- Differences between GIS and conventional cartography- Maps-its projection-Toposheet and Map reading
14. Spatial and non-spatial data- Integration of attribute data with spatial data; spatial data - Raster and Vector data-Thematic over lays in GIS, TIN, DEM
15-16. Geographical Information Analysis-Data analysis- Visual image processing - interpretation techniques, spectral pattern recognition. Principles of digital image processing - image enhancement, supervised and unsupervised classification.
17. Application of RS and GIS in forestry – forest- cover mapping, NDVI and damage assessment.
18. Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, IRNSS- Application of GIS in forestry – using imageries and integration with GIS data

Practical

GPS handling and working; Scale-Maps; Google Earth-Bhuvan; Introduction to various GIS software – Q-GIS, ERDAS, Arc GIS; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping. Digital image processing; Exercises in viewing, editing, overlay. Preparation maps; Visit to the GIS labs at State level.

Practical schedule:

1. Conversion of DMS to Decimal system and vice versa
2. Acquaintance with concepts like Map projections- GCS-Datum – IRM
3. Familiarization with survey of India Toposheets-various scale maps and map reading

GPS: handling- waypoint marking- tracking- area calculation.

4. Google Earth: downloading, historic imageries, creating vector and raster files.
5. Acquaintance with Bhuvan – Indian Geo platform of ISRO- GPS aided Geo Augmented navigation (GAGAN)
6. Acquaintance and visual interpretation of Aerial photograph, Satellite imagery

7-8. Acquaintance with digital image processing commercial softwares-Arc GIS, ERDAS, etc.

9-10. Digital image processing- supervised and unsupervised classification.

11. Hands on sessions on downloading images, file loading, FCC generation and image enhancement, Geo-referencing etc.

12-16. Exercises in on-screen digitization using open source softwares and preparation of maps

17. Visit to the GIS labs at State level
18. Final Practical Examination

Suggested reading

Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London.

Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI.

Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351p.

Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press.

Lillesand, T.M. and Kiefer,W.R. (1994).Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA.

Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS & LUP, Nagpur.

Narm 3211 Forest Inventory and Yield Prediction 2 (1+1)

Theory

Yield - In regular forests-In Irregular forests. Estimation of growth and Yield of stands - Forest Inventory - Point sampling Forest Inventory - Definition-objectives- Kinds of enumeration- Tree assessment techniques- Measurement of wood volume, tree volume & tree volume tables - Kinds of sampling -Sampling design - Kinds of sampling units- Fixed area and point sampling units - Plots, strips, topographical units - sampling intensity- Inventory designs used in India - Sampling errors and non-sampling errors- Organisation of field work and conduct of enumeration - Point sampling- Concept of horizontal point sampling . Estimation of growth and yield prediction in forest stands- Stand structure - Growth of stand - Methods of predicting future growth of stands - Stand density - Canopy density -Crown competition factor- Yield tables- definition- Preparation of yield table - Application and use of yield tables - Stand table- definition and use.

Lecture schedule

1. Forest Inventory-Definition-objectives-Kinds of enumeration-Choice of kinds of Enumeration- Advantages of sampling

2-3. Kinds of sampling - Random sampling- Simple random sampling - Stratified random sampling -Multi-stage sampling - Multi phase sampling - Sampling with varying probability - List sampling.

4. Non random sampling- Selective, systematic and sequential sampling – Sampling design

5. Kinds of sampling units - Fixed area and point sampling units- Shape of fixed area sampling units- Plots, strips, topographical units - Sampling intensity
6-7. Inventory designs used in India-Sampling errors and non-sampling errors.-Organization of field work and conduct of enumeration
8. Point sampling - Concept of horizontal point sampling - Definition of terms used in point sampling- Plot radius factor, calibration distance factor, and tree factor.
9-10. Instruments used in horizontal point sampling- Simple angle gauge- Wedge prism- Spiegel Relaskop, Tele Relaskop
11-12. Determination of number of trees per diameter class per ha from horizontal point sampling (HPS). HPS compared with plot sampling- Non sampling errors in HPS. Vertical point sampling (VPS).
13. Estimation of growth and yield prediction in forest stands-stand structure-growth of stand-Methods of determining past growth of stands- regular and irregular stands
14. Methods of predicting future growth of stands - Stand density - Canopy density-Crown competition factor –MCA-Growth modelling
15-18. Yield tables- Definition - Contents of yield table- Kinds of yield table- preparation of yield table application and use of yield table-Stand table-definition and use.

Practical

Study the demarcation and alignment of plots, strips etc. Field exercise on Horizontal Field demonstration of various sampling techniques- Simple, stratified, multi stage, multiphase, non-random sampling techniques. Visit forest areas for forest enumerations- point sampling- use of wedge prism and Relaskop - Field exercise on the determination of site quality -Visit to local forest divisions and study the methods of preparation and use of yield tables. Method demonstration on the use of aerial photographs in forest inventory

Practical schedule

1-4. Field demonstration of various sampling techniques- simple, stratified, Multi stage, multiphase, list sampling.
5-6. Field demonstration of non- random sampling techniques.
7-8 .Visit forest areas and study sampling methods followed in forest Enumerations- Study the demarcation and alignment of plots, strips etc
9-10. Field exercise on Horizontal point sampling- Use of wedge prism and Relaskop
11-13. Field exercise on the determination of site quality of forests at different localities.
14-15. Visits to local forest divisions and study the methods of preparation and use of yield tables
16-17. Field exercise on growing stock assessment
18. Final Practical Examination

Suggested Readings

Chapman, H.H and Meyer, W.H. (2008). Manual of Forest Mensuration: Methods and Techniques. Asiatic Publishing House, New Delhi, 522p.
Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364p.
Heindjik, D. (1975). Forest Assessment. International Book Distributors, Dehra Dun, 349p
Husch, B., Beers, T.W. and Kershaw, Jr. J.A. (2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature, 456p.
Kangas, A. and Maltamo, M. (2006). Forest Inventory: Methodology and Applications. Managing Forest Ecosystems (Vol.10). Springer.340p.
Philip, M.S. (1994).Measuring Trees and Forest. AB International, UK,310p
Scott,C.T and Gove, J.H. (2002). Forest Inventory. Encyclopedia of Environmetrics (Vol 2), John Wiley & Sons. 814–820p.

Shiver, B.D and Borders, B.E. (1996). Sampling Techniques for Forest Resource Inventory. John Wiley and Sons, New York, 356p.
Spurr, H.S. (1952).Forest Inventory. John Wiley and Sons, New York, 476p.

Narm 4212 Recreation & Urban Forestry 2 (1+1)

Theory

Forest recreation – Definition and scope – social and environmental aspects of recreation components new approaches in forest recreation. Principles and elements of landscaping - types of landscape designs formal-Persian and Mughal designs, and informal- British and Japanese. Landscape components- plant and other components- lawn, pergolas, hedges, edges, topiary, baloon, arbours, carpet beds, trees, flower beds, annuals, and climbers. Practices of landscaping-Tools and implements for landscaping. Specialised gardens-butterfly, water, bog or marsh, terrace, roof, Sunken, Indoor and rock. Planning and planting programmes in institutional and industrial complexes, roads, bridges, parking area and other structures. Urban forestry – definition and scope – uses of urban forests, Arboriculture and its importance in urban forestry-Management of urban forest and urban trees.

Lecture schedule

1. Forest recreation – definition and scope – Social and environmental aspects of recreation
2. Landscaping architecture-History of landscaping- scope and objectives
3. Principles and elements of landscaping
4. Landscape components- plant components- ground cover, Flower beds, carpet beds, Herbaceous borders/ flower borders, hedges, edges, topiary, lawn,trees, shrubs, herbs, grasses, creepers, bonsai, bamboos, ferns, palms and climbers.

5-8. Non plant components- Arches, Pergola, Rockery, Baloons, Fountains, Bridges, Water falls, Lilly pools-Bird bath, Garden seats, Hanging baskets and Garden pots, Trophy,Conservatory or green house-Arbours, Gazebos, Trellis, Pillars, Garden light, Sundial, Steps, Stones-Pebbles and Boulders, Statues, Stone lantern, Islands, Garden walls, Gates

9. Practices of landscaping- tools and implements
10. Types of landscape designs- and styles- formal- Persian and Mughal designs, and informal- British and Japanese

11-12. Specialised gardens-butterfly, water, bog or marsh, terrace, roof, Sunken, Indoor and rock

13. Planning and planting programmes for institutional and industrial complexes, roads, bridges, parking area and other structures
14. Urban forestry definition and scope, objectives-Green cities concept? Urban green space.
15. Urban forests- climatic, engineering, architectural and aesthetic relevance . Selection of trees with objectives and locality- balanced, unbalanced and sporadic system of planting– Avenue Planting.

16-18. Arboriculture and its importance in urban forestry-Management of urban forests and urban tree maintenance

Practical

Preparation, planning and designing the planting pattern for parks, sanctuaries and industrial complexes – familiarize with the components of landscaping – studies on the features of flowering and foliage trees suitable for avenue planting – visit to landscaped areas, parks tourist spots and centres, national parks and sanctuaries., practice planting methods.

Practical schedule:

1. Study of various landscape components and elements
2. Study of planting practices in landscaping
3. Study of various tools and implements in landscaping and draw
4. Study of various plants components in landscaping, prepare and plan a design
5. Study of usage of trees in a landscaping
6. Study of various non plants components in landscaping, prepare and plan a design

7-8. Visit to an urban forested areas and study tree management practices

9. Visit to a commercial landscaped areas-comparative study

10-14. Preparation of plan, design a planting pattern for indoors, water sources, deserted areas, tourist spot areas, zoo and museums

15-17. Preparation of plan, design and estimate for gardens and parks, national highway, state highways and railway Lines - Use of softwares in landscape design

18. Final Practical Examination

Suggested reading

Douglar, J., Hort, R. A and Ranganadhan, S. (1982). Forest Farming. Natraj Publications, Dehra Dun.

Gopikumar, K. (2008). Arboriculture Principles and Practices. Published by Khanna Bandhu, Dehra Dun.

Hamm, W.E and Cale, D.N.(1987). Wild Land Recreation, John Wiley and Sons, New York.

James, N. D. G. 1972. The Arboriculturalist's Companion: A guide to the care of Trees. Basil Blackwell.

Miller, R.W. (1988). Urban Forestry. Prentice Hall International Ltd. London.

Singh, S.P. (1986). Planting of Trees. B.R. Publishing Corporation, Delhi.

Narm 4213 Restoration Ecology 2 (1+1)

Theory

Ecosystem functions – Value of ecosystems – Ecosystem disturbances – fire -habitat fragmentation – felling – erosion- Mining – dams – pollution- overhunting-invasion of species – vulnerability – restoration of species diversity- ecosystem resilience & stability- Assembly- Restoration of soil- Phytoremediation – Bioremediation- forest restoration – restoration of critical habitat- translocation – reintroduction – Restoration of wetlands and aquatic ecosystems –Management of restoration projects – Monitoring – aftercare and assessment – Legal framework –integrated restoration efforts –Case studies –Decision making in ecological restoration.

Lecture Schedule

1. Introduction to Restoration ecology – Ecosystem functioning – value of ecosystems

2-4 Ecosystem disturbances due to fire, habitat fragmentation, forest degradation , erosion – factors affecting erosion - desertification- mining, dams, pollution – overhunting – Invasion of species – sand dunes and invasion of species.

5-6.Restoration of degraded ecosystems- species diversity – ecosystem resilience and stability- Assembly rules -species compatibility – Ecosystem thresholds - Ecosystem filters.

7-8. Phytoremediation and bioremediation

9-10. Restoration of critical habitats- restoration in mined areas – landscapes - invasive species – soil and sand dunes, polluted areas –Translocation and reintroduction

11-12. Restoration of aquatic ecosystems, - wetlands lakes and rivers- passive restoration and active restoration

13-14.Forest restoration – threat to forests –degradation process -obstacles for restoration- Recovery of forest

15-17.Management of restored areas- planning action plan- adaptive management- Monitoring, after care and final assessment
18. Integrated restoration efforts- Decision making in Ecological restoration

Practical

Exposure to the degraded sites and assesses the ground conditions- Visit to fire porn areas, impact assessment and preparation of action plan- Fauna, flora, soil and water quality assessment of of degraded sites - Social, economic and environmental assessment of post restoration changes of degraded sites- Plan preparation for the management of restored area

Practical schedule

1-4.Visits to degraded sites and assess the ground conditions
5-7. Visit to fire prone areas - impact assessment - preparation of action plan
8-12. Assessment of fauna, flora, soil and water quality of degraded sites.
13- 15. Social, economic and environmental assessment of post restoration changes of degraded sites.
16-17- Action plan preparation for the management of restored sites
18. Final practical examination

Suggested readings

Andre F. Clewell and James Aronson. (2013). Ecological Restoration, Second Edition: Principles, Values, and Structure of an Emerging Profession. Island Press.

David J Tongway and John A Ludwig. (2010). Restoring Disturbed Landscapes: Putting Principles into Practice. Island Press.

Greipsson, S. (2011). Restoration Ecology. Jones & Bartlett Learning, LLC, Canada, 408p.

Department of Forest Products and Utilisation (Fopu)

Fopu 1201 Wood Anatomy 3 (2 + 1)

Theory

Introduction to wood anatomy. Classification of plant kingdom. Gymnosperms versus angiosperms. Kinds of woody plants. The plant body; a tree and its various parts. Meristems; promeristem, primary meristem, secondary meristem. Simple tissues; parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body; typical stems and roots of dicots and monocots. Secondary growth in woody plants. Mechanism of wood formation in general, and with special reference to typical dicot stem. Ray initials and fusiform initials; anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood, sapwood, heartwood, pith, early wood, late wood, growth rings, wood rays, etc. Sapwood versus heart wood, anatomical differences. Transformation of sapwood to heartwood; factors affecting. Microscopic features of wood. Prosenchymatous elements, tracheids, vessels, fibers. Parenchymatous elements, parenchyma and rays, resin canals, gum canals, latex canals, infiltrants in wood. Three dimensional features of wood; transverse, tangential and radial surfaces. Elements of wood cell walls. The structure and arrangement of simple pit, bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers; classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood.

Lecture schedule

1. Introduction to wood anatomy. Its importance and application areas
2-3. Classification of plants - Kinds of woody plants.
4-5. The plant body - a tree and its various parts.
5-6. Classification of tissues. Meristems, Simple tissues; Complex tissues
7-8. Secondary growth in woody plants. Mechanism of wood formation in general, and with special reference to typical dicot stem.
9-10 Ray initials and fusiform initials; anticlinal and periclinal division.
11-12. Physiological significance of wood formation.
13-14. The macroscopic features of wood, sapwood, heartwood, pith, early wood, late wood, growth rings, wood rays, etc.
15. Sapwood versus heart wood, anatomical differences.
16-17. Transformation of sapwood to heartwood; factors affecting.
18-19. Three dimensional features of wood; transverse, tangential and radial surfaces.
20-21 Microscopic features of wood. Prosenchymatous elements, tracheids, vessels, fibers.
22-23. Parenchymatous elements, rays, resin canals, gum canals, latex canals
24-25. Elements of wood cell walls. The structure and arrangement of simple pit, bordered pits.
26-27. Extractives in wood.
28. Comparative anatomy of gymnosperms and angiosperms.
29. Classification into porous and non-porous woods
30. Classification into ring porous and diffuse porous woods.
31. Anatomical features of common Indian timbers.
32. Effect of growth rate on wood properties.
33. Juvenile wood and mature wood.
34. False and discontinuous growth rings.
35. Reaction wood; tension wood and compression wood.
36. Anatomical differences of reaction wood compared to normal wood.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Kerala.

