

COURSE CATALOGUE & SYLLABUS
FOR
M.Sc. (FORESTRY) PROGRAMME



SCHOOL OF FORESTRY & ENVIRONMENT
SHIATS - DEEMED UNIVERSITY,
ALLAHABAD - 211007
UTTAR PRADESH

M.SC. FORESTRY PROGRAM

Course Code	Title of course	L	P	Credits	Min. credit
MAJOR COURSES [Core courses + Optional/ specialization courses + Seminar]					
CORE COURSES					
SVC-701	Advanced Silviculture	1	1	2	18
SVC-702	Forest Biometric	1	1	2	
TBR-701	Tree Breeding	1	1	2	
TBR-702	Advanced Forest Ecology, Biodiversity and Conservation	1	1	2	
TBR-703	Wood based Industries	1	1	2	
FBL-701	Wildlife Management	2	1	3	
FBL-702	Forest Protection	1	1	2	
AGF-701	Agroforestry Practices	2	1	3	
OPTIONAL/SPECILAZATION COURSES					
1. Medicinal and Aromatic Plants					
AGF-731	Principles of Breeding of Medicinal Herbs	2	1	3	15
AGF-732	Cultivation of Commercially Important Medicinal and Aromatic Plants	1	2	3	
AGF-733	Processing of Medicinal and Aromatic Plants	1	2	3	
AGF-734	Role of Medicinal and Aromatic Plants in Health care systems	2	1	3	
AGF-735	Study Tour (Visit to Pharmaceutical and processing Units)	0	3	3	
2. Plantation Technology					
SVC-731	Seed Collection, storage and testing	2	1	3	15
SVC-732	Modern Nursery Production	2	1	3	
SVC-733	Vegetative Propagation Techniques	2	1	3	
SVC-734	Management of Insect pest and Diseases	2	1	3	
SVC-735	Energy plantation and Biofuel	2	1	3	
3. Watershed management					
SAC-731	Watershed Concept, Project formulation and Planning	2	1	3	15
SAC-732	Watershed Survey, Mapping and Structural Engineering Design	1	1	2	
SAC-733	Watershed Hydrology and Resource Conservation	2	1	3	
SAC-734	Afforestation and Agroforestry in Watershed areas	1	2	3	
SAC-735	Watershed Biodiversity and Livestock Management	1	1	2	
SAC-736	Peoples participation in watershed Management	1	1	2	
4. Tree breeding / Forest Biotechnology					
TBR-731	Seed production and quality control	2	1	3	15
TBR-732	Introduction to forest biotechnology	2	1	3	
TBR-733	Plant tissue culture	2	1	3	
TBR-734	Advances in Tree Improvement	2	1	3	
TBR -735	Environmental pollutants and biotechnology	2	1	3	

5.Environmental management				
ENV-731	Environmental pollution	3	0	3
ENV-732	Environmental Impact Assessment	2	1	3
ENV-733	Global Climatic changes	2	0	2
ENV-734	Environmental pollution and Wildlife Health	2	1	3
ENV-735	Environmental policy and Law	1	1	2
ENV-736	Natural Resource Management	2	0	2
SEMINAR				
FOR-780	Seminar-I	0	1	1
FOR-880	Seminar-II	0	1	1
BASIC/SUPPORTING COURSES				
MAS-711	Statistics-I	2	1	3
MAS-715	Statistics-II	2	1	3
COMP-709	Computer Orientation	2	1	3
AGF-703	Research Methodology	0	1	1
SVC-707	Forest Resource Management and Economics	2	1	3
SVC-703	Advanced Forest Management	2	0	2
SVC-704	Forest policy and Utilization	2	0	2
FBL-704	Tree Physiology	2	1	3
ENV-711	Remote Sensing and GIS	1	1	2
DISSERTATION AND INDUSTRIAL/ INSTITUTE ATTACHMENT				
FOR-898	Attachment with Industry/ Institute etc.	0	7	7
FOR-899	Dissertation	0	8	8

SYLLABUS

SVC-701 **ADVANCED SILVICULTURE**

(2+0)

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of World's forest vegetation. Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation, water relationship, mineral nutrients and temperature. Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments. Intensive studies pertaining to important commercial species. Advanced and modern nursery tools & techniques.

Lecture Schedule

Theory

● Content	Lectures
● Forest ecosystem concept	2
● stand dynamics-forest succession	2
● competition and tolerance	2
● classification of World's forest vegetation	2
● Productivity and vegetation forms of India	2
● forest composition and structure	2
● Ecophysiology of tree growth	2
● effect of radiation	2
● water relationship	2
● mineral nutrients and temperature	2
● competition and tolerance	2
● Natural regeneration of species and types including unevenaged silviculture	3
● Intermediate treatments	2
● Intensive studies pertaining to important commercial species	3
● Advanced and modern nursery tools & techniques	2

Suggested readings:

1. Champman, G.W. and Allan, T.G. 1978. Establishment Techniques for Forest Plantation F.A.O Forestry Paper No.8. F.A.O Rome
2. David M. Smith. 1989. "The Practice of silviculture". EBD Educational Pvt. Ltd. Dehradun, India.
3. Dwivedi, A. P. 1992. Principles and Practice of Indian Silviculture, Surya Publication.
4. Dwivedi, A.P. 1993. A Text Book of Silviculture, International Book Distributors, Dehradun
5. Khanna, L. S. 1984. Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun.

6. Ram Prakash and L.S. Khanna. 1991. Theory and Practice of Silvicultural systems.
International Book Distributors, Dehra Dun.

SVC-702 FOREST BIOMETRIC (2+0)

Measurement of trees and stand, diameter (crop), girth, height, volume, form, bark thickness, crown width and crown length, determination of age and volume of felled as well as standing trees. Volume, yield and stand tables. Increment, forest inventory and sampling procedures. Growth and yield of standard density measures. Canopy density and its importance. Simulation techniques, growth and yield models and their applications. Modern tools of GPS etc. for measurements.

Lecture Schedule

• Content	Lectures
• Measurement of trees and stand, diameter (crop), girth, height, volume, form, bark thickness, crown width and crown length,	8
• determination of age and volume of felled as well as standing trees.	3
• Volume, yield and stand tables.	2
• Increment, forest inventory and sampling procedures.	4
• Growth and yield of standard density measures.	4
• Canopy density and its importance.	2
• Simulation techniques, growth and yield models and their applications.	6
• Modern tools of GPS etc. for measurements.	3

Suggested Reading:

1. Chaturvedi, A.N. and L.S. Kanna. 1982. A handbook on Forest Mensuration. International Book Distributors
2. Faulkner, R.1975. Seed orchard. Forestry Commission Bulletin No.54.
3. Fins, L., Friedman,S.T. and Brotschol (Eds.)Handbook of Quantitative Forest Genetics. Kluwer Academic Press, The Netherlands.
4. Mandal, A.K. and Gibson,G.L. (eds) 1997. Forest genetics and tree breeding. CBS Publi. & Distr. New Delhi.
5. Poehlman,J.M. 2002. Breeding of field crops, AVI Publishing Company, New York.
6. Phundan S. 2004. Biometrical approaches of Quantitative genetics. Kalyani Publishers. New Delhi -2.
7. Roy P 2000. Plant breeding: Analysis and exploitation of variation. Narosa Publishing House, New Delhi.
8. Singh B.D. 2005. Fundamentals of Genetics. Kalyani Publishers. New Delhi -2.
9. White, T.M. and Hodges, G.R.1989.Predicting breeding values with application in forest improvement. Kluwer Publishing, Netherlands.
10. Wright, J.W. 1976. Introduction to forest genetics. Academic press. New York.
11. Young, A., Boshie, B. and Boyle, T.2002.Forest conservation genetics principles and practice (Ed.) CABI, Australia.
12. Zobel, B.J.,Talbert, J. 1984. Applied forest tree improvement. John Wiley Sons, New York.

13. Avery, T.E. 1967. Forest Measurements. Mc Grand Hill Book Company, New York.
14. Hamilton, G.L. 1988. Forest Mensuration Handbook. Periodical Expert Book Agency.
15. Husch, B., C.I. Miller and T.N. Beers. 1982. Forest Mensuration. The Ronald Press Company, New York.
16. Maslekar, A.R. 1990. Foresters Companions. Jugal Kishore and Co. (Publn. Dvn.), Dehra Dun. P. 603.