Practical schedule

1. Study of primary growth in stems of typical dicots and monocots.
2. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots.
3. Parts of the logs (woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes).
4. Identification of timber and its importance. Common methods of identification. Equipments used commonly for field identification of timbers. Procedure for examination of wood sample
5. Diagnostic features of wood. General features - colour, hardness, weight, odour, lustre , texture.
6. Anatomical features of porous woods- pores, pore size, pore arrangement and pore number.
7. Anatomical features of porous woods- parenchyma or soft cells. Anatomical features of porous woods- inclusions, tyloses.
8. Anatomical features of porous woods- rays and their classification. Anatomical features of porous woods- fibres, ripple marks, intercellular canals and included phloem.
9. Use of keys for identification - dichotomous keys. Perforated card keys.
10. Field identification of the following timber species of Kerala:
11. *Tectona grandis*
12. *Dalbergia latifolia*
13. *Artocarpus heterophyllus*
14. *Artocarpus hirsutus*
15. *Pterocarpus marsupium* and *Mangifera indica*
16. *Hevea brasiliensis* and *Grewia tiliifolia*
17. *Xylia dolabriformis*
18. Practical Examination

Suggested reading

Anoop, E. V., Antony, F., Bhat, K. V., Lisha, D. A. and Babu, L. C. (2005). Anatomical key for the identification of important timbers of Kerala. Kerala Agricultural University, Thrissur and Kerala State Council for Science, Technology and Environment, Thiruvananthapuram, Kerala, India. 126p.

Hoadley, B. (2000). Identifying wood-Accurate results with simple tools. Taunton Press, Newtown, USA. 223p.

Panshin, A. J. and De Zeeuw, C. (1980). Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

Rao, R. K. and Juneja, K. B. S. (1992). Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

Fopu 2102Wood Science and Technology 3 (2+1)

Theory

Kinds of woods; hardwood, softwood, bamboos and palms, merits and demerits of wood as a raw material, the physical features of wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Wood water relationship; shrinkage, swelling, movement, fibre saturation, equilibrium moisture content. Wood seasoning; merits, principles and types; air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Classification of timbers based on durability. Wood preservation; principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage. Non-pressure methods; steeping, dipping, soaking open tank process, Boucherie process. Pressure methods; full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing; techniques, kinds of saws; cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Lecture schedule

1. Introduction to wood technology-definition- Classification of plant kingdom in terms of wood availability
2. Dendroid nature of trees- Formation of wood-role of cambium-anti-clinal & peri-clinal divisions.
3. Sapwood & Heartwood-anatomical & other differences-tyloses, structure and composition of wood cell wall
4. Hardwood & Softwood tissues-vessels, fibres, tracheids, rays etc-role & importance

5-6. Growth rings-earlywood and latewood-Dendro-chronology and its applications-3 D structure of wood-transverse, radial & tangential sections of wood

7. Knots in wood & reaction wood: compression wood and tension wood.

8-9. Grain & texture in wood-spiral, twisted & interlocked grain-figure in wood-formation and significance. Influence of direction of grain on the utilisation of wood.

10-11. Physical properties of wood: colour, odour, lustre, fluorescence, weight and density, specific gravity-variation in density of wood-practical significance of density.

12. Electrical, acoustical, optical and thermal properties of wood. Combustibility and calorific value of wood.

13-14. Introduction to mechanical properties of materials; Young's Modulus, stress vs strain in wood, elastic limit.

15. Various stresses acting upon wood: Tensile, Compressive, Bending, Shearing Stress and torsion.

16-17. Elasto-plastic nature of wood. Strength of wood. Important factors affecting strength of wood-inherent characteristics-growth conditions, age of the tree etc.

18-19. Wood water relationship in wood, hygroscopic nature of wood, free and bound water, fibre saturation point, equilibrium moisture content in wood.

20. Movement of moisture in wood, differential shrinkage. Effect of moisture loss in the dimensional stability of wood.

21-22. Chemistry of wood-cell wall substances, cellulose, hemi- cellulose, pectin and lignin; extractives, organic and inorganic materials. Their impact on the various strength properties.

23. Seasoning of wood-importance and general principles

24. Methods of seasoning -Classification of Indian timber for seasoning
25-27. Air seasoning-Principle-importance of stacking-horizontal and vertical stacking-seasoning of planks and railway sleepers
28. Different types of air seasoning sheds
29. Kiln seasoning-classification of kilns
30. Kiln drying schedules. Kiln seasoning vs air seasoning
31. Special seasoning methods-high temperature drying boiling in oily liquid, solvent seasoning, chemical seasoning, storage of logs.
32-33. Defects vs blemish. Defects in timber-natural defects and other than natural defects except those caused by biological agents- knots, shakes reaction wood, compression failure,
34-35. Seasoning defects and defects caused during subsequent treatment of felled timber.
36. Steps to be taken to avoid defects in timber.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories.

Practical schedule

1. Brief review of the history of timber mechanics
2. Instructions for collection of specimens for mechanical& physical properties testing, selection of trees, marking, felling, conversion and transportation.
3-4. Marking and conversion of wood into small clear specimens for testing: making of composite bolt
5-11. Detailed procedure for carrying out the various tests for mechanical properties; Static bending test, impact bending test, compression parallel to the grain, compression perpendicular to the grain, indentation test, shear parallel to the grain, tension parallelto the grain, tension perpendicular to the grain, torsion test, nail & screw pulling test,brittleness test.
12-13. Detailed procedure for carrying out the various tests for physical properties; moisture content, specific gravity, radial & tangential shrinkage, ring count.
14. Visit to preservative treatment plants.
15. Visit to saw mills to study stacking of timber and air seasoning practices
16. Visit to seasoning kilns.
17. Visit to Wood Testing Laboratory
18. Practical Examination

Suggested reading

Bowyer J. L., Shmulsky, R. and Haygreen, J. G. (2007). Forest products and wood science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.

Brown, H. P. (1985). Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.

FRI. [Forest Research Institute]. (1976). Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.

Panshin, A. J. and De Zeeuw, C. (1980). Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

USDA [U.S. Department of Agriculture]. (1999). Wood handbook - Wood as an engineered material. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p.

Fopu 3103 Wood Products and Utilization 3 (2+1)

Theory

Uses of wood. Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy. Wood as a source of energy and chemicals, wood as raw material for industries like pulp, paper, rayon, composite woods and improved woods. 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. Structural uses of Timber – bridges and other super structures. Decorative uses of wood. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.). Primary conversion; sawing and veneering. Composite wood; plywood, laminated wood, core board, sandwich board, fibre board, particle board; manufacturing process, uses and properties. Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties. Nano technology in wood. Pulp and paper making; history, raw materials used. Pulping; mechanical, chemical, semi-chemical and semi-mechanical. Pulp bleaching, stock preparation and sheet formation. Types of paper. Manufacture of rayon and match. Wood carving and handicrafts. Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Biochar, technology, bioenergy concepts - short rotation crops as raw materials.

Lecture schedule

1. Uses of wood - Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy.
2. Wood as a source of energy and chemicals, wood as raw material for industries like pulp, paper, rayon composite woods and improved woods.
3-4. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making.
5. Use of wood of lesser known forest species for commercial purposes.
6. Structural uses of Timber – bridges and other super structures. Decorative uses of wood.
7-8. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.).
9 Primary conversion- sawing and veneering.
10-11 Composite wood- definition, types of composite woods and their scope.
12. Plywood- historical development and general description.
13-15. Plywood manufacture- veneer preparation, drying, mixing and spreading of glue, conditioning of panels, trimming. Sanding and storage. Uses and advantages of plywood. Species suitable for use as core and outer plies.
16. Laminated wood- definition, manufacturing process, advantages and disadvantages. Species suitable.
17-18. Core board and sandwich board - definition, manufacturing process, advantages and disadvantages. Species suitable.
19-20. Improved wood- definition and scope. Impregnated wood, heat stabilized wood and compressed wood- manufacturing process, advantages and disadvantages.
21-22. Compregnated wood, heat stabilized compressed wood and chemically modified wood- manufacturing process, advantages and disadvantages.
23-24. Fibre board and particle board - definition, manufacturing process, advantages and disadvantages. Species suitable.
25-26. Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties.

27. Pulp and paper manufacture- wood pulp fibre and its constituents. Fibrous raw materials used for paper making in India.
28-30. Process of paper making - pulping, mechanical, chemical and semi-chemical methods, pulp cleaning, pulp bleaching, stock preparation and sheet formation. Types of paper.
31. Manufacture of rayon and match.
32-33. Match manufacture- kinds of matches, process of match manufacture, qualities of match wood. Species used in India- wood requirement in making matches.
34. Alternate uses of wood. Destructive distillation of wood.
35. Saccharification of wood. Production of wood molasses, alcohol and yeast.
36. Biochar, technology, bioenergy concepts - short rotation crops as raw materials.

Practical

Estimation of specific gravity and calorific value of wood specimens. Maceration techniques and determination of sizes of fibres, vessels etc. Visits to various wood based industries like, plywood, packing case, paper and pulp, match, tannins, furniture, saw mills etc. to study the manufacturing process. Visit to saw mill to study veneering and different kinds of sawing. Handicraft manufacturing unit. Visit to wood distillation unit. Visit to nearby industrial plantations.

Practical schedule

1-2 Determination of specific gravity of different wood specimens – converntional methods
3-4 Determination of wood density using Non-Destructive Testing methods (Pilodyne)
5-6 Demonstration of different maceration techniques.
7-8 Estimation of calorific value of woody materials using bomb calorimeter
9-10 Determination of percentages and dimensions of wood elements like fibres and, vessels.
11-12 Determination of percentages and dimensions of wood elements like axial and ray parenchyma.
13 Determination of knot size and frequency in timber specimens.
Visits to the following wood based industries to learn the manufacturing procedures adopted and raw materials used.
14. Plywood factory.
15. Paper mill
16. Match industry.
17. Saw mill and Furniture factory
18. Practical Examination

Suggested reading

Baldwin, R. F. (1995). Plywood and veneer-based products: manufacturing practices. Backbeat Books.

FRI [Forest Research Institute]. (1976). Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.

Hoadley, B. (2000). Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

Fopu 3104 Non-Timber Forest Products 3 (2 +1)

Theory

Introduction, methods of collection, management and importance of Non-Timber Forest Products (NTFP). Fodder, canes and bamboos. Essential Oils. Non –essential oils – Gums and resins – Resins and Oleoresins. Tans. Dyes – classification and sources of dyes, Fibers and flosses. Katha and Cutch- sources, extraction and uses. Drugs, wild fruits, spices, edible

products, poisons, bio- pesticides and other miscellaneous products. Animal products, lac, honey and wax- fish, trophies like tiger, panthers, elephants etc- minor products. Types of markets for timber and non-timber forest produce, market locations of timber and non-timber forest produce and their features. type and degree of competition in market for services of saw mill and other intermediate wood processing industries, price spreads across different channels of marketing.. Economics of gathering medicinal plants from forests, economics of processing medicinal plants. Domestic demand and trade in timber and non-timber forest products. International demand and trade in timber and non-timber forest produce. Market inefficiencies in timber, non-timber forest produce and measures to check in efficiencies, role of cooperative societies in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO) and timber certification.

Lecture schedule

1-2. Introduction – Scope of NWFP in India and Kerala Method of collection, management and importance of Non-Timber Forest Products (NTFP)
3-5. Fodder, canes and bamboos. Essential Oils. Non –essential oils – Gums and resins, Resins and Oleoresins. Tans. Dyes – classification and sources of dyes, Fibers and flosses
6-7 Katha and Cutch- sources, extraction and uses
8-9 Drugs, wild fruits, spices, edible products, poisons, bio- pesticides and other miscellaneous products. Animal products, lac, honey and wax- fish, trophies like tiger, panthers, elephants etc- minor products.
10-11 Types of markets for timber and non-timber forest produce,
13-14. Market locations of timber and non-timber forest produce and their features.
15. Demand forecasts. Price determination in timber and non-timber forest produce
16. Forest based medicinal plants, trees, and other non-timber forest products.
17-19 Economics of gathering medicinal plants from forests, economics of processing medicinal plants.
20-21 Domestic demand and trade in timber and non-timber forest products.
22-23. International demand and trade in timber and non-timber forest produce.
24-25. Market inefficiencies in timber, non-timber forest produce
26-27 Measures to check inefficiencies.
28-29 Economic policy and regulations of international timber trade.
30-31. Essentials of World Trade Organization, GATT, Dunkel proposals
32-33. Intellectual Property Rights and Patenting.
34-36 International Timber Trade Organization (ITTO) and timber certification.

Practical

Library review of studies on marketing and trade of; timber forest produce (teak, rosewood, *Terminalia* spp. *Pterocarpus* and other important timber of national importance etc.); Non-Timber Forest Produce (NTFP such as bamboo, canes, eucalypts etc.); forest based medicinal plants. Visits to timber produce and NTFP markets to collect price data and quantity sold and to observe auctions and competitions. Analysis of price and quantitative data of timber forest produce, NTFP for examining trend; seasonal, cyclical variations. Visit to markets of forest based medicinal plants. Study of buy back arrangements in forest based medicinal plants trade. Valuation of timber and NTFP (existence value, use and option values, intrinsic value etc). Development of hypotheses to study the marketing of forest produce. Presentation of results on analysis of price and quantity. Study of plant yielding drugs, spices, wild fruits, poisons and bio- pesticides and their collection from nearby forests. Visit to nearby extraction units.

Practical schedule

1. Library review of studies on marketing and trade of timber forest produce (teak, rosewood, Terminalia spp. Pterocarpus etc.);
2. Library review of studies on marketing and trade of Non-Timber Forest Produce
3. Library review of studies on marketing and trade of forest based medicinal plants.
4. Visits to timber markets to collect price data and quantity sold.
5. Visits to timber markets to observe auctions and competitions.
6. Visits to NTFP markets to collect price data and quantity sold and to observe auctions and competitions.
7. Visits to NTFP markets to observe auctions and competitions.
8. Analysis of price and quantity data of timber forest produce for examining trend seasonal, cyclical and secular variations.
9. Analysis of price and quantity data of NTFP for examining trend; seasonal, cyclical and secular variations.
10. Visit to markets of forest based medicinal plants to study buy back arrangements in forest based medicinal plants trade.
11. Valuation of timber (existence value, use and option values, intrinsic value etc).
12. Valuation of NTFP (existence value, use and option values, intrinsic value etc).
13. Development of hypotheses to study the marketing of forest produce.
14. Presentation of results on analysis of price and quantity.
15. Study of plant yielding drugs, spices, wild fruits, poisons and bio- pesticides and their collection from nearby forests Exercise on cost benefit analysis.

16-17. Visit to nearby extraction units of various NWFP

18. Practical Examination

Suggested reading

Gray, J. W. (1993). Forest resource systems in developing countries. Food and agricultural organization. Rome. 259p.

ITTO. [International Tropical Timber Organisation]. (1993). The economic linkages between international trade in tropical timber and sustainable management of tropical forests. London environmental economic centre, International Institute for Environment and Development, London, UK. 330p.

ITTO. [International Tropical Timber Organisation]. (2012). Annual review and assessment of the world timber situation, Yogyakarta, Indonesia. 182p.

Kula, E. (Ed.). (2012). *The economics of forestry: modern theory and practice*. Springer Science & Business Media.

Muraleedharan, P. K. Subramanian, K. K., and Pillai, P. P. (1998). Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p

Tewari, D. N. (1995). Marketing and trade of forest produce; International Book Distributors (Book Sellers & Publishers), Dehradun, India. 140p.

Fopu 3205 Logging and Ergonomics 2 (1+1)

Theory

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation; traditional and improved tools. Felling rules and methods, Work contracts related to felling and removing (contract system, convener systems) etc. Conversion, measurement and description of converted material. Means of transport of timber; carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water; floating, rafting and concept of booms. Non-destructive sampling methods of wood. Grading and storage of timber in the depots for display and disposal, temporary and final storage.

Timber Depots; types, lay out and management. Systems of disposal of timber. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Lecture schedule

1. Definition and scope of logging, logging plan and execution.
2. Location and demarcation of the area for logging and estimation of produce available for extraction.
3. Implements used in logging operation; traditional and improved tools.
4. Felling rules and methods.
5. Conversion, measurement and description of converted material.
6. Means of transport of timber; carts, dragging, skidding, overhead transport, ropeways, skylines.
7. Transport by road and railways.
8 Transport by water; floating, rafting and concept of booms.
9. Grading and storage of timber in the depots for display and disposal, Temporary and final storage.
10. Timber Depots; types, lay out and management.
11. Systems of disposal of timber.
12. Size of material in logging operation.
13. Ergonomics: definition, components and provision of energy.
14. Requirement of energy and rest periods.
15. Effect of heavy work, posture, weather and nutrition.
16. Personal protective equipments, safety helmets, ear and eye protections.
17. Accidents: causes, statistics, safety rules and first aids.
18. Plants, animals and insect infestations; diseases and their prevention.

Practical

Equipments and tools used in logging operations and their uses. Instructions regarding maintenance of various records and registers in logging operations; Conversion of felled trees into logs, poles, firewood, pulpwood etc. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of Kerala Forest Department.

Practical schedule

1. Equipments and tools used in logging operations and their uses-traditional tools
2. Equipments and tools used in logging operations and their uses-modern tools
3. Instructions regarding maintenance of various records and registers in logging operations.
4. Conversion of felled trees into various types of materials.
5. Measurement of logs and poles in forests.
6. Measurement of firewood in forests.
7. Maintenance of records in relevant registers.
8. Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites.

9. Familiarize the e-auctioning procedure of Kerala Forest Department. Sorting of logs and poles in depots according to species, quality, length and girth classes.
10. Sorting of firewood in depots according to species, quality, length and girth classes.
11. Stacking and stock checking of different logs, poles and firewood in the depots. Stacking of the lots for display and final disposal.
12. Recording of the lots for auction through sale.
13. Final disposal of the material.
14. Visit during the auction sale in the government timber depots.
15. Preparation of ergonomic check lists.
16. Study of personal protective equipments, safety helmets, ear and eye protections.
17. Safety rules and first aids in forestry operations.
18. Practical Examination

Suggested Reading

Brown, N. C. (2002). Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.

Staaf, K.A.G. and Wiksten, N.A. (1984). Tree Harvesting Techniques. Martinus Nijhoff/DR W. Junk Publishers, Netherlands.

FRI. [Forest Research Institute]. (1976). Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.

GFC. [Guyana Forestry Commission]. (2002). Code of practice for timber harvest. 2nd Ed. Georgetown, Guayana. 42p.

Hakkila, P. (1989). Utilization of residual forest biomass. Springer-verlag, Berlin. 567p.

Jones, J. T. (1993). A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.

Mehta, T. (1981). A handbook of forest utilization. IBD Dehradun. 298p.

Wakermann, A. E. (2002). Harvesting timber crops. Biotech books, Delhi. 433p.

Fopu 4206 Certification of Forest Products 2 (2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Programme for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Lecture schedule

1-2 Forest certification. Defined. Responsible sourcing of wood. Why is it important?
3 Principal stages in the process of certification.
4 Initial contact to annual monitoring
5-7 Producers motivation for supplying certified forest products. Market access, credibility, premiums
8-9 Key aspects of certification. Forest Management Unit (FMU) certification and the Chain of Custody (COC) certification.
10-11 Principles of sustainable forest management. SFM initiatives in India
12-13 Bhopal India process. Working plan code etc.
14-15 Origin of certification. Organizations responsible. UNECE, ITTO, CIFOR (Certification tool kit) etc.

16-17 Legislations and policies of importance. Lacey Act and FLEGHT.
18-19 Certification schemes in operation. Forest Stewardship Council (FSC) - FSC initiatives in India,
20-21 Programme for Endorsement of Forest Certification Schemes (PEFC), ATFS, CSA, MTCC etc.
22-23 Indian scenario in certification. SFM cell of MOEF.
24-25 International trade in tropical logs and sawn wood. India's share in world timber trade.
26-27 Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Pros and cons of certification.
28-30 Case studies in forest certification.
31-32 The CIFOR certification tool kit.
33-34 Technologies for tracing illegal logging.
35-36 Identification of species (genetic method) and region of origin (genetic and analysis of stable isotope ratios.)

Suggested readings

Bass, S. Introducing forest certification. (1996). A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest Institute, Discussion Paper 1. 30p. Details available at: http://www.giz.de/Themen/de/dokumente/en-d28-inenpenennt-certification-verification-forest-manage.pdf

Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. (2001). Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.

Conroy, M. E. (2007). Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.

Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. (2013). Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

Department of Wildlife Sciences (Wild)

Wild 1201-Wildlife Biology 3 (2+1)

Theory

Origin of life; Classification and its significance, nomenclature and basis of classification, Classification of animal kingdom – Phylum Chordata; History of Wildlife studies in India; Classification of Indian Mammals, Characteristic features of mammalian orders such as Order Monotremata, Marsupialia, Edentata, Dermoptera, Tubulidentata, Hyracoideae, and Macroscledidae. Characteristic features and representatives of Indian mammals, their distribution, habitat, food and feeding, ecological niche, conservation status and conservation issues of members of orders Insectivora, Scandentia, Chiroptera, Primates, Carnivora, Cetaceae, Sirennia, Proboscidae, Perissodactyla, Artiodactyla, Pholidota. Rodentia, and Lagomorpha. Animal Physiology: Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior: instinctive behavior, learned behavior, dispersal behavior, individual and social behavior and adaptations –cursorial, saussorial, fossorial, scansorial, volant, gliding or passive flight and aquatic adaptations; Communication, Mimicry. Wildlife populations and their interactions – mortality, natality, sex ratio, associations.

Lecture schedule:

1-2. Introduction - Origin of life; Classification and its significance, nomenclature and basis of classification, Classification of animal kingdom – Phylum Chordata; definition of wildlife - free living, captive, domesticated and feral animals.
3-4. History of Wildlife studies in India; Classification of Indian Mammals.
5-6. Characteristic features of mammalian orders - Order Monotremata, Marsupialia, Edentata, Dermoptera, Tubulidentata, Hyracoideae, and Macroscledidae.
7. Characteristic features and representatives of Indian mammals, their distribution, habitat, food and feeding, ecological niche, conservation status and conservation issues of members of following orders.Insectivora
8. Scandentia, Pholidota and Lagomorpha
9-11. Chiroptera
12-13. Primates
14-15. Carnivora
16. Cetaceae
17. Sirennia
18. Proboscidae
19. Perissodactyla
20-21. Artiodactyla
22-23. Rodentia
24-25. Mammalian Physiology – Respiration, circulation, excretion – body temperature and water relations – movements – nervous system
26. Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids
27-28. Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals.
29-30. Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity
31-32. Animal behavior – instinctive behavior, learned behavior, dispersal behavior, individual and social behavior
33-34. Adaptations –cursorial, saussorial, fossorial, scansorial, volant, gliding or passive flight

and aquatic adaptations
35. Communication, Mimicry. Wildlife populations and their interactions – mortality, natality, sex ratio, associations.
36. Conservation of wildlife, with special reference to the Indian mammals

Practical
Visit to various protected areas, zoological parks and observations on the morphological, behavioral, feeding and reproductive activities of different species of wild animals. Familiarize with various equipment's used in Wildlife monitoring and research. Specimen preservation and management of Wildlife museum.

Practical schedule
1-4. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera trapping, for identification. Determination of age and sexing of animals including the small mammals
5 - 8 Field identification of large to medium sized mammals of Kerala belonging to the orders Proboscidae, Carnivora, Primates, Artiodactyla, Pholidota, Lagomorpha,
9-11 Field identification of small mammals of Kerala belonging to the Order Chiroptera, Soricidae and Rodentia
12. Visit State Zoo and familiarize with various wild animals
13-17. Visit to various protected areas of Kerala and observations on the morphological, behavioral, feeding and reproductive activities of different species of wild animals
18. Final Practical examination

Suggested reading

Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.
Dasmann, R.F. (1982). Wildlife Biology. Wiley Eastern Ltd. New Delhi.
Johnsingh, A.J.T. and N. Manjrekar. (2014). Mammals of South Asia. Vol. I & II. University Press, 614& 739p
Krebs C & Davis N. (1978). Introduction to behavioral ecology. Oxford University Press
Mathur R. (1985). Animal Behaviour. Oxford University Press
Menon V. (2014). Indian Mammals: A field guide. Hachette. 528p.
Mittermeier, RA Rylands, AB and Wilson DE. 2013. Handbook of the Mammals of the World - Volume 3. Lynx Edicions. 952.
Nameer, P.O. (2000). Checklist of Indian Mammals. Kerala Forest Department. 110p.
Prater, S.H. (1971). The Book of Indian Animals. Oxford University press, Bombay. 324p.
Wilson, D. E. Mittermeier, R.A. (2009, 2011, 2013, 2014 & 2015). Handbook of the Mammals of the World - Volume 1 to V. Lynx Edicions.

Wild 2102 Ornithology 3 (2+1)

Theory
Introduction. History of ornithology in India. Origin and ancestry of birds. A brief knowledge of bird anatomy, morphology and physiology, digestive, skeletal, respiratory, excretory systems of birds. Skeleton, feathers, skin, beak and taxidermy. Thermoregulation in birds. Bird ecology and behaviour; migration and territorial behaviour, feeding, song and nests. Eggs and egg laying. Water birds, scavenger birds, frugivorous birds, pest birds, pet birds and pollinator birds. Importance of birds to different ecosystems. Birds and man. Bird watching, Bird conservation and management in India. Important Bird areas of India, Red Data Book birds of India. Wetland conservation, Ramsar sites of India. Classification of Indian birds - birds belonging to the Orders Podicipediformes, Procellariformes, Pelicaniformes, Ciconiformes, Phoenicopteriformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Caradriformes,

Columbiformes, Psittaciformes, Cuculiformes, Strigiformes, Caprimulgiformes, Apodiformes, Trogoniformes, Coraciformes, Upupiformes, Piciformes and Passeriformes.

Lecture schedule

1-2. Introduction, definition, characteristic features. History and prospects of ornithology in India
3-4. Origin, speciation and ancestry of birds. Bird morphology - feathers and moults
5-6. Bird anatomy - bones, muscles and locomotion, Bird physiology - digestion, food and feeding guilds
7-8. Bird behaviour – communication, courtship displays, breeding behaviour
9-10. Different types of bird nests
11-12. Bird migration - migration pattern, seasonal and annual migration, origin and causes of migration some mechanics of migration, orientation, routes of migration
13-15. Ecology, endemism, Satpura hypothesis, affinity of Western Ghats with North East - habitat and niches, succession, bird populations - ecological adaptations.
16. Birds in our lives - birds as food, plumage, other economic products, habits in relation to man, miscellaneous damage by birds.
17-18. Conservation – threatened birds of India with special reference to Western Ghats region – avian extinctions.
19-20. Important Bird Areas (IBA) concept and IBA's of India and Kerala.
21-22. Ramsar Convention and the importance of wetland conservation. Ramsar site of India and Kerala.
23-36. Classification of birds of the bird - up to family level - Indian birds with special reference to the birds of Western Ghats – Grebes (Podicipedidae), Petrels & Shearwaters (Procellariidae), Storm-Petrels (Hydrobatidae), Tropicbirds (Phaethontidae), Pelicans (Pelecanidae), Boobies (Sulidae), Cormorants / Shags (Phalacrocoracidae), Darters (Anhingidae), Frigatebirds (Fregatidae), Herons, Egrets & Bitterns (Ardeidae), Storks (Ciconiidae), Ibises & Spoonbills (Threskiornithidae), Flamingos (Phoenicopteridae), Swans, Geese & Ducks (Anatidae), Hawks, Eagles, Buzzards, Old World Vultures, Kites, Harriers (Accipitridae), Osprey (Pandionidae), Falcons (Falconidae), Pheasants, Partridges, Quails (Phasianidae), Buttonquail/Bustard quails (Turnicidae), Cranes (Gruidae), Rails, Crakes, Moorhens, Coots (Rallidae), Bustards (Otididae), Jacanas (Jacanidae), Painted-Snipes (Rostratulidae), Oystercatcher (Haematopodidae), Plovers, Lapwings (Charadriidae), Sandpipers, Stints, Snipes, Godwits & Curlews (Scolopacidae), Avocets & Stilts (Recurvirostridae), Crab Plovers (Dromadidae), Stone-Curlew & Stone-Plovers/thick-knees (Burhinidae), Coursers & Pratincoles (Glareolidae), Gulls & Terns (Laridae), Pigeons & Doves (Columbidae), Parakeets & Hanging-Parrots (Psittacidae), Cuckoos, Malkohas & Coucals (Cuculidae), Barn Owls (Tytonidae), Owls (Strigidae), Frogmouths (Podargidae), Nightjars (Caprimulgidae), Swifts (Apodidae), Tree-Swifts (Hemiprocnidae), Trogons (Trogonidae), Kingfishers (Alcedinidae), Bee-eaters (Meropidae), Rollers (Coraciidae), Hoopoes (Upupidae), Hornbills (Bucerotidae), Barbets Capitonidae, Woodpeckers (Picidae), Pittas (Pittidae), Larks (Alaudidae), Swallows & Martins (Hirundinidae), Wagtails & Pipits (Motacillidae), Cuckoo-Shrikes, Flycatcher-Shrikes, Minivets, Woodshrikes (Campephagidae), Bulbuls (Pycnonotidae), ioras, Chloropsis/Leafbird, Fairy-Bluebird (Irenidae), Shrikes (Laniidae), Thrushes, Shortwings, Robins, Wheaters (Turdinae), Babblers, Laughingthrushes (Timaliinae), Prinias, Warblers (Sylviinae), Flycatchers (Muscicapinae), Monarch-Flycatchers & Paradise-Flycatchers (Monarchinae), Fantail-Flycatchers (Rhipidurinae), Tits (Paridae), Nuthatches (Sittidae), Flowerpeckers (Dicaeidae), Sunbirds & Spiderhunters (Nectariniidae), White-eyes (Zosteropidae), Buntings (Emberizinae), Finches (Fringillidae), Munias (Estrildidae), Sparrows (Passerinae), Weavers (Ploceinae), Starlings & Mynas (Sturnidae), Orioles (Oriolidae), Drongos (Dicruridae), Woodswallows/Swallow-Shrikes (Artamidae), Crows, Treepies (Corvidae).

Practical

Familiarisation of major bird families of India. Filed identification of birds of Kerala. Bird watching and drawings. Study of feathers, beak and leg types of different groups of birds. Study of the nest and eggs of birds. Mist netting and tagging/marking of birds for the bird migration studies. Bird census techniques. Visit to different bird habitats.