TBR-701 TREE BREEDING**(2+1)**

Variation in trees, importance and its causes. Natural variation as a basis for tree improvement. Geographic variations - Ecotypes, clines, races and land races. Species and provenance testing. Exotic forestry and tree breeding – gains and risks. Selection, migration rates and population sizes. Selective breeding: methods - mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses. Progeny and clone testing. Seed orchards - type, functions and importance. Estimating genetic parameters and genetic gain. Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples - teak, sal, Q.albergia, eucalypts, acacias, pines and poplars. Pollination mechanisms. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Biochemical methods in tree breeding. In vitro and marker assisted selection. Economics of tree breeding.

Practical

Identification of ecotypes, races, and land-races in natural forest. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate-, plus- and elite- trees. Visit to seed orchards. Estimating pollen viability. Comparison of parents and their putative hybrids. Induction of polyploidy through colchicines treatment. Estimation of phenolics/terpenes for indirect selection. Controlled pollination and pollen handling. Manipulation of flowering through hormones.

Lecture Schedule**Theory**

• Content	Lectures
• Variation in trees, importance and its causes.	2
• Natural variation as a basis for tree improvement.	2
• Geographic variations - Ecotypes, clines, races and land races.	2
• Species and provenance testing.	2
• Exotic forestry and tree breeding – gains and risks.	2
• Selection, migration rates and population sizes.	2
• Selective breeding: methods - mass, family, within family, family plus within family	2
• Plus tree selection for wood quality, disease resistance and agroforestry objectives.	2
• Selection strategies and choice of breeding methods and progress in selective breeding in forest trees.	2
• Indirect selection for biotic and abiotic stresses.	1
• Progeny and clone testing.	1
• Seed orchards - type, functions and importance.	1
• Estimating genetic parameters and genetic gain. Heterosis breeding: inbreeding and hybrid vigour	2
• Manifestation and fixation of heterosis.	1
• Species and racial hybridization	1
• Indian examples - teak, sal, Q.albergia, eucalypts, acacias, pines and	2

- poplars
- Pollination mechanisms. Polyploidy, aneuploidy and haploidy in soft and hard wood species. 2
- Induction of polyploidy. 1
- Biochemical methods in tree breeding. In vitro and marker assisted selection. Economics of tree breeding. 2

Practical

• Content	Lectures
• Identification of ecotypes, races, and land-races in natural forest.	2
• Visit to species, provenance and progeny trials.	1
• Selection of superior phenotypes.	1
• Marking of candidate-, plus- and elite- trees.	1
• Visit to seed orchards.	1
• Estimating pollen viability.	1
• Comparison of parents and their putative hybrids.	2
• Induction of polyploidy through colchicines treatment.	2
• Estimation of phenolics/terpenes for indirect selection.	2
• Controlled pollination and pollen handling.	2
• Manipulation of flowering through hormones.	2

Suggested Readings

- Zobel, B. J., Talbert, J. 1984. *Applied forest tree improvement*. John Wiley & Sons, New York, 505 p.
- Zobel, B. J., Wyh, G.V. and Stahl, P. 1987. *Growing exotic forests*. John Wiley & Sons, New York. 508 p.
- F.A.O. 1985. *Forest tree improvement*: FAO Publication, Rome, Italy. 270 p.
- Faulkner, R. 1975. *Seed orchard*. Forestry Commission Bulletin No.54. 149 p.
- Fins, L. Friedman S.T. and Brotschol, J.V. 1992. *Handbook of quantitative forest genetics*, Klumer Academy, Dordrach, London.
- Khosla, P.K. 1981. *Advances in forest genetics*. Ambika Publisher, New Delhi. 375 p.
- Khosla, P.K. 1982. *Improvement of forest biomass*. Pragati Press, Delhi. 472 p.
- Mandal, A.K. and Gibson, G.L. (eds) 1997. *Forest genetics and tree breeding*. CBS Publi. & Distr., New Delhi 268 p.
- Wright, J.W. 1976. *Introduction to forest genetics*. Academic press New York 463 p.

- Conservation, *in situ* and *ex situ* of gene resources. 1
- Biological diversity and its significance to sustainable use. 1
- Handling and storage of FGR. 1
- Intellectual property rights. Quarantine laws and FGR exchange. 2

Practical

- | • Content | Lectures |
|---|-----------------|
| • Study of forest community structure and its succession af st&tts; | 3 |
| • estimation of productivity of forest ecosystem; | 2 |
| • trip to different regions of the state to study forest vegetation; collection and preservation of specimen. | 3 |
| • Methods of vegetation analysis. | 2 |
| • Measurement of biomass and productivity. | 2 |
| • Quantification of litter production and decomposition. | 2 |
| • Visit to national parks, wildlife sanctuaries, botanical gardens and arboreta. | 3 |

Suggested Reading:

1. Mishra, R. 1968. Ecology Work Book Oxford and IBH Publishing Co, Calcutta, pp. 244.
2. Odum, E.P. 1983. Basic Ecology. Saunders College Publishing, Holt Saunders, Japan, 613.
3. Odum, E.P. Fundamentals of Ecology, Natraj Publisher, Dehradun
4. Arvind Kumar. Biodiversity and environment. Published by A.P.M. Publishing Corporation, New Delhi.
5. Global biodiversity status of the earth's living resources. Published by Crapman and Hall, 2-6 Boundary Row, London SE1 8HN. Compiled by World Conservation Monitoring Centre.
6. Kumar and Asija. Biodiversity – Principles and conservation. Published by Updesh Purohit for Agrobios, Jodhpur, India.
7. Singh, Vishwakarma. Forest environment and biodiversity. Daya Publishing House, Delhi.
8. Tewari, D.N. Biodiversity and forest genetic resources. Published by International Book Distributions, Dehra Dun.
9. Kovacs, M. 1995. Pollution Control and Conservation. Ellis Horwood Ltd., Chichester. 398p
10. Sinha, B.N. 1990. Eco-system Degradation in India. Ashish Publishing House, New Delhi.

TBR-703 WOOD BASED INDUSTRIES**(2+0)**

Introduction, scope and importance of wood based industries in relation to Indian economy; brief description of types of wood based industries in India; pulp and paper industry - types of paper and raw material; pulp-mechanical, chemical and semi-chemical; beating, bleaching, sizing and sheet formation; description about rayon and other cellulose derived products; composite wood-plywood, laminated wood, core board, sand witch board, particle board and their manufacturing processes, properties and uses; principles of destructive distillation of hardwood and softwood; preparation of wood alcohol, acetic acid, acetone, charcoal and allied chemicals; scarification of wood-chemistry and processes; production of wood molasses, alcohol yeast and other by products from wood hydrolysis, wood substitution. Manufacture of Katha and cutch, visit to nearby wood based industries.

Content	Lectures
• Introduction, scope and importance of wood based industries in relation to Indian economy; brief description of types of wood based industries in India	6
• pulp and paper industry - types of paper and raw material; pulp-mechanical, chemical and semi-chemical; beating, bleaching, sizing and sheet formation	8
• description about rayon and other cellulose derived products; composite wood-plywood, laminated wood, core board, sand witch board, particle board and their manufacturing processes, properties and uses	6
• principles of destructive distillation of hardwood and softwood; preparation of wood alcohol, acetic acid, acetone, charcoal and allied chemicals	6
• scarification of wood-chemistry and processes; production of wood molasses, alcohol yeast and other by products from wood hydrolysis, wood substitution.	5
• Manufacture of Katha and cutch, visit to nearby wood based industries.	3

References

- 1.Hamilton, G.J. 1988. Forest Mensuration Handbook. Forestry Commission Booklet No. 39.
- 2.Luna, R.K. 1988. Plantation Forestry In India. International Book Distributors, Dehradun. p 476.
- 3.Srivastava A C 1992. Principles and Methods of Gasification. CBS Publishers and Distributors, New Delhi.
- 4.Troup, K.S. 1975. The Silviculture of Indian Trees Vol. I, II And III. Controller Of Publication New Delhi
5. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, Delhi. 298 p.
6. Anonymous. 1976. Indian forest utilization. Volume I and II ICFRE Publication, Dehradun.

Introduction

Definition and concept of wildlife in India - Distribution of wildlife in India - Status of wildlife conservation in India - Essentials of wildlife environment - Need for wildlife protection - Development and Management - Faunal zones in India - Survey of important fauna and flora in India.

Wildlife as a Natural Resource and Land Use

Multiple land use concept. Classification of area used for wildlife purpose - Biosphere reserve - National Parks - Sanctuaries - Gene reserve and closed areas - Classification of wildlife values - Consumptive and non-consumptive uses of wildlife. Wildlife as productive reserve - Wildlife as landed capital - As gene pool.