Practical schedule

1-5. Field identification of birds of Kerala - Grebes (Podicipedidae), Petrels & Shearwaters (Procellariidae), Storm-Petrels (Hydrobatidae), Tropicbirds (Phaethontidae), Pelicans (Pelecanidae), Boobies (Sulidae), Cormorants / Shags (Phalacrocoracidae), Darters (Anhingidae), Frigatebirds (Fregatidae), Herons, Egrets & Bitterns (Ardeidae), Storks (Ciconiidae), Ibises & Spoonbills (Threskiornithidae), Flamingos (Phoenicopteridae), Swans, Geese & Ducks (Anatidae), Hawks, Eagles, Buzzards, Old World Vultures, Kites, Harriers (Accipitridae), Osprey (Pandionidae), Falcons (Falconidae), Pheasants, Partridges, Quails (Phasianidae), Buttonquail/Bustard quails (Turnicidae), Cranes (Gruidae), Rails, Crakes, Moorhens, Coots (Rallidae), Bustards (Otididae), Jacanas (Jacanidae), Painted-Snipes (Rostratulidae), Oystercatcher (Haematopodidae), Plovers, Lapwings (Charadriidae), Sandpipers, Stints, Snipes, Godwits & Curlews (Scolopacidae), Avocets & Stilts (Recurvirostridae), Crab Plovers (Dromadidae), Stone-Curlew & Stone-Plovers/thick-knees (Burhinidae), Coursers & Pratincoles (Glareolidae), Gulls, Terns (Laridae)

6-11. Field identification of passerine/perching birds - Pigeons & Doves (Columbidae), Parakeets & Hanging-Parrots (Psittacidae), Cuckoos, Malkohas & Coucals (Cuculidae), Barn Owls (Tytonidae), Owls (Strigidae), Frogmouths (Podargidae), Nightjars (Caprimulgidae), Swifts (Apodidae), Tree-Swifts (Hemiprocnidae), Trogons (Trogonidae), Kingfishers (Alcedinidae), Bee-eaters (Meropidae), Rollers (Coraciidae), Hoopoes (Upupidae), Hornbills (Bucerotidae), Barbets Capitonidae, Woodpeckers (Picidae), Pittas (Pittidae), Larks (Alaudidae), Swallows & Martins (Hirundinidae), Wagtails & Pipits (Motacillidae), Cuckoo-Shrikes, Flycatcher-Shrikes, Minivets, Woodshrikes (Campephagidae), Bulbuls (Pycnonotidae), Ioras, Chloropsis/Leafbird, Fairy-Bluebird (Irenidae), Shrikes (Laniidae), Thrushes, Shortwings, Robins, Wheaters (Turdinae), Babblers, Laughingthrushes (Timaliinae), Prinias, Warblers (Sylviinae), Flycatchers (Muscicapinae), Monarch-Flycatchers & Paradise-Flycatchers (Monarchinae), Fantail-Flycatchers (Rhipidurinae), Tits (Paridae), Nuthatches (Sittidae), Flowerpeckers (Dicaeidae), Sunbirds & Spiderhunters (Nectariniidae), White-eyes (Zosteropidae), Buntings (Emberizinae), Finches (Fringillidae), Munias (Estrildidae), Sparrows (Passerinae), Weavers (Ploceinae), Starlings & Mynas (Sturnidae), Orioles (Oriolidae), Drongos (Dicruridae), Woodswallows/Swallow-Shrikes (Artamidae), Crows, Treepies, (Corvidae).

12 - 13. Bird census techniques and familiarisation with software

14 - 15. Taxidermy, preparation of bird skins and preservation

16 -17. Visit to bird sanctuaries - Thattekkad and other sanctuaries; Visit to Ramsar sites - Kole wetlands, Vembanad Lake, Ashtamudi Lake, Sasthamkotta Lake.

18. Final Practical Examination

Suggested reading

Ali, S. and Ripley, D.S. (1990). A compact Handbook of Birds of Indian subcontinent. Oxford University press, Bombay.

Grimmet, R. Inskipp T and Inskipp, I. (2003). Handbook of Birds of Indian subcontinent. Oxford University press

Grimmet, R. Inskipp, T and Nameer, P.O. (2007). Birds of southern India, BNHS series.

Kazmierczak, K. and van Perlo B. (2000). A field guide to the birds of the Indian subcontinent, Yale University Press, New Haven. CT.

Neelakantan, K.K. (1986). *Keralathile Pakshikal* (Birds of Kerala). Kerala Sahitya Academy, Thrissur.

Rasmussen P C and John C. Anderton. (2012). Birds of South Asia: The Ripley guide. Vol. I and II, Smithsonian Institution and Lynx Edicions, Washington DC and Barcelona.
Sashikumar, Praveen J., Palot, M.J. and Nameer P.O. (2012). Birds of Kerala, Status and Distribution. Volume 1.
Wallace GJ and HD Mahan. (2005). An Introduction to Ornithology. 3rd Ed. McMillion publishing company. New York.

Wild 2203 Herpetology 2 (1+1)

Systematics and zoogeography of amphibians and reptiles of India, with special reference to the Western Ghats forms: Factors affecting distribution and abundance of amphibian and reptilian fauna of Indian sub-continent. Biology of major Indian amphibians, caecilians, fresh water and marine turtles, crocodilians, lizards and snakes. Thermo-regulation, its role, aestivation, hibernation and other ecophysiological adaptations. Role of temperature in sex determination in reptiles. Classification of reptiles - Indian reptiles with special reference to the reptiles of Western Ghats – reptiles belonging to the families such as Acrochordidae, Agamidae, Boidae, Chamaeleonidae, Cheloniidae, Colubridae, Crocodylidae, Dermochelyidae, Elapidae, Gekkonidae, Geoemydidae, Gerrhopilidae, Homalopsidae, Lacertidae, Natricidae, Pythonidae, Scincidae, Testudinidae, Trionychidae, Typhlopidae, Uropeltidae, Varanidae, Viperidae and Xenodermatidae. Classification of amphibians - Indian amphibians with special reference to the amphibians of Western Ghats – amphibians belonging to the families such as Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlyidae, Micrixalidae, Microhylidae, Nasikabatrachidae, Nyctibatrachidae, Ranidae, Ranixalidae and Rhacophoridae. An overview of conservation problems and issues of herpetofauna of Indian sub-continent. Methods for herpetofaunal ecological studies. Threats to herpetofaunal biodiversity: global as well as in India. Threatened herpetaufauna of India, with special reference to Western ghats region.

Lecture schedule

1. Systematics and zoogeography of amphibians and reptiles of India, with special reference to the Western Ghats forms
2. Factors affecting distribution and abundance of amphibian and reptilian fauna of Indian subcontinent
3. Introduction to major Indian amphibians, caecilians, fresh water and marine turtles, crocodilians, lizards and snakes. Thermo-regulation, its role, aestivation, hibernation and other ecophysiological adaptations. Role of temperature in sex determination in reptiles.

4-8. Classification of reptiles - Indian reptiles with special reference to the reptiles of Western Ghats – reptiles belonging to the families such as Acrochordidae (File Snakes), Agamidae (Lizards), Boidae (Boas), Chamaeleonidae (Chamaeleons), Cheloniidae (Sea Turtles), Colubridae (Colubrid Snakes), Crocodylidae (Crocodiles), Dermochelyidae (Leatherback Turtles), Elapidae (Elapid Snakes), Gekkonidae (Geckoes), Geoemydidae (Turtles & Terrapins), Gerrhopilidae (Worm Snakes), Homalopsidae (Mud Snakes), Lacertidae (Lacertas), Natricidae (Keelbacks), Pythonidae (Pythons), Scincidae (skinks), Testudinidae (Tortoises), Trionychidae (Softshell Turtles), Typhlopidae (Worm Snakes), Uropeltidae (Shieldtails), Varanidae (Monitor Lizards), Viperidae (Vipers) and Xenodermatidae (Narrow-headed Snakes)

9-13. Classification of amphibians - Indian amphibians with special reference to the amphibians of Western Ghats – amphibians belonging to the families such as Bufonidae (Toads), Dicroglossidae (Fork-tonged Frogs), Ichthyophiidae (Asiatic Tailed Caecilians), Indotyphlyidae (Common Caecilians), Micrixalidae (Dancing Frogs), Microhylidae (Narrow-mouthed Frogs), Nasikabatrachidae (Purple Frogs), Nyctibatrachidae (Night Frogs), Ranidae (True Frogs), Ranixalidae (Leaping Frogs) and Rhacophoridae (Tree Frogs).

14. An overview of conservation issues of herpetofauna of Indian sub-continent
15. Methods for herpetofaunal ecological studies

16. Threats to herpetofaunal biodiversity: global as well as in India
17-18. Threatened herpetaufauna of India, with special reference to Western Ghats region.

Practical

Field identification of major herpetofauna, collection methods and equipments used in herpetological studies. Herpetofaunal assessment techniques and familiarisation with software.

Practical schedule

1-3. Field identification of reptiles and amphibians of Western Ghats - Acrochordidae, Agamidae, Boidae, Chamaeleonidae, Cheloniidae, Colubridae, Crocodylidae
4-6. Dermochelyidae, Elapidae, Gekkonidae, Geoemydidae, Gerrhopilidae, Homalopsidae, Lacertidae, Natricidae
7-9. Pythonidae, Scincidae, Testudinidae, Trionychidae, Typhlopidae, Uropeltidae, Varanidae, Viperidae and Xenodermatidae
10-12. Field identification of Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlyidae, Micrixalidae, Microhylidae, Nasikabatrachidae,
13-15. Nyctibatrachidae, Ranidae, Ranixalidae and Rhacophoridae.
16-17. Herpetofaunal assessment techniques and familiarisation with software
18. Final Practical Examination

Suggested reading

Biju, S.D. (2011). A taxonomic review of the Night Frog genus Nyctibatrachus Boulenger,1882 in theWestern Ghats, India (Anura: Nyctibatrachidae) with description of twelve new species. Zoo Taxa.3029: 1-96.

Biju, S.D. (2013). Taxonomic review of the tree frog genus Rhacophorus from the Western Ghats, India (Anura: Rhacophoridae), with description of ontogenetic colour changes and reproductive behaviour. 3636 (2): 257-289.

Biju, S.D. (2014). DNA barcoding reveals unprecedented diversity in dancing frogs of India (Micrixalidae, Micrixalus): a taxonomic revision with description of 14 new species. Ceylon Journal of Science (Bio Sci.) 43 (1): 1-87.

Daniel, J.C. (2002). The Book of Indian Reptiles. Bombay Natural History Society, Bombay, 141pp.

Das, I. (1995). Turtles and Tortoises of India. Oxford University Press. Bombay. 176pp.

Das, I. (2002). A photographic guide to Snakes and other reptiles of India. New Holland Publishers (UK) Ltd.

Gururaja KV. (2012). Pictorial Guide to frogs and toads of the Western Ghats. IISc. Bangalore.

Kentwood D. Wells. (2007). The Ecology and Behavior of Amphibians. The University of Chicago Press, Chicago. Madurai Kamaraj University, VI (unnumbered) + 132 pp.

Smith, M. A. (1931, 1935, 1943). The fauna of British India including Ceylon and Burma: Reptilia and Amphibia. Vol. I, II& III. Sauria. Taylor and Francis, London.

Tikader, B.K and R.C. Sharma. (1992). Handbook of Indian Lizards. Zoological survey of India, Kolkota. 250pp.

Whitaker, R. and Captain, A. (2004). Snakes of India. The Field Guide. Draco Books. Chengalpattu, Tamil Nadu, xiv+479, pls, text-figs.

William E. Duellman and Linda Trueb. (1986). Biology of Amphibians. John Hopkins University Press, Maryland.

Wild 3104 Wildlife Management 2 (1+1)

Theory

Definition, History of wildlife management and conservation in India; values of wildlife - aesthetic, recreational, scientific, educational, commercial, farming, technological and ecological values. Zoogeographic regions of the world – Palearctic region, Nearctic region, Oriental region, Ethiopian region, Neotropical region, Australasian region. Major biomes of the

world – polar region, coniferous forests, temperate forests, tropical forests, grasslands, deserts, mountains, inland waters, oceans and oceanic islands. Biogeographic zones of India - trans-Himalayan, Himalayan, Indian desert, semi-arid, Western Ghats, Deccan peninsula, Gangetic plain, North East India, islands, coasts. Habitat requirements of animals. Red Data Book and redlisting, IUCN revised red list categories – Extinct, Extinct in the wild, Vulnerable, Near Threatened and Least concerned. Wildlife census: Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect- statistical analysis. Telemetry- transmitters, receivers, analysis of data, visual tagging and marking. Captive wildlife: Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, CITES. Wildlife Damage - Appraisal, Control and Management. Healthcare, Disease Management and Nutrition in Wild Animals Protected areas concept, wildlife sanctuaries and national parks, biosphere reserves, major protected areas of India.

Lecture schedule

1. Introduction - definition - values of wildlife - aesthetic, recreational, scientific, educational, commercial, farming, technological and ecological values
2. Justification of wildlife conservation, uses, values and negative impact of wildlife
3. Zoogeographic regions of the world – Palearctic region, Nearctic region, Oriental region, Ethiopian region, Neotropical region, Australasian region
4. Major biomes of the world - polar region, coniferous forests, temperate forests, tropical forests, grasslands, deserts, mountains, inland waters, oceans and oceanic islands.

5-6. Biogeographic zones of India - trans-Himalayan, Himalayan, Indian desert, semi-arid, Western Ghats, Deccan peninsula, Gangetic plain, North East India, Islands, Coasts

7. IUCN red list categories – evolution of IUCN red list categories – pre 1989 to 2001 revision of red list categories – critically endangered, endangered, valuable, near threatened etc criteria for assessing the red list categories
8. Introduction to wildlife population estimation – direct methods – total count, block count, registration count, drive count, road-side count, waterhole count, fixed-point count, capture – recapture method, aerial count and line transect method

9-10. Wildlife population estimation - indirect methods, dung count for elephants and gaur,pugmark method for larger cats and pellet count for other animals, camera traps

11. Special projects for endangered species of Indian fauna - Project Tiger, Project Elephant
12. Project Gir Lion, Crocodile breeding project, Project Hangul, Himalayan Musk Deer Project, Manipur Brow- antlered Deer Project, Lesser Cats Project.
13. Radio telemetry, transmitters, receivers, visual tagging and marking.
14. Organisation and legislation for wildlife management and conservation - Wildlife (Protection) Act (1972), TRAFFIC, CITES, National Wildlife Action Plan, International conservation agreements signed by India

15-16. Zoological Gardens in India.Objectives and types of zoo. Captive breeding and reintroduction of endangered wild animals. Management of zoological gardens, deer parks and safari parks.

17. Central Zoo Authority and its guidelines on the zoological gardens in India.
18. Nutrition and health care of captive wildlife according to CZA.

Practical

Exercise on identification of animals based on indirect evidences. Census methods - direct method - total count, block count, water hole count, capture - recapture method, point transect, and line transect method – use of software for analysis. Exercise on the census

methods - indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey. Wildlife photography.

Practical schedule

1- 5. Exercise on the census methods - direct method - total count, block count, water hole count, capture - recapture method, point transect, and line transect method – use of software for analysis

6 -10. Exercise on the census methods - indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates

11-12. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife

13-14. Exercise on the identification of mammals based on hair samples, identification of mammalian scats.

15 -17. Field acquaintance with wildlife kept in captivity, Visit to elephant camps, Visit to various zoological gardens, Crocodile breeding farm, Snake Park

18. Final Practical Examination

Suggested reading

Davil, J.W. et al. (1981). Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

Krebs C & Davis N. (1978). Introduction to behavioral ecology. Oxford University Press

Lever, C. (1985). Naturalised mammals of the world. John Wiley, London

Mills, L. S. (2013). Conservation of Wildlife Populations Demography, Genetics and Management (Ed.2). Wiley-Blackwell.

Rajesh, G. (1995). Fundamentals of Wildlife Management, Justice Home, Allahabad.

Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun,

Wildlife Institute of India. (2004). Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun

Wodroffe, G. (1981). Wildlife conservation and modern zoo. Saiga Publishing Co., England

Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

Wild 3105 Anthropology & Tribal Welfare 2 (2+0)

Theory

Meaning, scope and development of Anthropology. Relationships with other disciplines. Main branches of Anthropology, their scope and relevance. Human Evolution and emergence of Man. Phylogenetic status, characteristics and geographical distribution. Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods. Culture, Society, Marriage, Family, Kinship, Economic and Political Organization, Social Control, Religion, Anthropological theories, Language and Communication, Research Methods in Anthropology. Race and Racism. Applications of Anthropology. Ethno-archaeology in India. Demographic profile of India. The structure and nature of traditional Indian social system. Caste system in India Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare.

Lecture Schedule

1. Meaning, scope and development of Anthropology.
2-3. Relationships with other disciplines. Main branches of Anthropology, their scope and relevance.
4-5. Human Evolution and emergence of Man. Phylogenetic status, characteristics and geographical distribution.
6-7. Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods.
8-10. Culture, Society, Marriage, Family, Kinship, Economic and Political Organization, Social Control and Religion
11-13. Anthropological theories, Language and Communication, Research Methods in Anthropology.
14. Race and Racism.
15. Applications of Anthropology.
16. Ethno-archaeology in India.
17. Demographic profile of India.
18-21. The structure and nature of traditional Indian social system. Caste system in India Definition and characteristics of a tribe.
22-23. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes.
24-25. Tribes in India and Kerala.
26. Tribal economy.
27-29. Tribals and Constitution of India Administration of tribal areas in independent India
30-31. Appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment.
32-33. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward.
34-36. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare.

Suggested reading:

Furer-Haimendorf, C.V. (1985). Tribes of India - the struggle for survival. OUP. New Delhi
Hasnain, N. (2007). Tribal India. New Royal Book Company
Hasnain, N. (2011). Indian Anthropology. Palaka Prakashan
Sharma, R.N. and Bakshi, S. (1984). Tribes and tribal development. Uppal Publ. House, New Delhi
Sharma, R. N., Sharma, R.K. (1997). Anthropology. Atlantic Publishers & Distributors.
Thakur, D. (1986). Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi.

Wild 3206 Fundamentals of Conservation Biology 2 (1+1)

Theory

Introduction to Conservation Biology, Conservation of biodiversity, documenting biodiversity; concepts of biodiversity, levels of biodiversity, valuing biodiversity. Extinctions in geological time. Biodiversity decline. Modern causes of extinction. Conservation Genetics, Management and conservation of genetic variation in natural populations. Ex-situ conservation. Demographic issues, Population viability analysis, ecological restoration, Designing conservation reserve, Management to meet conservation goal; Control of invasive species, scales of management (on population level, habitat and landscape) of management and cultural context.

Lecture Schedule

1. Introduction – Conservation Biology – Origin; Conservation and its approaches.

2-4. Biodiversity - Documenting biodiversity; Measuring biodiversity; Levels of biodiversity; Valuing biodiversity.

5-7. Documenting/predicting extinctions - Extinctions in geological time. Pre-industrial humans. Modern biodiversity decline. Modern causes of extinction (over-harvesting, habitat destruction /fragmentation, species invasions). Organizations that attempt to document these things. Predicting extinction risk of species.

8-9. Consequences of small populations - Rarity and demography. Rarity and metapopulation structure. Rarity and genetics. Minimum viable population concept

10. Choosing priority areas - Incorporating costs/tradeoffs when choosing conservation priority areas. SLOSS debate.

11-12. Management tools & issues - Single species care & costs. Establishing new populations. Habitat maintenance (fires) or management (selective logging, etc.). Restoration, captive breeding, cryogenesis, re-introductions, cloning

13-14. Policy - Conservation policy around the world, history. Enforcement of legislation; CITES (international agreement) and other approaches to conservation

15. Conservation Genetics, Management and conservation of genetic variation in natural populations.

16. Ex-situ conservation – Zoos, Aquariums, Botanical Gardens, Arboretums, Seed Banks

17. Demographic issues, Population viability analysis, ecological restoration,

18. Designing conservation reserve, Management to meet conservation goal; Control of invasive species, scales of management

Practical

Measurement of Biodiversity, Assessment of conservation status of species. Calculations of degree of inbreeding, MVP. Evaluation of existing protected areas from the point of view of principles of conservation biology.

Practical Schedule

1-6. Biodiversity indices calculation

7. Calculation of Minimum Viable Population

8. Calculation of inbreeding coefficient

9-11. Evaluation of conservation programmes such as Project Tiger in Periyar or Parambikulam Tiger Reserve

12-13. Evaluation of the effectiveness of Project Elephant programme in the State of Kerala.

14. Evaluation of various mitigation and preventive measures against Human-Wildlife conflict in the State

15. Evaluation on various initiatives on the removal of invasive from the Forest of Kerala

16-17. Visit to various protected Areas of the State and study various actions for the conservation of wild animals

18.Final Practical examination

Suggested reading

Bawa, K.S., Primack, R.B. and Oomen, M.A. (2011). Conservation Biology. A primer for South Asia. Universities Press, Hyderabad, India. 589 pp.

Hunter, M.L. (1996). Fundamentals of Conservation Biology. Blackwell

Hunter, L.M. and Gibbs, J.P. (2006). Fundamentals of Conservation Biology, 3rd Edition. Wiley-Blackwell Publications, New Jersey, USA. 516 pp.

Pielou, E.C. (1975). Ecological Diversity. Wiley Inter-science Pub.

Primack, R.B. (1993). Essentials of Conservation Biology. Soiner, MA.

Department of Basic and Social Science (Bass)

Bass 1101 Information and Communication Technology 2 (1+1)

Theory

IT and its importance. IT tools, computer fundamentals; hardware and software; input and output devices; word and character representation; principles of programming- algorithms and flowcharts; Introduction to application software Word Processors, Spreadsheets, Presentation Software, Image Processing Software, Local area network (LAN), Wide area network(WAN), computer programming, Audio visual aids, Internet and World Wide Web, Internet web programming , HTML, CSS, Javascript, Internet security, Mobile technologies

Lecture schedule

1. (Basic Concepts) IT and its importance, Introduction to Computer System: Hardware and Software – Hardware Components of a Computer – Processor – Main memory – Secondary Memory – Input Devices – Output devices – Storage and Backup Devices
2. Software Component – Software/Program – Operating System – Application Software/Program – Free and Open Source Software

3-4. Introduction to Application Software: Word Processors, Spreadsheets, Presentation Software, Image Processing Software,

5-6. Introduction to Computer Programming: Assemblers – Compilers – Interpreters – Machine Code – Assembly Language – High Level Languages – Algorithms and Flowcharts

7. Audio visual aids definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids

8-9. Introduction to Computer Networking: Types of networking – Peer to Peer, Client – Server, Networking components – Hubs, Switches and Routers – Functionality of Hubs, Routers and switches – LAN, WAN and Wireless LAN, MAN

10-11. Introduction to Database Management Systems – Tables – Relations – Queries – SQL

12-13. Introduction to Internet Technologies: Overview – IP Address – Domain Name Systems – Internet Services (Communication Services – Information Retrieval Services – Web services - Video-Conferencing) – Internet Connectivity – Websites (Static, Dynamic) - Website Types – Web designing – Web page anatomy

14. Introduction to Internet Web Programming – HTML, CSS, Java Script, PHP

15-16. Internet Security Overview – Threats & Vulnerabilities – Data Encryption – Digital Signature – Firewall

17-18. Mobile Technologies - Mobile Application Architecture

Practical

Exercises on binary number system,; Familiarization with Hard ware and software, operating system, Application software: MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, algorithms and flowcharts, database management system, internet, operation of Email account; Handling of audio visual equipments

Practical schedule

1-2. Exercises on Number system-Binary, Decimal, Hexadecimal and Octal

3. Familiarization of Hardware Components: Input Devices – Output devices – Storage and Backup Devices

4. Familiarization with Main memory and Secondary Memory: RAM - ROM - Cache memory

5. Software Component – Application & System Software

6. Operating System: WINDOS and LINUX
7-9. Application Software: Word Processor-different elements in word screen-moving and copying text-insertion of symbols, bookmarks, date, page numbers, pictures, header & footer, endnotes, page breaks, columns, tools like-spell check, auto correct, macros, mail merge and print
10-11. Spreadsheets: Auto fill, Auto sum, Automatic re-calculation. Inserting charts-editing-formatting-sorting-printing
12-13. Presentation Software: Introduction of MS PowerPoint- Making projects and presentations
14. Webpage creation basic concepts-demonstration
15. Database creation and updation through Database Management Systems-MS Access-Libero office base
16. Internet: Browsing-searching-chatting-mailing-video calling etc
17. Handling of audio-visual equipments
18. Final practical examination

Suggested reading

Arick, M.R. (1994). The TCP/IP Companion - A Guide for Common User. Shroff Publishers and Distributors Pvt. Ltd., Mumbai.
Balaguruswamy, E. (1998). Programming with ANSI C. Tata McGraw Hill, New Delhi.
Deitel, H.M. (1990). An Introduction to Operating System. Addison Wesley
Desai, B. C. (2000). Introduction to Database Systems. Galgotia Publications, New Delhi.
Freer, J. (1990). Computer Communication and Networks. Affiliated East West Press, New Delhi.
Mansfield,R. (2008). Working in Microsoft office, Tata McGraw Hill
Miller,M. 2007. Absolute Beginner's guide to computer Basics, Fourth Edition, Pearson Education.
Norton, P. (2007). Introduction to computers, Sixth Edition Tata McGraw Hill
Raj, K.(2007). Internet and web Technologies, Tata McGraw Hill
Tanenbaum, A.S. (2003). Computer Networks. Prentice Hall of India, New Delhi.

Bass 1102 Communication Skills and Personality Development 2 (1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal 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 presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. Transactional skills, group dynamics.

Lecture schedule:

1-4. Communication Skills: Structural and functional grammar
5-6. Meaning and process of communication, verbal and non-verbal communication. Listening and note taking, writing skills, oral presentation skills
7-8. Field diary and lab record; indexing, footnote and bibliographic procedures.
9-10. Reading and comprehension of general and technical articles,
11. Précis writing, summarizing, abstracting
12-13. Individual and group presentations, impromptu presentation, Public speaking
14-15. Group discussion. Methods of group interaction- seminars, workshop, Colloquium and conferences.

16. Transactional skills- Ego state, transactional skills, strokes and life positions
17-18. Group dynamics: concept and procedures and tips

Practical
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, precis writing, summarizing, abstracting; individual and group presentations. Transactional analysis, group dynamics

Practical schedule
1. Exercises in word clause
2-3. Thorough exercising on the verb patterns
4-6. Exercise on tense – use in different situations (News reporting conversation etc)- enriching daily expressions.
7. Use of voice – exercise on active and passive voice
8. Exercise on conjunction and preposition
9. Sentence pattern in English – its uses
10. Lab work of phonetic sounds
11. Developing reading skills, listening and note making
12. Developing skill in writing
13. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting;
14-15. individual and group presentations
16. Transactional analysis
17. Group dynamics
18. Final practical examination

Suggested Reading
Carroll, B.J. (1986). English for college, Macmillan India Ltd. New Delhi
Hornby, A.S. (1975). Guide to patterns and usage in English. Oxford University, NewDelhi.
James M and Jongeward, D. (1978). Born to Win: Transactional Analysis with Gestalt Experiments. New American Library, New York
Qurik, R and Green baum, S. (2002). A University Grammar of English, London.
Wren P.C. and Martin, H. (2006). High School English Grammar & Composition. S. Chand & Co. Ltd Group

Bass 1103Basic Mathematics 2 (2+0)

Theory
Elementary idea of complex number. Arithmetic and Geometric progressions. Elementary idea of permutation and combinations. Matrix of a system of linear equations. Binomial theorem for positive integral index, any index and their applications, addition and substraction formulae. A, B and C, D formulae. Sine and Cosine formulae. Inverse Trignometric functions, ratios and their inter relationships. Limit of functions-differentiations and integrations simple applications-maxima and minima least square techniques- Introduction to matrices and determinants, special type of matrices, addition, substraction and multiplication of matrices.

Lecture schedule:
1. Definition of a complex number – addition, substraction and multiplication of two complex numbers – Conjugate of a complex number.

2. Standard form of a complex number (Modulous – amplitude form) and problems based on modulous amplitude form.
3. Arithematic progression (A.P), standard form of A.P, n^{th} tern and sum of n terms of AP
4. Problems based on AP
5. Geometric progression (G.P), standard form of G.P, n^{th} tern and sum of n terms of GP.
6. Problems on Geometric progression.
7. Single arithmetic mean between any two given numbers, Single geometric mean between any two given numbers, relationship between AM and GM
8. Definition of permutation, Concept of factorial, formulae of n(P,r without proof)Simple problems on permutation.
9. Combination – definition, formulae n(C,r without proof) and problems on combination.
10. Binominal theorem for a positive integral index, any index – binominal coefficient, properties of binominal coefficients.
11. Problems on binominal theorem.
12. Matrices – definition, addition and multiplication of matrices – different types of matrices.
13. Problems on addition, substraction and multiplication of matrices.
14. Determinant of a square matrix of order 2 and 3. Properties of determinants and their evaluation.
15. Inverse of a square matrix - computation of inverse of matrix of order 2 and 3
16. Solution of system of linear equations by crammer's rule.
17. Trigonometric ratios and their inter relationships – trigonometrical ratios of certain angles like 0^0, 30^0,45^0, 60^0 and 90^0
18. problems on trigonometrical ratios
19. Angle of elevation, angle of depression and problems on heights and distances.
20. Trigonometric functions of sum and difference of angles.
21. Trigonometric functions of multiple and sub multiple angles like sin 2A, sin 3A, cos 2A, cos 3A, tan 2A, tan 3A
22. Problems on item 20 and 21
23. Conversion of sum or difference into a product of trigonometric functions and simple problems.
24. Function – continuity at a point – limit of a function – properties of limits and problems on limits.
25. differentiation – rules of differentiation – sum, product and quotient rule
26. Problems on differentiation
27. differentiation of a function of a function
28. Implicit functions, parametric functions and problems
29. Successive differentiation
30. applications of differentiation – increasing and decreasing functions
31. principle of least squares – concept of maximum and minimum value of a function, turning points. Conditions for maximum and minimum value of a function.
32. Problems on item no.31
33. Integration – integration using stand - results
34. Integration by substitution.
35. Definite integral and its properties
36. Applications of integration - area bounded by the curve y = f(x) and the ordinate at x = a and x = b.

Suggested reading

Chatterjee SK. (1970). Mathematical Analysis. Oxford & IBH.
Frank, A. (1962). Schaum's *Outline of Theory and Problems of Matrices.* McGraw-Hill.
Frank, A. (1967). *Theory and Problems of Differential Equations.* McGraw-Hill.

Gentle JE. (2007). Matrix Algebra: Theory, Computations and Applications in Statistics. Springer.
Narayan, S. (1953). *A Text Book of Matrices.* S. Chand and Company.
Parameswaran, S. (1976). An introduction to mathematics. Oxford & IBH Publishing Co.172 p.
Priestley, H.A. (1985). *Introduction to Complex Analysis.* Clarenton Press
Walter R. (1976). *Principles of Mathematical Analysis.*McGraw-Hill.

Bass 1104 Basic economics 1 (1+0)

Theory

Economics- Meaning, definition, subject matter- Divisions of economics -Importance of economics- Agricultural economics- Meaning, definition- Basic concepts - Goods, service, utility, value, price, wealth, welfare- Wants- Meaning, characteristics, classifications of wants, importance. Theory of consumption- Law of diminishing marginal utility, meaning, definition,assumption, illustration, limitations, law of equi-marginal utility-Importance-Consumer surplus- Meaning, definition, importance.

Demand- Meaning, definition, kinds of demand, demand schedule, demand curve, law of Demand, extension and contraction vs increase and decrease in demand. Elasticity of demand-Types of elasticity of demand, degrees of price elasticity of demand, methods of measuring elasticity, factors influencing elasticity of demand, importance of elasticity of demand – supply-meaning,supply function-Law of supply- factors influencing –Production- Meaning, factors of production- land, labour, capital, organization, entrepreneurship- Inflation: definition, types of inflation- Welfare economics- meaning and basic concepts, Production Economics: concepts, Three production relationships, returns to scale.