Wildlife Values

Classification of economic values of wildlife, positive values – Useful products, useful activities, Income from wildlife - Wildlife as tourist attraction.

Biological Base of Wildlife Management

Food : Quantity, quality, food chain, niches, size of food, pinch, period, carrying Capacity, predation. Shelter : Basic requirements, territory, home range. Animal Population : Biological surplus, breeding potential, internal adjustment factors, gregariousness and flocking, density and saturation point, population dynamics.

Wildlife Management

Concept - Practice - Habitat relationship - Selection Factors - The niche concept - Influence of fire on wildlife and its habitat - Predation theory - Management of predator/prey relationship - Predation on domestic livestock - Population biology.

Ecology of Wildlife

Distribution and behavior of animals, birds, raptiles as affected by various environmental and instinctive factors. Zoo - geographical regions of India. Important animals of India, their distribution and important characteristics, Rare, threatened and endangered species.

Wildlife Studies

Census and estimates, Track and trails, Recognizing kill evidence and Marking

National Parks, Wildlife Sanctuaries and Biosphere Reserves

National Parks, Wildlife Sanctuaries and Biosphere Reserves explained - Safari management - Jungle lodges and tourism - Safety management - Principles of animal behavior - Endangered flora and fauna - Management of sanctuaries during severe drought - Vaccination of the domestic cattle in the human settlement of the sanctuary against diseases - Water supply during drought - Resettlement of families living inside the sanctuaries.

Special Protection and Development Projects for Endangered Species

Project Tiger - Gir lion sanctuary project - Crocodile breeding project - Project Hangal, ecology and conservation of Himalayan musk deer – Manipuri brown antlered deer - Wildlife protection Act - Wildlife Education through specific television channels available - The role of animals on forest decomposition processes - Influence of animals on productivity of ecosystem.

Major Wildlife Management Problems in India

Major wildlife management problems in India and their probable solutions. Habitat evaluation and mapping - Objectives of captive breeding and rehabilitation - Problems and appropriate solutions.

Practical

Enumeration of wildlife, Study of pug marks of wild animals, Preparation of plaster casts of pug marks, Census of herbivores, Observing feeding pattern, food preference of selected herbivores, Visit one National Park or Wildlife Sanctuary in the region and study the wildlife management, Case studies of major wildlife projects in India, and their impact on wildlife, impact of project tiger, and Status of major Zoological Parks in India.

Lecture Schedule

Theory

• Content	Lectures
• Introduction Definition and concept of wildlife in India - Distribution of wildlife in India - Status of wildlife conservation in India - Essentials of wildlife environment - Need for wildlife protection - Development and Management - Faunal zones in India - Survey of important fauna and flora in India.	4
• Wildlife as a Natural Resource and Land Use Multiple land use concept. Classification of area used for wildlife purpose - Biosphere reserve - National Parks - Sanctuaries - Gene reserve and closed areas - Classification of wildlife values - Consumptive and non-consumptive uses of wildlife. Wildlife as productive reserve - Wildlife as landed capital - As gene pool.	4
• Wildlife Values Classification of economic values of wildlife, positive values – Useful products, useful activities, Income from wildlife - Wildlife as tourist attraction.	3
• Biological Base of Wildlife Management Food : Quantity, quality, food chain, niches, size of food, pinch, period, carrying Capacity, predation. Shelter : Basic requirements, territory, home range. Animal Population : Biological surplus, breeding potential, internal adjustment factors, gregariousness and flocking, density and saturation point, population dynamics.	4
• Wildlife Management Concept - Practice - Habitat relationship - Selection Factors - The niche concept - Influence of fire on wildlife and its habitat - Predation theory - Management of predator/prey relationship - Predation on domestic livestock - Population biology.	4
• Ecology of Wildlife Distribution and behavior of animals, birds, raptiles as affected by various environmental and instinctive factors. Zoo - geographical regions of India. Important animals of India, their distribution and important characteristics, Rare, threatened and endangered species.	4
• Wildlife Studies Census and estimates, Track and trails, Recognizing kill evidence and Marking.	2
• National Parks, Wildlife Sanctuaries and Biosphere Reserves National Parks, Wildlife Sanctuaries and Biosphere Reserves explained - Safari management - Jungle lodges and tourism - Safety management -	3

Principles of animal behavior - Endangered flora and fauna - Management of sanctuaries during severe drought - Vaccination of the domestic cattle in the human settlement of the sanctuary against diseases - Water supply during drought - Resettlement of families living inside the sanctuaries.

- **Special Protection and Development Projects for Endangered Species** 3
Project Tiger - Gir lion sanctuary project - Crocodile breeding project - Project Hangal, ecology and conservation of Himalayan musk deer – Manipuri brown antlered deer - Wildlife protection Act - Wildlife Education through specific television channels available - The role of animals on forest decomposition processes - Influence of animals on productivity of ecosystem.
- **Major Wildlife Management Problems in India** 3
Major wildlife management problems in India and their probable solutions. Habitat evaluation and mapping - Objectives of captive breeding and rehabilitation - Problems and appropriate solutions.

Practical

- | ● Content | Lectures |
|---|-----------------|
| ● Enumeration of wildlife, Study of pug marks of wild animals | 3 |
| ● Preparation of plaster casts of pug marks | 2 |
| ● Census of herbivores, Observing feeding pattern, food preference of selected herbivores, | 4 |
| ● Visit one National Park or Wildlife Sanctuary in the region and study the wildlife management, | 3 |
| ● Case studies of major wildlife projects in India, and their impact on wildlife, impact of project tiger | 3 |
| ● Status of major Zoological Parks in India. | 2 |

Suggested Readings

- HOSETTI, B.B. (1997), Concepts in Wildlife Management, Daya Publishing House, Delhi.
- MAHESH RANGARAJAN (1999), Hunting and Shooting, Vol.1., The Oxford Anthology of Indian Wildlife.
- Watching and Conserving, Vol.11., Oxford Anthology of Indian Wildlife; Oxford University Press, New Delhi.
- Arora, B.M. (2002). Reproduction in Wild Mammalia & Conservation. AIZ & WV, Bareilly.
- Arora, B.M. (2007). Rehabilitation in free living wild animals, AIZ & WV, Bareilly.
- SAMAR SINGH (1987), Conserving India's Natural Heritage, Natraj Publication, Dehra Dun.
- SHARMA, B.D. (1999), Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi
- SINHA, P.C. (1998), Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi.
- SINH, P.C. (1998), Wildlife, Anmol Publishing Pvt. Ltd., New Delhi.

FBL-702 FOREST PROTECTION

(2+1)

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management. Biodegradation of wood - microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration Heart rots - factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health^ Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health. Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance in trees.

Practical: Collection, identification and preservation of important insect pests and disease specimens of forest plants Detection of insect infestation and seed borne mycoflora. Assessment of losses due to diseases, insect pests etc. Habitat management of vertebrate pests. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices. Familiarization with the meteorological and plant protection equipment. Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in^nurseries and plantations.Extraction of spores of arguscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection.

Lecture Schedule**Theory**

• Content	Lectures
• Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management.	5
• Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds.	4
• Insect pests and mycoflora of seeds of forest trees and their management.	4
• Biodegradation of wood - microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration Heart rots - factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots.	5
• Role of mycorrhiza in tree health^ Theories of natural regulation of insect populations.	3
• Wildlife damage in nurseries, plantations and their management.	3
• Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.	4
• Biological control of insect pests and diseases of forest trees.	3
• Molecular tools for developing disease resistance in trees.	3

Practical

• Content	Lectures
• Collection, identification and preservation of important insect	3

pests and disease specimens of forest plants Detection of insect infestation and seed borne mycoflora.

- Assessment of losses due to diseases, insect pests etc.Habitat management of vertebrate pests. 3
- Laboratory tests for estimating decay resistance in wood. Fire control methods and devices. 3
- Familiarization with the meteorological and plant protection equipment. 2
- Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations. 3
- Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection. 3

Suggested reading:

1. Khanna, L.S. 1984. Forest Protection. Khanna Bandhu, Dehra Dun.
2. Khanna, L.S. 1995. Forest protection. Khanna Bandhu Publication, Dehra Dun. 219 p.
3. Bakshi, B.K. Forest Pathology. 1976. Principles and Practices in Forestry. Controller of Publications, New Delhi.
4. Khanna, L.S. 1984. Forest Protection, Khanna Bandhu, Dehra Dun.
5. Beeson, C.F.C. 1941. Forest Insects of India, The Ecology and Control of the Bishen Singh and Mahendrapal Singh, Dehra Dun.