Lecture Schedule

1. Economics-meaning-Definition-wealth-welfare-scarcity and growth approaches-subject matter-Divisions-micro and macro-importance
2. Agricultural Economics – meaning - definition- subject matter – importance- relationship with other disciplines
3-5. Basic terms and concepts – goods, services, Utility-types, value- attributes, price, wealth-attributes, welfare- goods- types- circular flow of money
6.Human wants-meaning-characteristics-classification of wants, importance
7.Theory of consumption – Meaning- Importance-Standard of Living-Engel's Law of Family Expenditure
8. Law of Diminishing Marginal Utility-Meaning-Definition-Illustrations-Assumptions-Limitations
9.Law of Equi- Marginal Utility-Meaning-Definition- Limitations-Importance
10-12. Consumer Surplus-meaning-definition-importance-Demand-meaning-definition-types of demand-law of demand-Extension Vs Contraction-Increase and decrease in demand-demand schedule-shift in demand-exceptions to demand-factors influencing demand- Supply- meaning-supply function-law of supply- factors influencing
13-14. Elasticity of demand-definition-meaning-types–price-income-cross-degree of elasticity-measurements of elasticity-factors influencing elasticity of demand-Supply-definition-types-law of supply-factors
15. Production-meaning-factors of production-Land-meaning-importance-peculiarities, labour, capital, organisation, entrepreneurship
16.Inflation -definition-causes-types-demand pull and cost push inflation, Welfare economics-basic concepts
17-18. Production relationships- factor-product, product-product and factor-factor relationship, returns to scale

Suggested readings

Dewett, K.K., Verma. (2005). Elementary Economic Theory, S.Chand, New Delhi.

Reddy, S.S., RaghuRam, P., Neelakanta Sastry, T.V., Bhavani, D.I. (2009). Agricultural Economics.Oxford and IBH Publishers, New Delhi.

Bass 1207 Geology and Soils 2 (1+1)

Theory

Introduction to geology - its significance, composition of earth's crust, Soil: pedological and edaphological concepts. Rocks -types – igneous, sedimentary and metamorphic. Soil forming minerals. Weathering of rocks and minerals, Soil formation factors - parent material, climate, organism, relief, time. Soil forming processes-eluviations and illuviation. Components of soil. Soil profile, soil physical properties-soil texture, textural classes, particle size analysis, soil structure, classification, soil aggregates- significance, bulk densityand particle density of soils and porosityand their significance and manipulation. Soil colour.Soil water, retention and potentials, soil moisture constants, movement of soil water, infiltration, percolation, permeability, drainage- methods of determination of soil moisture. Thermal properties of soils, soil temperature.Soil air, gaseous exchange, Influence of soil temperature and air on plant growth. Chemical properties -soil colloids,properties, nature, types and significance; organic-humus-inorganic- layer silicate clays-hydrous oxides and sources of charges. Soil organic matter decomposition - concept of pH - soil acidity -nutrient availability-soil buffering capacity. Ion exchange, CEC & AEC. A brief overview of saline, sodic and calcareous soils. Forest soils-characteristics- distinguishing features- changes in physical and chemical properties compared to agricultural soils.

Practical

Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, organic matter, pH, EC; Textural analysis by hydrometer method; Study of soil profile; Study tour for identification of rocks and minerals and profile studies; Practicals on introduction to tensiometer, pressure plate and neutron probe etc.

Lecture schedule

1. Introduction to geology- its significance –composition of earth's crust.
2. Rocks - different kinds of rocks, formation, and classification.
3. Soil - definition –pedological, and edaphological approach - major soil components.
4. Soil forming minerals: definition- classification-silicates-oxides-carbonates– sulphides - phosphates- primary, secondary, accessory minerals - occurrence.
5. Weathering of rocks and minerals- physical –chemical - biological agents involved.
6. Factors of soil formation - parent material-climate - organism- relief-time.
7. Fundamental and specific soil forming processes -eluviations and illuviation - Podzolisation and laterisation - soil development, profile differentiation, horizons.
8. Soil texture,classifications of soil separates, importance of soil texture, particle size analysis.
9. Soil structure and types of soil structure- mechanism of soil structure formation-management of soil structure -Soil aggregate and its significance in agriculture.
10. Soil colour-definition-its significance-colour variable-hue, value, chroma, Munsellcolour chart-factors influencing. Particle density - bulk density and porosity - importance in soil fertility, factors affecting. Pore space-definition-factors affecting capillary and non-capillary porosity.Soil temperature: and factors affecting soil temperature in relation to plant growth. Soil aeration, gaseous exchange and its composition in relation to plant growth
11. Chemical properties-soil colloids- properties of colloids, different kinds of colloids, sources of charges on soil colloids, role of colloids in soil fertility.
12. Soil organic matter - role of organic matter in physical and chemical properties of soils and plant nutrition.

13. Soil pH-nutrient availability-soil buffering capacity- liming.
14. Cation and anion exchange phenomenon - its importance - CEC and nutrient availability.
15. A brief overview of saline, sodic and calcareous soils.
16. Soil water-forms of soil water, hygroscopic capillary and gravitational-Soil moisture constants-hygroscopic coefficient-wilting point-field capacity-moisture equivalent, maximum water holding capacity, energy concepts-pF scale.
17. Soil moisture measurement gravimetric-electric and tensiometer methods-pressure plate and pressure membrane apparatus-Neutron probe. Soil water movement-saturated and unsaturated flow - infiltration and percolation.
18. Forest soils- characteristics- distinguishing features- changes in physical and chemical properties compared to agricultural soils.

Practical schedule

1. Identification of rocks and minerals.
2. Examination of a soil profile.
3. Collection and preparation of soil samples for analysis.
4. Soil moisture determination.
5 & 6. Determination of soil bulk density, particle density and porosity
7 & 8. Particle size analysis of soils
9. Textural identification of soil using Textural Triangle.
10. Soil aggregate analysis.
11. Determination of soil pH
12. Determination of electrical conductivity of soil
13. Determination of soil organic carbon
14&15. Determination of CEC of soils
16 &17. Practical on introduction to Tensiometer, pressure plate and neutron probe etc.
18. Final practical examination

Suggested reading

Biswas, T.D. and Mukherjee, S. K. (2006). Test Book of Soil Science, Tata McGraw Hill Publishing Co., New Delhi.
Brady, N.C. and Weil, R.R. (2002) The nature and properties of soils, Prentice Hall of India Pvt. Ltd, M-97, Connaught Circus, New Delhi.

Gupta, P,K. (2007). Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur
Das, D.K. (2002) Introductory Soil Science, Kalyani publisher, New Delhi.
Indian society of soil science (ISSS). (2002). Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
Jaiswal, P.C.(2006). Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiyana
Pritchett and Fisher R, F. (1987). Properties and Management of Forest Soils. John Wiley, New York.

Bass 1208Climate Science 2(1+1)

Theory

Agrometeorology – definition, aim and scope. Factors and elements of weather and climate. Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Cyclones, anticyclones and thunder storms. Solar radiations components and effect on plant growth. Effect of weather and climate on the growth and development of crops. Climatic normals for crops and trees. Agro climatic zones of India. Evaporation and transpiration. Climate change: Understanding climate change

and its Consequences. Global warming and its effects on Forest. Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on agro-forestry- Climate resilient forestry. Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives –Kyoto protocol, awareness about climate change. National action plan for climate change.

Lecture schedule

1 Agrometeorology aim and scope

2 Concepts of weather and climate. Macro, meso, micro and phytoclimate.

3 Laws of radiation - solar constant - short wave and long wave radiation - composition of the atmosphere; absorption by carbon dioxide, water vapour and ozone.

4 Stratification of atmosphere - troposphere, stratosphere mesosphere and thermosphere. Temperature inversion; effects on air pollution; ionosphere and homosphere.

5-6 Meteorological elements – temperature; factors affecting temperature at a place - latitude, altitude, nearness to sea, prevailing winds, ocean currents, topography, condition of atmosphere. Isothermal charts, diurnal variation of air and soil temperature, cardinal temperatures.

7 Atmospheric pressure; units; variation with height; isobars; pressure gradient and Coriolis force; geostrophic wind, general circulation, trade and antitrade winds, cyclones and anticyclones, Beaufort's scale.

8 Humidity; saturated and actual vapour pressure; absolute, specific and relative humidity, psychrometry; diurnal variation of humidity.

9 Forms of precipitation - rainfall, frost, snow, fog; isohyets. Classification of clouds, cloud seeding for agriculture.

10 Cyclones and anticyclones and thuderstorms

11-12 Spectral distribution of solar radiation. Radiation balance - albedo; radiation distribution in plant canopy - net radiation; radiation instruments; sensible heat flux and air temperature leaf temperature; thermoperiodism; growing degree days

13 Moisture factor in plant growth - Evapotranspiration - measurement and computation

14 Climatic and agroclimatic classification - Koppen and Thornthwaite's methods; agroclimatic classification of India and Kerala.

15 Understanding climate change – global warming- GHG emissions-Consequences of climate change Kyoto Protocol.

16 Global warming effects on Forest. Forest and climate change mitigation – Vulnerability and adaptability

17 Evidence of forest disturbance due to climate change –Climate change influence on agroforestry- Climate resilient forestry

18 Climate change during 20th century – Historical perspectives of climate change monitoring and mitigation- Global initiatives- basic concepts on Rio Summit- WMO- UNEP-UNFCCC-IPCC- NATCOM initiatives- IPCC assessment reports, INCCA

Practical

Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer. Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of greenhouse gases into atmosphere.

Practical schedule

1. Agromet Observatory - choice of site and layout.
2. Installation of stevenson screen and thermometers, and soil thermometers.
3. Installation of windvane and anemometer.

4. Installation of rain gauges and sunshine recorder.
5. Installation of evaporimeter and dew gauge.
6. Recording and tabulation of the observations.
7. Measurement of air temperature - Stevenson screen; dry bulb, wet bulb maximum and minimum thermometers.
8. Measurement of soil temperature - soil thermometers.
9. Measurement of wind speed - cup anemometer,Measurement of wind direction - windvane.
10. Rainfall measurement - FRP raingauge.
11. Rainfall measurement - self recordingraingauge.
12. Measurement of evaporation - open pan evaporimeter
13. Measurement of duration of sunshine - Sunshine recorder.
14. Measurement of humidity and vapour pressure using psychrometer.
15. Measurement of dew - Duvdevani dew gauge.
16. Thermograph, Hygrograph.
17. Estimation of soil respiration
18. Final practical examination

Suggested reading

Adam Markham (Ed.). (2010). Potential Impacts of Climate Change on Tropical Forest Ecosystems. Amazon publishers.

Bravo, F., LeMay, V., Jandl, R., Gadow, K. von (Eds.).(2008). Managing Forest Ecosystems: The Challenge of Climate Change. Springer publication. Pp 324

Charlotte Streck, Robert O'Sullivan, Richard G. Tarasofsky, Toby Janson-Smith. (2011). Climate Change and Forests: Emerging Policy and Market Opportunities. Brookings Institution Press.

Claussen, E. Cochran, V D. and Debra P D. (2001). Climate Change: Science, Strategies, & Solutions. Brill Academic Pub. Pp 393

Ghadekar, S.R. (2003) Meteorology .Agromet Publishers, Nagpur

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Mavi, H.S. (1994) Agrometerology. Oxford &IBH, New Delhi

Peter H Freer-Smith, Mark S J Broadmeadow, Jim M Lynch. (2011). Forestry and Climate Change. CABI Publishers.

Peter Thompson. (1991). Global warming – The debate. Strategy Europe Ltd., London, U.K. p.130.

Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,

Richard Max-Lino. (2012). Sustainability, climate change, forestry and forest carbon. World Scientific Publishing Co. pp 250.

Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg

Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR, New Delhi.

Bass 3114Statistical Methods & Experimental Designs 3 (2+1)

Theory

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data. Construction of frequency distribution, tables –graphical representation of data, simple, multiple component and percentage bar diagram, pie diagram, histogram, frequency polygon and frequency curve. Average and measures of location- mean, mode, median, geometric mean, harmonic mean, percentiles and quartilesfor raw and grouped data. Dispersion- Range, Quartile deviation, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions,

binominal, poisson and normal distributions. Sampling: basic concepts, sampling vs. Completeenumeration,parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of significance: Basic concepts, tests for equality mean,independent and paired t-tests, chi-square tests for application of attributes and test for goodnessof fit. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, tests of significance of correlation and regression co-efficient. Introduction to design of experiment- Basic principles of experimental design-replication, randomization and local control. Analysis of variance-assumptions-construction of ANOVA table- conclusions based on ANOVA. Comparisons based on means-critical difference, DMRT. Transformations of data-square root, logarithmic and angular transformations. Completely randomised design-Layout, analysis, advantages and limitations, Randomised block design-layout, analysis, choice of no. of blocks, advantages and limitations. Latin square designs-layout, analysis, applications, advantages and limitations. Factorial experiments: basic concepts, analysis of factorial experiments up to 3 factors. Split plot design.

Lectureschedule

1. Elementary statistical concepts -functions ofstatistics -collection, classification and tabulation ofstatistical data
2. Formation of frequency distribution
3. Diagrammatical representation of statistical data
4. Graphical representation of statistical data
5. Measures of central tendency-requisites for an ideal measures of central tendency-arithmetic mean –its calculation- properties-weighted arithmetic mean.
6. Median and other measures of location - their calculation - merits and demerits - comparison of differentaverages
7. Measures of dispersion-range-mean deviation-quartile deviation-their calculation
8. Variance and standard deviation-comparisons among different measures of dispersion and their applications to specific situations - relative measures of dispersion - coefficient of variation measuresof skewness and kurtosis
9. Presentation of bi-variate data - scatter diagram - measures of association – product moment correlation coefficient –rank correlation.
10. Linear regression –its application in forestry-interpretation of regression coefficient-correlation vs regression
11. Elementary ideas on probability-addition and multiplication theorems on probability
12. Binomial theorem on probability-binomial and Poisson distributions.
13. Normal distribution-properties-its importance in statistics-normal probability integral
14. Basic concepts on sampling–sampling unit, sampling frame, sample size – Sampling Vs complete enumeration, parameter and statistic, sampling distribution of a statistic &standard error
15. sampling methods, simple random sampling and stratified randomsampling
16. Tests of statistical hypotheses-critical region-large sample tests-transformation of the correlation coefficient.

17-18.Small sample test-tests for equality of means and variances –t and F tests-Applications and assumptions-test of significance of correlation coefficient

19-20.Chi-square test-assumption and limitations-application of Chi-square test.

21. Important terms and definitions - need for designing an experiment. Basic principles of experimental design-replication, randomization and local control.
22. Practical considerations in field experiments coping with soil heterogeneity- size and shape of plots and blocks- bordereffect- uniformity trials and their uses.
23. Analysis of variance-assumptions-construction of ANOVA table conclusions based on ANOVA.
24. Comparisons based on means-critical difference.

25. Transformations of data- squareroot, logarithmic and angular transformations.
26. Completely randomized design-Layout, analysis, advantages and limitations
27. Randomized block design-layout, analysis, choice of no.of blocks, advantages and limitations.
28. Latin square designs-layout, analysis, applications, advantages and limitations
29. Analysis of covariance-its application
30. Factorial experiments-symmetrical and asymmetrical-main effects and interaction effects-advantages
31-32. Split plot design-layout, applications and advantages
33-34 Strip plot design-layout, applications and advantages
35-36. Introduction to long-term experiments

Practical:

Construction of frequency distribution table and its graphical and diagrammatic representation. Calculation of various measures of central tendency and dispersion for both individual and grouped series. Problems on small sample and large sample tests. correlation and linear regression. Analysis of experimental data in the case of single factor and multi factor experiments.

Practicalschedule

1. Formation of frequency distribution, Diagrammatic and graphic representation
2. Calculation of different measures of central tendency
3. Computation of various measures of dispersion- Calculationof coefficient of variation-coefficients of skewness and kurtosis
4. Computation of product moment correlation coefficient-rank correlation coefficient-and coefficient of concordance
5. Fitting of linear regression models forprediction
6. Simple problems on probability-fitting of binomial distribution
7. Fitting of poisson distribution , problems on normal distribution
8. Selection of simple random sample – estimation of parameters – sample size determination
9. Selectionofstratifiedrandomsample–equal, proportiona land Neyman's allocation in stratified sampling
10. Large sample tests
11. Small sample tests, t and F tests
12. Chi –square test, test of goodness of fit – test of independence of attributes in a contingency table - computation of mean – square contingency
13 Analysis of variance-construction of ANOVA table of one-way classified data.
14 Analysis of variance-construction of ANOVA table of two-way classified data.
15 Lay out and analysis of CRD, Lay out and analysis of RBD
16 Analysis of data from 2^n factorial experiments in RBD. Formation of Yate's table-calculation of main effects and interaction effects.
17 Layout and analysis o fsplit-plotdesign.
18 Final practical examination

Suggested Readings

Anderson, R.L. and Bancroft, T.A. (1952).StatisticalTheoryinResearch. Mc.Graw Hill BookCo.,NewYork.
Cochran, W. GandCox, G.M.(1958).Experimental designs. Wiley, NewYork
Das, M.N. and Giri, N.C. (1986). Design and analysis of Experiments. Wiley EasternLtd., NewDelhi.
Federer, W.T. (1955). Experimental Design. Macmillan, NewYork.

Gomez, K.A. and Gomez,A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. NewYork.680p.
Goon, A.M., Gupta, M.K. and Dasgupta, B. (1983). Fundamentals of Statistics. Vol.1. The World Press Pvt. Ltd., Calcutta.
Garcia, D., A. and Phillips, D.T. (1995). Principles of Experimental Design and Analysis. Champman and Hall, London.
Gupta, S.C. (2004). Fundamentals of Statistics. Himalaya Publishing House Pvt Ltd.
Kempthorne, O.(1952).The design and analysis of experiments.Wiley,NewYork.
Nigam A.K. and Gupta,V.K.(1979). Handbook on Analysis of Agricultural Experiments. IASRI Publication, NewDelhi.
Panse, V.G.andP.V.Sukhatme. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, NewDelhi, India.
Petersen Roger G. (1994). Agricultural Field Experiments:Design and Analysis. MarcelDekker, NewYork.
Snedecor, G.W. and Cochran, W.G. (1989). Statistical Methods. Iowa State University Press, Ames, Iowa.

Bass 3215 Forestry Extension 2 (1+1)

Theory

Concept, scope, principles, philosophy and objectives of extension education and forestry extension education. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Forestry extension: process, principles and types of education, Formal, informal non-formal education. People's participation in Forestry programmes. Elements of extension education, man himself man's environment and man's created devices. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like Lab to Land programme (LLP) National Demonstration (ND), Front Line Demonstration (FLD) KrishiVigyanKendras (KVK), Van VigyanKendras, Technology Assessment and Refinement Programme (TARP) of ICAR/ICFRE. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Programme planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Classification of group- Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group.

Lecture schedule

1. Concept, scope and principles of extension education and forestry extension education
2. Philosophy and objectives of extension education and forestry extension education
3. Elements of adult learning situation and process of transfer of technology
4. History of rural development and forestry extension in India - pre independent and post independent efforts
5. Extension and forestry extension abroad - cases of developed and developing countries
6. Functional and technical literacy in forestry
7. Process and elements in communication - constraints and feedback mechanisms
8-9. Diffusion process – elements of diffusion, adoption process, attributes of innovation
10. Programme planning – steps in programme planning, microlevel planning for forestry extension
11. Monitoring and evaluation for development projects – project appraisal
12. Peoples participation in forest management – participatory rural appraisal
13-15. Extension teaching methods - importance - classification - individual, group and mass contact methods - procedures to be followed.
16-17. Audio-visual aids - importance - classification - projected and non-projected aids

18. Public speaking and effective oral communication. Organisation of extension seminars - organisational set up of agriculture and forest departments

Practical:
Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/MahilaMandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing). Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards. Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises.

Practical schedule
1-2. Farm and home visits to successful communities, forest areas etc.
3-4. Group discussion exercises
5-9. Method demonstration presentations by individual students
10-11. Preparation of charts, maps, graphs, flash cards, flannel graphs etc.
12-13. Familiarization with the use of audio-visual aids such as projectors etc.
14-15. Participation in conducting exhibitions, campaigns etc.
16. Preparation of individual and village level production plans
17. Visits to agricultural extension and forestry extension organisations, PRA exercises.
18. Final Practical Examination

Suggested reading
Dahama, O.P. and Bhatnagar, O.P. (1980). Education and communication for development, Oxford & IBH Pub. Co., New Delhi.
Mishra, S.N. and Sharma, K. (1983). Problems and prospects of rural development in India. Uppal Publ. House, New Delhi.
Reddy, A.A. (1978). Extension education. Sree Laxmi Press, India.
Sandhu, A.S. (1993). Text book on agricultural communication: process and methods. Oxford & IBH Pub. Co., New Delhi.
Sandhu, A.S. (1994). Extension programme planning, Oxford & IBH Pub. Co., New Delhi.
Supe, S.V. (1983). An introduction to extension education, Oxford & IBH Pub. Co., New Delhi.
Waghmare, S.K. (1980). Teaching extension education, Prashant Publishers, India.

Bass 4217Agricultural Informatics 2 (1+1)

Theory
Introduction to Informatics, e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes, Geospatial technology for generating valuable agri-information, Neural Networks and Decision Support Systems concepts, components and applications in Agriculture, Agriculture Expert System, Knowledge Management Systems, E-learning, Agricultural resources and services management systems, Research Management Information Systems, Smartphone Apps in Agriculture, Basic concepts of Bioinformatics

Lecture schedule
1. Agroinformatics – Definitions, Objectives of Agroinformatics, Information Systems Terminology, Agroinformatics Tools, e-Agriculture
2. Agriculture Information Systems – Major Trends, Internet Based Agriculture Information System - AGRIS/CARIS, AGROVOC.2-3.
3. IT Infrastructure, Telecom, and Internet including Web 2.0, CRM, SCM, ERP - Data mining – Business Intelligence – Ethical issues relating to Information Systems

4. Use of ICT in Agriculture – Computer Models for understanding plant processes – E-Agriculture – Computer Controlled Devices in Agri-input Management -
5-6. Geo-Informatics: Definition of GIS, Fundamentals of GIS, Mapping concepts, Geographical Data Sets, Remote Sensing in Agriculture,
7. Global Positioning System- Components, Remote Sensing and GIS, General Packet Radio Service (GPRS) Network – Benefits
8. Neural Networks and Decision Support Systems- Concepts, Components and Applications in Agriculture
9. Agriculture Expert Systems- Characteristics of Agricultural Expert System, Need of Expert Systems in Agriculture, Issues related Expert Systems
10-11. Knowledge Management Systems – Agriculture Database Concepts and Importance, Agriculture Databases-Types, Agriculture Libraries, Agriculture Journals, E-Books in Agriculture
12. E-Learning – Open Education Initiatives - Case studies
13. Agricultural resources and services management systems, Research Management Information Systems
14. Extension and Advisory Services, Methods and tools of communication
15. Agricultural Open Archives and Repositories - Virtual Extension, Research and Communication Network (VERCON)
16. Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc.
17-18. Bioinformatics- Definition of Bioinformatics, History of Bioinformatics, Bioinformatics-Application in Agriculture, Sequence Analysis, Structural Bioinformatics, Internet Sites For Bioinformatics

Practical

Agriinformatics tools and systems, Hands on Geospatial Technology for generating valuable information for Agriculture, Case studies - Neural Networks and Decision Support Systems- Knowledge Management systems- E-Learning- Agricultural resources and services management systems- Research Management Information Systems- Smartphone applications, Preparation of contingent crop-planning

Practical schedule

1. Familiarization with Agroinformatics Tools and Agriinformation systems
2-3. Use of GIS in agriculture, Map creation
4-5. Global Positioning System- Uses and applications in agriculture
7. Neural Networks and Decision Support Systems- Case studies
8-9. Knowledge Management: Case studies
10-11. E-Learning - Case studies
12-13. Agricultural resources and services management systems - Case studies
14-15. Research Management Information Systems - Case studies
16. Smartphone Apps in Agriculture- Case studies
17. Preparation of contingent crop-planning using IT tools
18. Final practical examination

Suggested reading

Shanmughavel, P. (2005). Principles of Bioinformatics Pointer Publication, Jaipur
Vanitha G. and Kalpana, M. (2011). Agro-informatics. New India Publishing Agency, New Delhi
Vijayakumaran Nair K and Vinod Chandra SS. (2014). Informatics, PHI Learning Private Limited

Bass 4218 Entrepreneurship Development and Business Management 2 (1+1)

Theory

Concept of Entrepreneur, Entrepreneurship Development, Entrepreneurial skills, SWOT Analysis & achievement motivation, Entrepreneurial behavior, Government policy and plan for entrepreneurship development, Leadership Skills, , Communication skills for entrepreneurship development, organizational skill , Managerial skills, Problem solving skill, Encoding and decoding Supply chain management and Total quality management, Project Planning Formulation and report preparation.

Lecture schedule

1. Concept of entrepreneurship; entrepreneurial and managerial characteristics.
2. Managing an enterprise; motivation and entrepreneurship development.

3-4 Importance of planning, monitoring, evaluation and follow up; managing human resources, Managing conflict and negotiation

5 Generation, incubation and commercialization of ideas, SWOT analysis

6. Financing of Entrepreneurship –Venture capitals, Angel investors, Orgnisational support, KSIDC, DIC, SME etc

7-8. Entrepreneurial behavior, Government policy and plan for entrepreneurship development.

9. Communication skills; Communication skills for entrepreneurship development

10 Developing organizational skill, Managerial skills, Problem solving skill, encoding and decoding

11-14 Supply chain management and Total quality management,

15. Management – concepts, functions and principle, Forest business management

16-18. Business development Plan- Project identification Pre-feasibiltiy study- feasibility study- techniques-Techniques of financial appraisal- Project preparation

Practical

SWOT analysis, developing leadership skills, developing managerial skills, problem solving skill, supply chain management and total quality management, project planning formulation and report preparation.

Practical schedule:

1-2.Exercises in SWOT analysis.
3. Communication skills
3. Leadership skills- case studies
4. Managerials skills- case studies
5. Problem solving skill- case studies
6. Idea generation.
7-8.Business development plan -Selection of ideas,
9.Converting to business proposal,
10.Prefeasibility study,
11. Feasibility study,
12-13. Appraisal techniques- Discounting techniques, Non-discounting techniques
14-16. Decision making- Cash flow, NPV, IRR, ARR, Payback, DSCR
17. Report writing
18. Final Practical Examination

Suggested reading

Chandra, P. (2002). Projects: planning, analysis, selection, financing, implementation and review. Tata McGraw-Hill, New Delhi, India

Downey, W.D and Troche, J.K. (1981). Agribusiness Management. McGraw-Hill, New Delhi, India.

Gittinger, J.P. (1982). Economic Analysis of Agricultural Projects. The Johns Hopkins University
Gregory, G.R. (1971). Forest Resource Economics. John Wiley and Sons, New York.
Kotler, P. (2004). Marketing Management. Prentice Hall, New Delhi.
Maslow, A.H (1970) Motivation and personality. Harper and Row publishers, New York.
Perelson, B and Steiner, G (1964) Human behaviour. Harcourt Brace Jovanovich, New York.
Press, Baltimore

Bass 4219Forest Economics 2 (1+1)

Theory

Nature and concepts of forest economics- Importance of forestry in economic development – challenges of Indian forestry sector**,** National income- Estimation methods-components of forest resource accounting, concept of Green GDP**,** Production forestry: investment requirements- Importance of finance in forest sector: institutional and non-institutional sources, financing through cooperatives, commercial banks, RRB, NABARD**,** Forest project planning and evaluation: phases of project cycle, project appraisal tools: discounted and undiscounted measures-NPV, BCR, IRR, Payback period**,** Tangible and intangible benefits of forestry, introduction to valuation of ecosystem services: use and non-use values, market and non- market based valuation techniques (replacement cost, hedonic price method, contingent valuation method etc)**,** Forest valuation: financial and highest income rotation -Soil Expectation ValueMarketing and international trade: Concepts of marketing, classification of markets and market structure, Domestic and international trade in forest and wildlife products: tariff and non-tariff barriers to trade, import and export status of forest products**,** Trade agreements, Domestic and International organizations involved in forest trade and marketing- ITTO, WTO, FAO etc**,** Forest based industries in Kerala and the resource requirements.

Lecture Schedule

1. Nature and concepts of forest economics- Importance of forestry in economic development –challenges of Indian forestry sector
2. National income- Estimation methods-components of forest resource accounting, concept of Green GDP
3. Production forestry: investment requirements- Importance of finance in forest sector: institutional and non-institutional sources

4-6. Financing through cooperatives, commercial banks, RRB, NABARD

7. Forest project planning and evaluation: phases of project cycle

8-10. Project appraisal tools: discounted and undiscounted measures-NPV, BCR, IRR, Payback period

11**.** Tangible and intangible benefits of forestry, introduction to valuation of ecosystem services: use and non-use values

12.Market and non- market based valuation techniques (replacement cost, hedonic price method, contingent valuation method etc)

13**.** Forest valuation: financial and highest income rotation -Soil Expectation Value

14. Marketing and international trade: Concepts of marketing, classification of markets and market structure

15-16.Domestic and international trade in forest and wildlife products tariff: and non-tariff barriers to trade, import and export status of forest products

17. Domestic and International organizations involved in forest trade and marketing- ITTO, WTO, FAO etc

18. Forest based industries in Kerala and the resource requirements

Practical

Understanding the contribution of forest sector to GDP. Familarising the marketing practices and price trends of important timber species and NWFPs. Economic feasibility of forest

enterprises – NPV,BCR,IRR. Understanding the total economic value (TEV) of major forest ecosystems of Kerala, Forest dependent communities and livelihood dependence on forests. Understanding of different timber and non-timber based market structure, Supply chain management of forest based industries.

Practical schedule

1. Contribution of forest sector to GDP
2. Marketing practices and price trends of important timber species and NWFP

3-6. Economic feasibility of forest enterprise – NPV, BCR, IRR
7-8. Understanding the total economic value (TEV) of major forest ecosystems of Kerala
9-10. Forest dependent communities and livelihood dependence on forests
11-13.Supply chain management of forest based industries
14-16. Understanding of structure of different timber and non-timber based market
17. Visit to forest based industries
18. Practical examination

Suggested readings:

Dewett, K.K., Verma. (2005). Elementary Economic Theory, S.Chand, New Delhi.

Gunatilake, H.(2011). Environmental valuation: theory and application. Postgraduate Institute of Agriculture, University of Peradeniya.

Reddy, S.S., RaghuRam, P., Neelakanta Sastry, T.V., Bhavani, D.I. (2009). Agricultural Economics.Oxford and IBH Publishers, New Delhi.

Non-credit courses

Bass 1105 Physical Education & Yoga Practice–I 1(0+1*)

Concept of Physical Education-Meaning, need & importance, aim, & objectives.Conditioning exercises- warming up, warming down (general & specific), and flexibility exercise. Physical Fitness exercises for speed, strength, agility, endurance and coordination. Posture & Concept - Definition, values of good posture, causes & drawbacks of bad posture, Common postoral deviation, their causes and correct exercises, Kyphosis, Scoliosis, Lordosis, Knock knee & Bowlegs, Flatfoot. Running ABC'S, walking ABC'S - Major games- Rules and regulations of important games, Skill development in any one of the games - Football, Basketball &Ballbadminton. Indoor games - Participation in one of the indoor games - Shuttle badminton & table tennis. Athletic events- Rules & regulations of athletic events, Participation in any of the athletic events–Broad jump,high jump and shortput. Conduct of Health Related Physical Fitness Test (TPFP):One mile run/Beep test, Sit-Up 60 sec,Sit and reach, Modified pull-ups. NOTE: (one to be selected major games, indoor games and Athletic events). Regular basic training in Yoga.