AGF 601 PRINCIPLES AND PRACTICES OF AGROFORESTRY Cr. 3(2+1)

Theory

Agroforestry - definition, objectives, importance, potential and impediments in implementation - Land capability classification and land use - Overview of global agroforestry systems – Shifting cultivation, Taungya system, multiple and mixed cropping, shelterbelts and windbreaks, energy plantations and homestead gardens - Concepts of community forestry and social forestry - linear strip plantations - Wastelands - definitions, extent, characteristics, reclamation of degraded land through agroforestry interventions.

Practical

Survey and analysis of land use systems in the adjoining areas - Design and plan of suitable models for improvement

Theory

Content	Lecture
• Agroforestry - definition, objectives, importance, potential and impediments in implementation	4
• Land capability classification and land use	4
• Overview of global agroforestry systems	2
• Shifting cultivation, Taungya system, multiple and mixed cropping	3
• Shelterbelts and windbreaks	4
• Energy plantations and homestead gardens	4
• Concepts of community forestry and social forestry	4
• Linear strip plantations	2
• Wastelands - definitions, extent, characteristics	4
• Reclamation of degraded land through agroforestry interventions	3

Practical

Content	Lecture
• Survey and analysis of land use systems in the adjoining areas	8
• Design and plan of suitable models for improvement	7

References

1. Abrol, I.P. and Dhuruva Narayana, V.V. 1990. Technologies for wasteland development. by ICAR, New Delhi.
2. Dwivedi, A.P. 1992. Agroforestry principles and practices. Oxford and IBH Publication Co., New Delhi.
3. Huxley, P. 1999. Tropical agroforestry. Blackwell Science, Oxford.
4. Khosla, P.K. and Khurana, D.K. 1987. Agroforestry for rural needs. Vol. 1 and II, ISTS, Solan, H.P.
5. Nair, P.K.R. 1993. An introduction to agroforestry. Kluwer Academic Publishers.
6. Ong, C.K. and Huxley, P.K. 1996. Tree crop interactions – A physiological approach. ICRAF, Kenya.

AGF-731 PRINCIPLES OF BREEDING OF MEDICINAL HERBS (2+0)

Role of genetics and related sciences in breeding of medicinal herbs. Breeding methods in relation to mode of reproduction, Methods of breeding self & cross pollinating and asexually propagating medicinal herbs. Heterosis, sterility and self incompatibility in herbs. Mutation and polyploidy breeding. Wide hybridization. Production and maintenance of pure seed. Systems followed in the release of plant varieties.

Lecture Schedule

Theory

Content	Lectures
• Role of genetics and related sciences in breeding of medicinal herbs.	5
• Breeding methods in relation to mode of reproduction, Methods of breeding self & cross pollinating and asexually propagating medicinal herbs.	6
• Heterosis, sterility and self incompatibility in herbs.	5
• Mutation and polyploidy breeding.	4
• Wide hybridization.	3
• Production and maintenance of pure seed.	5
• Systems followed in the release of plant varieties.	6

Suggested Reading:

1. Chadha, K.L. 2001. Hand Book of Horticulture. ICAR Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
2. Chadha, K.L. 2001. Hand Book of Horticulture. ICAR, Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
3. Farooqi, A.A. and B.S. Sreeramu. 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd. 3-5-819, Hyderguda, Hyderabad – 29.
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5. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
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9. Purseglove, J.W. 1972. Tropical crops Monocotyledons. Longman Singapore Publishers Pvt. Ltd., Singapore.

10. Shanmugavelu, K.G., N. Kumar and K.V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios Publications, Bikenar, Rajasthan.
11. Spice India. Monthly Publication from Spices Board, Cochin.
12. Zobel, B.J. and Talbert, J. 1984. Applied Forest Tree Improvement. John Wiley & Sons, New York. 505p.
13. FAO. 1985. Forest Tree Improvement, FAO Publication, Rome, Italy. 270p.
14. Faulkner, R. 1975. Seed Orchard Forestry Commission Bulletin No.34. 149p.
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AGF-732 CULTIVATION OF COMMERCIALY IMPORTANT MEDICINAL AND AROMATIC PLANTS (1+2)

Importance and need of cultivation of medicinal and aromatic plants. Origin, distribution, morphological features, climatic and soil requirements, propagation and nursery techniques, transplanting and after care, nutritional and water requirements, plant protection, harvesting and post harvest processing, active constituents and uses of important medicinal and aromatic plants: *Picrorhiza kurrooa*, *Saussurea costus*, *Aconitum heterophyllum*, *Podophyllum hexandurm*, *Swertia chirayita*, *Valeriana jatamansi*, *Viola serpens*, *Asparagus racemosus*, *Chlqrophytum borivilianum*, *Stevia rebaudiana*, *Aloevera*, *Echninacea spp.*, *Withania somnifera*, *Solanum nigrumi* *Cassia angustifolia*, *Andrographispaniculata*, *Pelargonium graveolens*, *Rosa damacena*, *Tagetes minuta*, *Matricaria chamomilla* or any other species specific to the region, crop geometry and crop management (seasonal, biennial and perennial crops), Organic cultivation of medicinal and aromatic herbs. Good agricultural practices (GAP) in medicinal plants. Precision farming. .

Practical: Preparation and layout of nursery and field beds/plots. Methods of seed sowing. Preparation of shoot and root cuttings. Transplantation of seedling and rooted cuttings irrigation techniques. Hoeing and weeding, weed identification and their control. Harvesting, cleaning, drying and grading of crop produce. Demonstration of different storage methods. Essential oil distillation. Raising and harvesting of at least one crop grown in the area.

Lecture Schedule

Theory

• Content	Lectures
• Importance and need of cultivation of medicinal and aromatic plants.	2
• Origin, distribution, morphological features, climatic and soil requirements, propagation and nursery techniques, transplanting and after care, nutritional and water requirements, plant protection, harvesting and post harvest processing,	4
• active constituents and uses of important medicinal and aromatic plants: <i>Picrorhiza kurrooa</i> , <i>Saussurea costus</i> , <i>Aconitum heterophyllum</i> , <i>Podophyllum hexandurm</i> , <i>Swertia chirayita</i> , <i>Valeriana jatamansi</i> , <i>Viola serpens</i> , <i>Asparagus racemosus</i> , <i>Chlqrophytum borivilianum</i> , <i>Stevia rebaudiana</i> , <i>Aloevera</i> , <i>Echninacea spp.</i> , <i>Withania somnifera</i> , <i>Solanum nigrumi</i> <i>Cassia angustifolia</i> , <i>Andrographispaniculata</i> , <i>Pelargonium graveolens</i> , <i>Rosa damacena</i> , <i>Tagetes minuta</i> , <i>Matricaria chamomilla</i> or any other species specific to the region,	6
• crop geometry and crop management (seasonal, biennial and perennial crops),	2
• Organic cultivation of medicinal and aromatic herbs. Good agricultural practices (GAP) in medicinal plants. Precision farming.	3

Practical

• Content	Lectures
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- Preparation and layout of nursery and field beds/plots. 4
- Methods of seed sowing. 3
- Preparation of shoot and root cuttings. 4
- Transplantation of seedling and rooted cuttings irrigation techniques. 4
- Hoeing and weeding, weed identification and their control. 4
- Harvesting, cleaning, drying and grading of crop produce. 4
- Demonstration of different storage methods. 3
- Essential oil distillation. 3
- Raising and harvesting of at least one crop grown in the area. 5

Suggested reading:

1. Chadha, K.L. 2001. Hand Book of Horticulture. ICAR Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
2. Chadha, K.L. 2001. Hand Book of Horticulture. ICAR, Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
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4. Handa, S.S. and M.K. Kaul. 1987. Cultivation and Utilization of Medicinal Plants. RRL, Jammu.
5. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Planters Chronicle. Monthly Publication. UPASI, Coonoor.
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9. Purseglove, J.W. 1972. Tropical crops Monocotyledons. Longman Singapore Publishers Pvt. Ltd., Singapore.
10. Shanmugavelu, K.G., N. Kumar and K.V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios Publications, Bikenar, Rajasthan.
11. Spice India. Monthly Publication from Spices Board, Cochin.

AGF-733 PROCESSING OF MEDICINAL AND AROMATIC PLANTS (1+2)

Harvesting, drying, grading and storage of medicinal plants. Post harvest handling of aromatic plants. Different methods of essential oil extraction and their drying and storage. Active content dynamics vis-a-vis plant growth and post harvest processing for evaluation of chemical constituents.