Bass 1209Physical Education & Yoga Practice–II 1(0+1*)

Concept of Health -Physical health, mental health, social health, spiritual health, spectrum of health. Fitness & wellness- Motor components. Regular exercises, Amount of training, Scientific way of training, Restand relaxation, conditioning, Good posture, Heredity, Environment, Standard of living, Balance Diet, Stress & tension, Drugs, Intoxication. Means of Fitness Development- Aerobic activities, anaerobic activities, Sports & Games, Yoga, Recreational Activity. Safety Education – Swimming. Yoga-Meaning & importance of Yoga, Role of Yoga in life, Teaching of Yoga. Physical Fitness test – TPFP Fitness test : One mile run /Beep test, Sit-Up 60 sec, Sit and reach, Modified pull-ups. Major games- Rules and regulations of important game, Skill development in anyone of the game- Hockey, Volleyball, Handball and KhoKho. Indoor games- Participation in one of the indoor games–(Table Tennis & Badminton). Athletic events- Rules & regulations of athletic events participation in any one of the athletic events- Triple jump, Discus throw and Javelin throw. NOTE :(one to be selected, major games, indoor games and Athletic events). Regular basic training in Yoga.

Bass 2111 Physical Education & Yoga Practice -III 1 (0+1*)

Lifestyle diseases & dietary and life style changes that reduce the incidence of chronic diseases. Obesity, Coronary heart diseases (CAD), ischemic stroke Diabetes Mellitus, Blood pressure, Osteo porosis. Injuries –Injuries in sports, Prevention of sports injuries. First aid training in sports -Sprain, Fractures, Burns, Snakebite, Drowning, Unconscious victim, First aid ABC, First aid CPR, Sling and Splint and carrying techniques. Yoga continuation. Major games, Rules & regulation of important games, Skilld evelopment in any one of the game- Cricket, Football, Basketball, Volley Ball and Netball. Athletic events – Rules & regulations of athletic events–participation in any one of the athletic events – short & long distance running. Any one to be selected major games and Athletics events. Adventure training – On Land – Trekking, High Altitude Trekking, Rock Climbing, Mountaineering. In water - River Crossing. Regular basic training in Yoga.

Bass 1106 NCC/NSS -I 1(0+1)

Introduction to NCC, defense services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm,order arm, present arm, guard of honour,ceremonial drill.

or

Aims and objectives of NSS. NSS logo, motto etc. Orientation of students in national problems, study of philosophy of NSS, fundamentalsrights,directive principles of state policy, Village adoption.

Bass 1210 NCC/NSS-ll 1(0+1)

Weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush.

or

Socio-economic structure of Indian society, population problems, brief of Five Year Plan.Functional literacy, non-formal education of rural youth, eradication of social evils, village adoption- continued.

Bass 2112 NCC/NSS-III 1 (0+1*)

Field engineering, map reading, conventional signs, grid systems,use of service protractor, prismatic compass and its use,self defence, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song.

or

Awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition, village adoption-continued.

Bass 2213 Study Tour of State Forests 1 (0+1*)

Study tour of one week duration in the respective States/part of India. To familiarize the students with the fauna, flora and other research activities of SAUs, Research institute, forest industries, Govt. and private organizations of different parts of respective states/ part of India. To expose the students to various national / heritage monuments as part of national integration activity. (One week duration)

BS 4116 All India Study Tour 3 (0+3*)

To familiarize the students with the flora , fauna and other research activities of SAUs, research institutes, forest industries, govt. and private organization of different parts of India. To expose the students to various national /heritage monuments as part of national integration activity. (Fifteen days duration)

STUDENT READY

A. FOWE 4101 - Forestry Work Experience 20 (0+20)

Orientation (10 days)	0+1
Forest Range Training Programme &Weapon Training and First-Aid Training (50 +8 =58 days)	0+13
Industrial placement (20 days)	0+3
Socio-economic Surveys and Village Attachment (20 days)	0+2
Report writing and presentations (12 days)	0+1
120 days	**0+20**

Orientation
Conducting various exercises for exposing the students on the recent trends in the field of forestry, transactional analysis, personality development, soft skills etc. and to prepare students for the rigours of professional life after completing B.Sc. Forestry programme.

Forest Range Training Programme
Visit to modern forest nurseries,herbal gardens and watersheds, study the felling and logging operations, timber lots and important industrial products, study working plan, enumeration, volume and yield calculation & compartment history files, study the 'CAT' (Catchment Area Treatment Plan) and FDA (Forest Development Agencies).Use of forestry equipments/instruments, Study there generation and management of important forestry tree species, Sample plots, layout studies, stump analysis, preparation of local volume Tables. Study the working of other Forestry related organizations/industries.

At the Wildlife Sanctuaries/National Parks / Tiger Reserves, the student s are expected to earn about the aspects related with the preparation of the Management Plans/Conservation Plans, to undertake and familiarize the various wildlife population enumeration techniques and the biodiversity assessment techniques. To undertake pilot studies on the man-animal conflict and other issues in the forest areas etc.

Weapon Training and First-Aid Training:
Hands on training in the handling of various kinds of weapons and their operation, limitations and precautions during their use. Getting basic knowledge on different first aid practices which are required in case of field emergencies, like snake bite, animal attack, poachers and accidents. Also to learn about the first aid to be given to wild animals in distress and volunteer in ginrural health services.

Industrial placement
Attachment with Forest Based Industries like Wood Workshop, Saw Mills,Wood Seasoning and PreservationTreatment Plants,Pulp and Paper Industries,Aromatic and Medicinal Plant Units including AMPRS,Odakkali,Oushadhi, Kottakkal, KAPL,Aluwa, Ayurdhara,etc. Carpentry, bamboo and reed crafts, other Wood Products Industries,rubber, NWFP etc.Works to be undertaken includes study the nature of industrial and business organization–structure,raw material–collection and processing of raw-material, hands on practicals, production and management process, marketing and financial management.

Socio-economic surveys and villageattachment:
Data collection, use of PRA techniques with respect to village profile including socio-economic and cultural status, farm technology used, homesteads, agroforestry, biodiversity etc., Bench Mark survey of plant resources (cropping pattern, homesteads, agroforestry, biodiversity, yield

system etc.), Schedule development, tabulation, analysis and preparing plan of work. Under standing local forestry and other village level institutions (Panchayat, Village Forest Committees, corporations, youth/women group setc.), People's participation in developmental programmes with special reference to forestry. Exercises on the use of extension methods and teaching aids for Transfer of Technology.

Report writing and presentation
Compilation of the work/experience detailing the objectives, places and persons visited, work done, experiences/skills gained and suggestions for improvemen to ftraining. Presentation of the report before faculty.The assessment will be based on Project Report evaluation and viva-voce.

B. Experiential Learning/Hands on TrainingI & II, for B.Sc. Hons. (Forestry)
(in the Vth and VIth semesters & the students' would choose any one of the following)

1. Foel 3101/ Foel 3201 Agro and farm forestry 5 (0+5)
2. Foel 3102/ Foel 3202 Tree inventory 5 (0+5)
3. Foel 3103 / Foel 3203 Raising Quality Planting Materials of tree species 5 (0+5)
4. Foel 3104/ Foel 3204 Mass multiplication through tissue culture 5 (0+5)
5. Foel 3105/ Foel 3205 Mass production and marketing of quality planting materials 5 (0+5)
6. Foel 3106/ Foel 3206 Natural Resource monitoring and mapping via Remote Sensing & GIS 5 (0+5)
7. Foel 3107/ Foel 3207 Production and Marketing of high value forest produce 5 (0+5)
8. Foel 3108/ Foel 3208 Biodiversity assessment, documentation and conservation strategies using advanced techniques including GIS 5 (0+5)
9. Foel 3109/ Foel3209 DNA fingerprinting - a tool for wild animal forensic/ individualisation and Conservation genetics 5 (0+5)

1. Foel 3101/ Foel 3201Agro and farm forestry 5 (0+5)
Design and development of farm forestry plan: The programme is intended to equip the student with design and development of tree based farm plans as an economically and ecologically viable land use practice for farmers belonging to various socio-economic classes. Development of multi species, multitier integrated farming systems for small, medium and large farmers.

The project involves diagnostic survey of the selected farm holdings, assessment of existing crop components and biophysical conditions prevailing in the selected land use system. Socio-economic analysis of the existing farm. Discussion on the possible agroforestry interventions in the farm. Identification of compatible tree species- crop species and animal components-feasibility study- socioeconomic analysis- Farm plan preparation: layout and designing a model tree farm- farmer interface for the acceptance and implementation of the farm plan. Implementation of farm plan proposals in the farmer's field. Appraisal and evaluation of farm forestry plan- Project Report & Presentation, Final examination.

2. Foel 3102/ Foel 3202 Tree inventory 5 (0+5)
Project formulation, Tree enumeration- sampling techniques- use of modern instruments in forest inventory- volume assessment at tree and stand level- tree evaluation- pricing- Yield regulation- Monitoring growth of stands- growing stock assessment- volume tables and yield table preparation- Growth increment- age determination- stump and stem analysis. Site quality

evaluation- Direct and indirect methods- Site Index method. Density management in even aged stands: Thinning regimes, thinning intensity and thinning cycle- returns from thinning. Project Report & Presentation, Final examination.

3. Foel 3103/ Foel 3203 Raising Quality Planting Materials of tree species 5 (0+5)

Project formulation, Identification of species. Assessment of demand in local /potential markets and institutions. Identification of plus trees. Identification of superior seed sources, seed collection, treatment and storage. Clonal propagation of the selected plus tree through conventional or tissue culture under controlled and ambient conditions. Collection, Handling, Processing and Storage of seed from the plus trees. Seed treatments. Nursery raising of bare root and containerized seedlings. Evaluation of seedlings. Project Report and Presentation, Final examination

4. Foel 3104/ Foel 3204Mass multiplication through tissue culture 5 (0+5)

Project formulation. Establishment of commercial tissue culture laboratory. Tissue culture methods. Explant selection, sterilization, culture establishment, hardening.. Planting out and related problems. Commercial micropropagation. . Problems of *in vitro* propagation. Production of virus free plants. Somaclonal variation, somatic hybridisation. Tissue culture as a tool in genetic engineering Sub-culturing, Hardening and establishment, Initiation of callus cultures – suspension cultures. Production of artificial seeds. Marketing and cost analysis.

5. Foel 3105/ Foel 3205 Mass production and marketing of quality planting materials 5 (0+5)

Project formulation, Identification of species (Timber & medicinal trees & fodder green manure and wild fruit trees, bamboos- ornamental trees etc) for nursery raising, collection of plant material from selected seed sources, quantity of seed/plant material required, nursery area (open and protected), inputs required, Schedule for intercultural operation-seed treatment, sowing, weeding, fertigation, root hardening treatments. Tree nursery technology – Structures in High tech nursery -Treatment and processing of bare root and containerized seedlings. Assessment of demand in local/potential markets and institutions. Collection, Handling, Processing and Storage of planting material. Project Report and Presentation, Final examination.

6. Foel 3106/ Foel 3206 Natural Resource monitoring and mapping via Remote Sensing & GIS 5 (0+5)

GPS: handling- waypoint marking- tracking- area calculation. Google Earth: downloading, historic imageries, creating vector and raster files. Bhuvan: downloading spatial data from Bhuvan. Map reading. Downloading Aerial photograph, Satellite imagery, visual interpretation, Digital image processing- Image preprocessing - radiometric and geometric correction; Image processing- FCC generation and image enhancement; Geo referencing- image to image registration Extraction- supervised and unsupervised classification- accuracy assessment using commercial softwares-Arc GIS, ERDAS- thematic map preparation – LULCC maps- resource maps. Working with open source software QGIS: Downloading and installing GIS open software, downloading data files, digitizing, geo-referencing, adding – editing layers, processing, NDVI, creating Digital Elevation Model (DEM), map composing. Project Report and Presentation, Final examination.

7. Foel 3107/ Foel 3207 Production and Marketing of high value forest produce 5 (0+5)

Project formulation, Market survey and prioritization of species. The species (imported and indigenous) that are currently available in the market has to be surveyed through personal visits to timber markets, saw mills, forest depots etc. Lesser known, but highly utilizable indigenous species of timbers will be given priority. Fast rotation timber species raised under various trials of the University will also be included to the extent possible.

Potential of different species for various end uses will be determined. Timber samples have to be converted into sticks / smaller sizes / macerated through appropriate procedures such as sawing and sizing in a saw mill or maceration in a laboratory. Mechanical tests: Static bending, compressive tests-across and along the grain. Finding out safe working stresses of lesser known or exotic/new species. Wood database currently available in the department will be updated based on the test results. Wood conversion in an integrated saw mill, turnery for handicrafts, joineries and furniture making. Data analysis, report writing, presentation and final examination.

8. Foel 3108/ Foel 3208 Biodiversity assessment, documentation and conservation strategies using advanced techniques including GIS 5 (0+5)

Project formulation, Literature review, the sampling based approach to monitoring, Assessing available resources, Decision making - matching objectives and resources, Preparation of maps, inventories and reports using GIS and Remote Sensing applications. Population monitoring, Conceptual framework, Statistical framework, Kinds of indices Reducing bias, Estimation of relative abundance, Large carnivores, Social organization and land tenure, Ecological determinants of large carnivore density, Survival, mortality and population dynamics, Effect of environmental factors on monitoring, Large carnivore ecology: challenges to monitoring, Need for a unified framework for monitoring. Presence absence surveys, Mapping and spatial distribution, Field surveys, Questionnaire surveys, Organising the survey data for mapping and analysis, Indices of relative abundance for the predator and the prey species, Line transect theory, assumption, survey designs, data analysis, Camera trapping - capture/recapture models, Survey design and considerations.

Mist netting for Volant small mammal surveys, Sherman trapping and pit fall trapping for the non-volant small mammal surveys, Surveying/studying the avifauna, Herpeto-faunal studies, Spatial distribution of the prey and the predators: mapping and the use of GIS. Data sources, Compiling the survey data in GIS Ancillary sources of GIS data. Summarizing data and querying the GIS database, Producing maps of spatial distribution. Analyzing the prey-predator environment relationships. Case Studies, Faunal assessment and documentation of one of the protected areas or reserved forest, Project Report and presentation.

9. Foel 3109/ Foel 3209 DNA fingerprinting - a tool for wild animal forensic/individualisation and Conservation genetics 5 (0+5)

Project formulation, Literature review, Develop a DNA sequence-based technique for identification of common wild animals found in Kerala. Role of Biotechnology in Forensic Science: Wildlife forensic science - the biological tools or techniques - Accurate identification of confiscated biological samples - application of molecular biology in forensic science – DNA analysis to identify an individual from hairs, bloodstains, and other items - ABO blood typing and its relevance to forensic investigations - DNA profiling - DNA typing - Southern blot hybridization - Polymerase Chain Reaction (PCR) and its application. Molecular genetic markers in Conservation Biology, Development of microsatellite markers to study genetic variation in the big cats, Mitochondrial DNA and wildlife identification: A forensic perspective

Extraction and purification of DNA from tissue samples - solid-surface binding/purification - resin based separation - column based separation – standardization of quantity, quality of the source tissue - PCR-amplification/DNA analysis – Amplification of specific DNA sequences using

PCR - sequences of cytochrome C oxidase subunit 1 (COI), cytochrome-b, and d-loop control region - using appropriate primers. Cloning and sequencing - pGEMT and sequencing.

Case Studies, Development of a database on the common wild animals found in Kerala - unique species specific DNA sequences based on mitochondrial cytochrome c oxidase subunit 1, cytochrome b genes, and d-loop region – for the identification of the species. Project Report and Presentation.

C. Prw 4201 Project Work & Dissertation 10 (0+10)

This course shall provide the B.Sc. (Hons) Forestry students an understanding of the principles and procedures of the experimental design, layout, analysis and interpretation of data and technical writing. Each student shall work on a specific research project to be identified with the help of the supervising teacher. They shall also prepare and present a proposed plan of work (PPW) specifying the objectives and procedures of the study and present the same before an audience consisting of faculty and students. The research work will be conducted leading to the preparation of a project report in the format and style of M.Sc. Thesis. Evaluation will be done based on the quality of work, quality of report and its presentation before an audience consisting of faculty and students.