Practical: Use of thin layer chromatography during extraction and purification of phyto-pharmaceuticals. Preparation of active constituent enriched extracts. Separation and purification of phytopharmaceuticals through conventional and column chromatographic techniques. Extraction of essential oils and their evaluation for quality parameters. Preparation of concretes and absolutes from plants containing essentials oils.

Lecture Schedule

Theory

Content	Lectures
Harvesting, drying, grading and storage of medicinal plants.	3
Post harvest handling of aromatic plants.	2
Different methods of essential oil extraction and their drying and storage.	6
Active content dynamics vis-a-vis plant growth and post harvest processing for evaluation of chemical constituents.	6

Practical

Content	Lectures
Use of thin layer chromatography during extraction and purification of phyto-pharmaceuticals.	8
Preparation of active constituent enriched extracts.	6
Separation and purification of phytopharmaceuticals through conventional and column chromatographic techniques.	6
Extraction of essential oils and their evaluation for quality parameters.	6
Preparation of concretes and absolutes from plants containing essentials oils.	8

Suggested Reading:

- 1.Chadha, K.L. 2001. Hand Book of Horticulture. ICAR Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
- 2.Chadha, K.L. 2001. Hand Book of Horticulture. ICAR, Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi.
- 3.Farooqi, A.A. and B.S. Sreeramu. 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd. 3-5-819, Hyderguda, Hyderabad – 29.
- 4.Handa, S.S. and M.K. Kaul. 1987. Cultivation and Utilization of Medicinal Plants. RRL, Jammu.
- 5.Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

6. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
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9. Purseglove, J.W. 1972. Tropical crops Monocotyledons. Longman Singapore Publishers Pvt. Ltd., Singapore.
10. Shanmugavelu, K.G., N. Kumar and K.V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios Publications, Bikaner, Rajasthan.
11. Spice India. Monthly Publication from Spices Board, Cochin.

AGF-734 ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS (1+0)

Concept of Health Care systems. Brief introduction to Ayurveda, Unani, Sidha, Homeopathy, allopathy, naturopathy, electrohomoeopathy, etc. Important medicinal plants used in treating various diseases in modern and complementary systems. Biological activity of selected medicinal plants. Methods of preparing poultices, decoctions, powders, tinctures, active content rich extracts, etc.

Lecture Schedule

Theory

Content	Lectures
• Use of thin layer chromatography during extraction and purification of phyto-pharmaceuticals.	8
• Preparation of active constituent enriched extracts.	6
• Separation and purification of phytopharmaceuticals through conventional and column chromatographic techniques.	6
• Extraction of essential oils and their evaluation for quality parameters.	6
• Preparation of concretes and absolutes from plants containing essentials oils.	8

Suggested Reading:

1. Farooqi, A.A. and B.S. Sreeramu. 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd. 3-5-819, Hyderguda, Hyderabad – 29.
2. Handa, S.S. and M.K. Kaul. 1987. Cultivation and Utilization of Medicinal Plants. RRL, Jammu.
3. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Planters Chronicle. Monthly Publication. UPASI, Coonoor.
6. Shanmugavelu, K.G., N. Kumar and K.V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios Publications, Bikenar, Rajasthan.
7. Spice India. Monthly Publication from Spices Board, Cochin.

AGF-735 STUDY TOUR (VISIT TO PHARMACEUTICAL AND PROCESSING UNITS)) (0+1)

Visit to government and private Pharmaceutical Units/Institutes in adjoining areas. Visit to large scale herb growing and processing units engaged in commercial cultivation and preparation of purified photochemical/standardized extracts. Visit to nearby marketing/trade centers.

Tour Schedule

Content	Lectures
• Visit to government and private Pharmaceutical Units/Institutes in adjoining areas.	6
• Visit to large scale herb growing and processing units engaged in commercial cultivation and preparation of purified photochemical/standardized extracts.	8
• Visit to nearby marketing/trade centers.	3

SVC-731 SEED COLLECTION, STORAGE AND TESTING**(2+1)**

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems -limiting factors in tree propagation and afforestation. Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/fruit. Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, Stage methods and seed testing techniques. Seed certification.

Eco-physiological role of seed storage. Classification of seed storage potential/Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds. Fumigation and seed treatment.

Practical: Identification of forest seeds. Seed sampling, different storage methods. Seed quality testing -purity, viability and germination, collection and processing of seeds/fruits. Tests of viability viz., cutting, hydrogen peroxide, excised tetrzolium, embryo, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, Recording, calculation and use of results.

Lecture Schedule**Theory**

•	Content	Lecture
•	Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand.	4
•	Seed problems -limiting factors in tree propagation and afforestation.	3
•	Flowering and seed production in gymnosperms and angiosperms.	2
•	Development and maturation of seed/fruit.	2
•	Modes of seed dispersal.	2
•	Determining optimal harvest maturity indices.	2
•	Factors influencing choice of collection methods.	2
•	Methods of seed collection and processing, Stage methods and seed testing techniques. Seed certification.	3
•	Eco-physiological role of seed storage.	3
•	Classification of seed storage potential/Factors affecting seed longevity.	3
•	Pre-storage treatment.	2
•	Physiological change during ageing.	2
•	Viability and vigor.	1
•	Storage of orthodox, recalcitrant and pre-storage intermediate seeds.	2
•	Fumigation and seed treatment.	1

Practical

•	Content	Lecture
•	Identification of forest seeds.	2
•	Seed sampling, different storage methods.	3
•	Seed quality testing -purity, viability and germination, collection and processing of seeds/fruits.	4

• Tests of viability viz., cutting, hydrogeji peroxide, excised tetrazolium, embryo, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests	6
• Recording, calculation and use of results.	2

References

1. Agrawal, P.K. and M. Dadlani. 1987. *Techniques in Seed Science and Technology*, South Asian Publishers, Delhi.
2. Agrawal, R.L. 1996. *Seed Technology*. Oxford & IBH, Publishing Co., New Delhi.
3. Anon. 1965. *Field Inspection Manual and Minimum Seed Certification Standards*, NSC Publication, New Delhi.
4. Faulkner, R. 1975. *Seed orchard*. Forestry Commission Bulletin No.54.149 p.
5. Fins, L., Friedman, S.T. and Brotschol (Eds.) *Handbook of Quantitative Forest Genetics*. Kluwer Academic Press, The Netherlands.
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7. Lars Schmidt 2000. *Guide to Handling of tropical and sub-tropical forest seeds*. Danida Forest Seed Centre, Denmark.
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18. Wright, J.W. 1976. *Introduction to forest genetics*. Academic press. New York. 463 p.
19. Young, A., Boshie, B. and Boyle, T. 2002. *Forest conservation genetics principles and practice (Ed.)* CABI, Australia.
20. Zobel, B.J., Talbert, J. 1984. *Applied forest tree improvement*. John Wiley Sons, New York, 505 p.

SVC-732 MODERN NURSERY PRODUCTION**(1+1)**

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery. Bare root nursery -nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out -planting. Containerized nursery -type and size of container including root trainers, selection of growing medium. Types of green house and mist propagation. Vegetative propagation -selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering. Factors affecting rooting of cuttings.

Practical: Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Use of vegetative propagation methods slich as budding, grafting and layering. Maintenance of nursery records. Identification of nursery insects and diseases and their control measures. Visit to nurseries.

Lecture Schedule**Theory**

• Content	Lecture
• Introduction and importance of nursery.	2
• Types of nurseries. Bare root, containerized and vegetatively produced nursery.	3
• Bare root nursery -nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing.	3
• Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques.	2
• Lifting windows, grading, packaging and storing and out -planting. Containerized nursery -type and size of container including root trainers, selection of growing medium.	3
• Types of green house and mist propagation.	1
• Vegetative propagation -selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering.	2
• Factors affecting rooting of cuttings.	1

Practical

• Content	Lecture
• Introduction and identification of modern equipments and tools used in nursery.	3
• Pre-sowing seed treatments.	1
• Preparation of nursery beds and growing media for containerized nursery.	3
• Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings.	2
• Use of vegetative propagation methods slich as budding, grafting and	3

	layering.	
•	Maintenance of nursery records.	1
•	Identification of nursery insects and diseases and their control measures.	2
•	Visit to nurseries.	1

Suggested Readings:

1. Kumar, V. 1999. Nursery and plantation practices in forestry. Scientific publication. Jodhpur. 531 p.
2. Chaturvedi, A.N. 1994. Technology of forest nurseries, Khanna Bandhu, Dehradun.
3. Duryea, M. L. and Landis, T.D. 1984. Forest nursery manual: Production of bare root seedlings. Martinus Nijhoff. The Hague. 385 p.
4. F.A.O.1978. Establishment techniques for plantations, F.A. O. Publication, Rome, Italy.
5. Luna, R.K. 1988. Plantation Forestry In India. International Book Distributors, Dehradun. p 476.
6. Srivastava A C 1992. Principles and Methods of Gasification. CBS Publishers and Distributors, New Delhi.
7. Troup, K.S. 1975. The Silviculture of Indian Trees Vol. I, II And III. Controller Of Publication New Delhi

SVC-733 VEGETATIVE PROPAGATION TECHNIQUES (1+1)

Introduction and importance of propagation. Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation, Techniques of propagation by cutting, grafting, budding and layering and its natural modification. Propagation of selected plants and rootstock for the important wild fruit species. Bud orchards.

Practical: Techniques of propagation by cutting, grafting, budding and layering. Precautions required in vegetative propagation. Use of plant bio-regulators for rooting. Handling of field propagated cuttings.

Lecture Schedule

Theory

• Content	Lecture
• Introduction and importance of propagation.	3
• Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation	5
• Techniques of propagation by cutting, grafting, budding and layering and its natural modification.	4
• Propagation of selected plants and rootstock for the important wild fruit species.	4
• Bud orchards.	1

Practical

• Content	Lecture
• Techniques of propagation by cutting, grafting, budding and layering.	7
• Precautions required in vegetative propagation.	4
• Use of plant bio-regulators for rooting.	3
• Handling of field propagated cuttings.	3

Suggested Reading:

1. Zobel, B.J. and Talbert, J. 1984. Applied Forest Tree Improvement. John Wiley & Sons, New York. 505p.
2. FAO. 1985. Forest Tree Improvement, FAO Publication, Rome, Italy. 270p.
3. Faulkner, R. 1975. Seed Orchard Forestry Commission Bulletin No.34. 149p.
4. Fins, L., Friedman, S.T. and Brotschol, J.V. 1992. Handbook of Quantitative Forest Genetics, Klumer Academy, Dordrach, London.
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8. Wright, J.W. 1976. Introduction to Forest Genetics. Academic Press, New York. 463p.
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SVC-734 MANAGEMENT OF INSECT PEST AND DISEASES**3 (2+1)**

Insect pests responsible for damaging nursery stock and forest plantation. Principles and methods of integrated pests management – physical, cultural, chemical and biological methods. Use of attractants and repellents. Male sterility techniques. Diseases of forest nurseries and plantations. Abiotic and biotic components of tree diseases and their relationship with hosts. Methods of disease control – exclusion, cultural, biological and chemical. Rodents, birds, squirrels, herbivores. Forest plant quarantine.

Practical: Collection and identification of insects and non-insects. Inspection and collection of damaged material showing insect damage. Identification and use of plant protection equipments. Preparation of different concentrations of pesticides and their use. Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation diseases.

Lecture Schedule**Theory**

● Content	Lecture
● Insect pests responsible for damaging nursery stock and forest plantation.	4
● Principles and methods of integrated pests management – physical, cultural, chemical and biological methods.	6
● Use of attractants and repellents.	4
● Male sterility techniques.	3
● Diseases of forest nurseries and plantations.	5
● Abiotic and biotic components of tree diseases and their relationship with hosts.	5
● Methods of disease control – exclusion, cultural, biological and chemical.	4
● Rodents, birds, squirrels, herbivores. Forest plant quarantine.	3

Practical

● Content	Lecture
● Collection and identification of insects and non-insects.	3
● Inspection and collection of damaged material showing insect damage.	3
● Identification and use of plant protection equipments.	3
● Preparation of different concentrations of pesticides and their use.	2
● Identification of important diseases in forest nurseries and plantations.	3
● Preparation of fungicidal concentrations and their use in controlling nursery and plantation diseases.	3

Suggested Readings:

1. Bakshi, B.K. 1976. Forest Pathology. Principles and Practices in Forestry. Controller of Publications, New Delhi.
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SVC-735 ENERGY PLANTATION AND BIOFUEL**(2+1)**

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy. Assessment of bio-energy programmes in India. Power generation from energy plantation. Producer gas. High Density Energy Plantations (HDEP). Land And biomass availability for sustainable bioenergy. Impact of energy efficiency in power sector. Need for research and development on environment friendly and socio- economically relevant technologies. Energy from plants- problems and prospects. Petro-crops. Criteria for evaluation of different species of energy plantation. Network of NGOs in renewable energy use. Recent energy technologies in the production of bio-fuels.

Practical: Identification of important fuel woods and petro-crops. Study of different bio-fuels used in India. Determination of calorific value, moisture and ash content in biomass. Study of energy consumption pattern in rural and urban areas through survey. Visit to nearby units.

Lecture Schedule**Theory**

• Content	Lecture
• Introduction and advantages of energy plantations.	3
• Energy and biomass consumption patterns in India.	3
• Environmental impacts of biomass energy.	2
• Assessment of bio-energy programmes in India.	2
• Power generation from energy plantation.	2
• Producer gas.	2
• High Density Energy Plantations (HDEP).	2
• Land And biomass availability for sustainable bioenergy.	3
• Impact of energy efficiency in power sector.	2
• Need for research and development on environment friendly and socio-economically relevant technologies.	3
• Energy from plants- problems and prospects.	2
• Petro-crops.	1
• Criteria for evaluation of different species of energy plantation.	2
• Network of NGOs in renewable energy use.	2
• Recent energy technologies in the production of bio-fuels.	3

Practical

• Content	Lecture
• Identification of important fuel woods and petro-crops.	4
• Study of different bio-fuels used in India.	4
• Determination of calorific value, moisture and ash content in biomass.	5
• Study of energy consumption pattern in rural and urban areas through survey. Visit to nearby units.	4

Suggested Readings:

1. Aaron G. Johnson Jr., Mervin B. Johnson and Rueban C. Buse, *Econometrics – Basic and Applied* (New York: Macmillan Pub. Co.), 1990.
2. Damoder N. Gujarati, *Basic Econometrics* (New York: McGraw Hall Book Co.), 1995.

3. Harry, K. Kelejan and Wallace E. Oates, *Introduction to Econometric Principles and Application* (New York: Harper and Row Pub.), 1974.
4. Koutsoyianis, *Theory of Econometrics* (New York: Barner and Noble), 1977.
5. Maddala, G.S., *Econometrics* (New York: M. Graw Hall Book Co.), 1992.
6. Pisdyck, R.S. and D.L. Rubinfeld, *Econometric Models and Econometric Forecasts* (New York: McGraw Hill), 1990
7. Hamilton, G.J. 1988. Forest Mensuration Handbook. Forestry Commission Booklet No. 39.
8. Luna, R.K. 1988. Plantation Forestry In India. International Book Distributors, Dehradun. p 476.
9. Srivastava A C 1992. Principles and Methods of Gasification. CBS Publishers and Distributors, New Delhi.
10. Troup, K.S. 1975. The Silviculture of Indian Trees Vol. I, II And III. Controller Of Publication New Delhi

SAC-731 WATERSHED CONCEPT, PROJECT FORMULATION AND PLANNING (2+1)

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity Issues. Formulation of watershed projects (micro and macro watershed). Components of natural resources for watershed management. Preparation techniques for micro plan of watershed . Impact assessment techniques for upliftment of socio-economic status and environment. Valuing Inputs and Outputs Introduction -Approach, Using Market Prices in the Financial Analysis, Estimating Future Prices - Treatment of Inflation, Estimating Relative Price Changes. The big project effect, appropriate economic value measure for different types of inputs and outputs. Identifying and valuing remedial measures to maximize benefits of investment. Comparing costs and benefits-introduction, constructing value flow tables, discounting benefits and costs. Net present value (NPV), internal rate return (IRR), relationships between NPV and IRR. Sensitivity analysis - introduction, purpose, guidelines, sources and techniques of sensitivity analysis.

Practical: Survey of watershed, preparation of micro-plan and planning of watershed for effective implementation. Exercises on "economic profitability of various land-based enterprises bases in cost and revenue concepts.

Lecture Schedule

Theory

• Content	Lecture
• Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity Issues.	4
• Formulation of watershed projects (micro and macro watershed). Components of natural resources for watershed management.	4
• Preparation techniques for micro plan of watershed.	3
• Impact assessment techniques for upliftment of socio-economic status and environment.	3
• Valuing Inputs and Outputs Introduction -Approach, Using Market Prices in the Financial Analysis, Estimating Future Prices - Treatment of Inflation, Estimating Relative Price Changes.	5
• The big project effect, appropriate economic value measure for different types of inputs and outputs.	3
• Identifying and valuing remedial measures to maximize benefits of investment.	3
• Comparing costs and benefits-introduction, constructing value flow tables, discounting benefits and costs.	3
• Net present value (NPV), internal rate return (IRR), relationships between NPV and IRR.	3
• Sensitivity analysis - introduction, purpose, guidelines, sources and techniques of sensitivity analysis.	3

Practical

• Content	Lecture
• Survey of watershed, preparation of micro-plan and planning of watershed for effective implementation.	9
• Exercises on "economic profitability of various land-based enterprises	8

	bases in cost and revenue concepts.	
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Suggested Readings:

- 1.Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
- 2.Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
- 3.Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
- 4.Moorthy, V.V.N. 1990, Land and Water Management, Kalyani Publishers, New Delhi.
- 5.Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
- 6.Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
- 7.Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
- 8.Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
- 9.Tideman, E.M. 1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

SAC-732 WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGN (1+1)

Compass, Surveying, plane table surveying, leveling, preparation of contour maps of watershed. Terraces and bunds- types, design. Soil and water conservation and water harvesting structures - types, design. Sedimentation- sources, estimation of sediment bank treatment techniques.

Practical: Preparation of contour maps, estimation of earth work, design of check dams, acquaintance with water lifting devices, use of measurement, conveyance and control structures.

Lecture Schedule

Theory

• Content	Lecture
• Compass, Surveying, plane table surveying, leveling, preparation of contour maps of watershed.	4
• Terraces and bunds- types, design.	3
• Soil and water conservation and water harvesting structures - types, design.	5
• Sedimentation- sources, estimation of sediment bank treatment techniques.	5

Practical

• Content	Lecture
• Preparation of contour maps, estimation of earth work, design of check dams	8
• Acquaintance with water lifting devices, use of measurement, conveyance and control structures.	9

Suggested Readings:

1. Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
2. Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
3. Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
4. Moorthy, V.V.N. 1990, Land and Water Management, Kalyani Publishers, New Delhi.
5. Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
6. Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
7. Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
8. Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
9. Tideman, E.M. 1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

SAC-733 WATERSHED HYDROLOGY AND RESOURCE CONSERVATION

(2+1)

Hydrological cycle and characteristics of small and medium watersheds- precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration. Resources inventory- soil, land, water and Niota. Soil survey and land use planning -soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency. Biota- vegetation types, distribution and utilization. Wildlife -role and conservation.

Practical: Rain water budgeting - run off and soil loss, infiltration, soil moisture, deep percolation and ground water change, rainfall measurements hydrograph.

Lecture Schedule

Theory

• Content	Lecture
• Hydrological cycle and characteristics of small and medium watersheds- precipitation	6
• infiltration, run-off (run-off hydrographs) total and peak.	4
• soil moisture, hydrograph, ground water and evapo-transpiration.	4
• Resources inventory- soil, land, water and Niota.	2
• Soil survey and land use planning -soil types, fertility, productivity, erosion and conservation practices.	5
• Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency.	6
• Biota- vegetation types, distribution and utilization.	5
• Wildlife -role and conservation.	3

Practical

• Content	Lecture
• Rain water budgeting - run off and soil loss	5
• Infiltration, soil moisture	3
• Deep percolation and ground water change	5
• rainfall measurements hydrograph.	4

Suggested Readings:

- 1.Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
- 2.Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
- 3.Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
- 4.Moorthy, V.V.N. 1990, Land and Water Management, Kalyani Publishers, New Delhi.
- 5.Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
- 6.Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
- 7.Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
- 8.Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.

9. Tideman, E.M. 1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

SAC-734 AFFORESTATION AND AGROFORESTRY IN WATERSHED AREAS

(1+1)

Afforestation, Reforestation: - constraints, scope and basic principles. Techniques of afforestation; soil working techniques, selection of species, stock quality, weding pruning, lopping, manures and fertilizers. Growth measurements and harvesting. Multipurpose trees, Their characteristics and management practices for fuel, fodder, fibre, fruits and timber production. Agroforestry- Definition, its role in water development. Diagnosis and design, Agroforestry models for different land types-arable, pastures and wastelands. Alley cropping, silvi-pastoral system, high density short rotation plantations/ energy plantation. Agri-horticulture and horti-slivi-medicinal systems. Environmental benefits of afforestation, reforestation and agroforestry.

Practical: Preparation of site for planting, planting layout pattern. Layout of different soil working techniques for hill slopds. Preparation of suitable plantation models for farmlands and catchments areas, Visit to different watershed and prepare watershed plans for plantation.

Lecture Schedule

Theory

• Content	Lecture
• Afforestation, Reforestation: - constraints, scope and basic principles.	2
• Techniques of afforestation; soil working techniques, selection of species, stock quality, weding pruning, lopping, manures and fertilizers.	2
• Growth measurements and harvesting.	2
• Multipurpose trees, Their characteristics and management practices for fuel, fodder, fibre, fruits and timber production.	2
• Agroforestry- Definition, its role in water development. Diagnosis and design	2
• Agroforestry models for different land types-arable, pastures and wastelands.	2
• Alley cropping, silvi-pastoral system, high density short rotation plantations/ energy plantation.	2
• Agri-horticulture and horti-slivi-medicinal systems.	1
• Environmental benefits of afforestation, reforestation and agroforestry.	2

Practical

• Content	Lecture
• Preparation of site for planting, planting layout pattern.	4
• Layout of different soil working techniques for hill slopds.	4
• Preparation of suitable plantation models for farmlands and catchments areas	5
• Visit to different watershed and prepare watershed plans for plantation.	4

Suggested Readings:

- 1.Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
- 2.Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.

3. Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
4. Moorthy, V.V.N. 1990, Land and Water Management, Kalyani Publishers, New Delhi.
5. Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
6. Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
7. Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
8. Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
9. Tideman, E.M. 1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

SAC-735 WATERSHED BIODIVERSITY AND LIVESTOCK MANAGEMENT

(1+1)

Concepts of biodiversity in watershed, threat biodiversity. Biodiversity conservation - Insitu conservation and Ex-situ conservation. In-situ conservation; Natural preservation, standard stand. Ex-situ conservation - clone banks/ seedling bank, breeding seed orchard, botanical garden, seed banks, pollen banks in vitro conservation. Tree spp. For watershed. Identification of tree, shrub and grass for watershed areas. Production and management of important fodder spp. Importance of livestock in improving the economy of farmers. Management of livestock-breeding feeding, weeding. Fodder and feed requirement, calendar to produce green fodder round me year and its preservation. Optimization of animal production. Animal product technology and marketing. Prevention and control common disease of animals/livestocks.

Practical: Visit to different watershed area. Identification of tree spp. grasses, shrub. Establishment of vegetative barrier in watershed area. Management of tree, shrubs and grasses in watershed areas. Identification of important breed of cattle. Identification of various tools used in livestock management. Preparation and marketing of milk products.

Lecture Schedule

Theory

• Content	Lecture
• Concepts of biodiversity in watershed, threat biodiversity	2
• Biodiversity conservation -Insitu conservation and Ex-situ conservation. In-situ conservation Natural preservation, standard stand.	2
• Ex-situ conservation - clone banks/ seedling bank, breeding seed orchard, botanical garden, seed banks, pollen banks in vitro conservation.	3
• Tree spp. For watershed. Identification of tree, shrub and grass for watershed areas.	2
• Production and management of important fodder spp.	1
• Importance of livestock in improving the economy of farmers.	2
• Management of livestock-breeding feeding, weeding. Fodder and feed requirement, calendar to produce green fodder round me year and its preservation.	3
• Optimization of animal production.	1
• Animal product technology and marketing.	1
• Prevention and control common disease of animals/livestocks.	1

Practical

• Content	Lecture
• Visit to different watershed area. Identification of tree spp. grasses, shrub.	4
• Establishment of vegetative barrier in watershed area.	3
• Management of tree, shrubs and grasses in watershed areas.	3
• Identification of important breed of cattle.	2
• Identification of various tools used in livestock management.	3
• Preparation and marketing of milk products.	2

Suggested Readings:

1.Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.

- 2.Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
- 3.Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
- 4.Moorthy, V.V.N. 1990, Land and Water Management, Kalyani Publishers, New Delhi.
- 5.Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
- 6.Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
- 7.Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
- 8.Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
- 9.Tideman, E.M. 1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

SAC-736 PEOPLES PARTICIPATION IN WATERSHED MANAGEMENT(1+1)

Participation -meaning scope, objectives, principles and historical perspective. People's participants-case studies on ^uccesses and failures. Participatory research approaches-AR, PAR, PR, PL A. Participatory planning, implementation, monitoring and evaluation.

Practical: Case studies and their analysis. Visit to selected wate&fteds for understanding concepts of people's participation . Application of participatory research approaches - review and analysis of selected cases. Application of participatory techniques in programme cycle, viz., resources inventory, analysis of production problems, need assessment, prioritization of need, planning, implementation, monitoring and evaluation.

Lecture Schedule

Theory

- | Content | Lecture |
|--|----------------|
| • Participation -meaning scope, objectives, principles and historical perspective. | 5 |
| • People's participants-case studies on ^uccesses and failures. | 3 |
| • Participatory research approaches-AR, PAR, PR, PL A. | 4 |
| • Participatory planning, implementation, monitoring and evaluation. | 5 |

Practical

- | Content | Lecture |
|---|----------------|
| • Case studies and their analysis. Visit to selected watersheds for understanding concepts of people's participation. | 5 |
| • Application of participatory research approaches - review and analysis of selected cases. | 5 |
| • Application of participatory techniques in programme cycle, viz., resources inventory, analysis of production problems, need assessment, prioritization of need, planning, implementation, monitoring and evaluation. | 7 |

Suggested Reading:

- 1.Datta, S.K. 1986. Soil Conservation and Land Management, International Book Distributors, Dehra Dun.
- 2.Hamilton, I.S. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific, International Book Distributors, Dehra Dun.
- 3.Hamilton, I.S. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation, International Book Distributors Dehra Dun.
- 4.Moorthy,V.V.N. 1990, Land and Water Management, Kalyani Publishers, NewDelhi.
- 5.Oswal, M.C., 1999. Watershed Management (For Dry land Agriculture), Associated Publishing Company, New Delhi.
- 6.Rajesh Rajora, 1998. Integrated watershed Management, Ravat Publication, New Delhi.
- 7.Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
- 8.Richard, Lee. 1980. Forest Hydrology, Columbia University Press, New York.
- 9.Tideman,E.M.1996. Watershed Management for Indian Conditions, Omega Scientific Publishers, New Delhi.

TBR-732 INTRODUCTION TO FOREST BIOTECHNOLOGY (2+0)

Historical development of biotechnology; scope of biotechnology in forestry; different methods of biotechnology related to forestry; plant tissue culture and response¹ pattern; application of plant tissue culture in tree improvement; *in vitro* selection and micro propagation in forestry for conservation; gene regulation, genetic engineering techniques; basis of operation in DNA manipulation; transgenic plants; molecular markers and its application in forestry; modification of plant species to practically desired products; bio-degradation of forestry wastes through genetically engineered microbes.

Lecture Schedule

Theory

Content	Lecture
• Historical development of biotechnology;	3
• scope of biotechnology in forestry;	2
• different methods of biotechnology related to forestry;	3
• plant tissue culture and response ¹ pattern;	2
• application of plant tissue culture in tree improvement;	3
• <i>in vitro</i> selection and micro propagation in forestry for conservation	4
• gene regulation, genetic engineering techniques;	3
• basis of operation in DNA manipulation;	3
• transgenic plants; molecular markers and its application in forestry;	3
• modification of plant species to practically desired products.	3
• Bio-degradation of forestry wastes through genetically engineered microbes.	5

Suggested Readings:

1. Bajaj, Y.P.S. 1986. Biotechnology in Agriculture and Forestry Springer Verlag, New York.
2. Bonga, J.M. and Durjan, J. 1987. Cell and Tissue culture in Forestry Vol. I & II. Martinus Nijost Publishers, Dordrecht.
3. Burley, J. and B.T. Styles. 1976. Tropical trees: variation breeding and conservation. Academic Press, London.
4. F.A.O. 1985. Forest tree improvement. FAO Publication, Rome, Italy. 270 p.
5. Hainer, R. 1996. Biotechnology in Forest Tree Improvement. (FAO Bulletin 1994). International Book Distributors. Dehra Dun.
6. Hayer, H. and D. Smith. 1975. Methods of plant breeding. McGraw Hill Book Co., London.
7. Khosla, P.K. 1982. Improvement of forest biomass. Pragati Press, Delhi. 472 p.
8. Mandal, A.K. and G.L. Gibson. (eds.). 1997. Forest genetics and tree breeding. CBS Publ. & Distr., New Delhi. 268 p.
9. Murphy, T.M. and Thompson, W.F. 1988. Molecular plant Development Prentice Hall, Englewood, Cliffs, New Jersey.
10. Pochlman, J.M. 2002. Breeding field crops. AVI Publishing Co., New York.
11. Richards, A.J. 1986. Plant breeding systems. George Allen and Urwin, London.
12. Roy, Darbeshwar. 2000. Plant breeding: Analysis and exploitation of variation. Narosa Publishing House, New Delhi. p. 701.

13. Russel, G.E. 1988. Biotechnology of Higher Plants. Intercept publishers, Nimborne, Dorset.
14. White, T.M. and G.R. Hodges. 1989. Predicting breeding values with application in forest improvement. Kluwar Publishing, Netherlands.
15. Wright, J.W. 1976. Introduction to forest genetics. Academic Press, New York. 463 p.
16. Zobel, B.J. and J. Talbert. 1984. Applied forest tree improvement. John Wiley & Sons, New York. p 505.

TBR-733 PLANT TISSUE CULTURE

(2+1)

Plant Tissue Culture-1

Plant tissue culture-principles, history, development, fields of application, progress and prospects with special reference to tree crops. Culture conditions. Stages of micro propagation. In vitro propagation via enhanced release of auxiliary buds, somatic organogenesis and somatic embryo genesis. Problems and Progress in *in vitro* propagation of tree crops. In vitro pollination and fertilization for distant hybridization. Somaclonal variation-factors influencing-exploitation for crop improvement. Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration; Protoplast fusion for somatic hybridization and its application. Techniques for direct gene transfer to protoplasts.

Practical: Preparation and storage of stock solutions, preparation of culture media. Collection, handling and pre-treatment of explants. Micro-propagation of crops via different routes. Ex vitro establishment of plantlets. Production of somatic embryos. In vitro pollination and fertilization. Protoplast isolation and culture. Haploid culture. Components and preparation of culture medium. Collection, handling and surface sterilization of explants. Inoculation and incubation. Essential features of tissue culture laboratories.

Plant Tissue Culture- II

Need of in vitro conservation. Short and medium term conservation. Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, pre-freezing treatments - use of cryo-protectants, dry freezing, incubation. Alteration/modifications in cell components during cryo-preservation. Recalcitrant species. Thawing and reculture. Survival of freeze preserved cells/tissues. Clonal fidelity and karyotype stability of cryopreserved cultures and regenerates. Use of biochemical and molecular markers for testing trfe stability, Protocol development.

Practical: Preparation of in vitro cultures for short, medium and long term preservation. Practicing different protocols for conservation. Thawing and re-culture. Assessing the stability of regenerates. RFLP, RAPD and other techniques. Manipulation of culture media and conditions for prolonging the culture period.

Lecture Schedule

Theory

- | ● Content | Lecture |
|--|---------|
| ● Plant Tissue Culture-1 | 3 |
| Plant tissue culture-principles, history, development, fields of application, progress and prospects with special reference to tree crops. Culture conditions. | |
| ● Stages of micro propagation. In vitro propagation via enhanced release of auxiliary buds, somatic organogenesis and somatic embryo genesis. | 3 |
| ● Problems and Progress in <i>in vitro</i> propagation of tree crops. | 2 |
| ● In vitro pollination and fertilization for distant hybridization. | 2 |
| ● Somaclonal variation-factors influencing-exploitation for crop improvement. | 2 |
| ● Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration; | 2 |
| ● Protoplast fusion for somatic hybridization and its application. | 2 |

- Techniques for direct gene transfer to protoplasts. 2
- **Plant Tissue Culture- II** 2
- Need of in vitro conservation. Short and medium term conservation.
- Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, pre-freezing treatments - use of cryo-protectants, dry freezing, incubation. 4
- Alteration/modifications in cell components during cryo-preservation. 2
- Recalcitrant species. Thawing and reculture. 2
- Survival of freeze preserved cells/tissues. 2
- Clonal fidelity and karyotype stability of cryopreserved cultures and regenerates. 2
- Use of biochemical and molecular markers for testing trfe stability, Protocol development. 2

Practical

- | • Content | Lecture |
|---|----------------|
| • Practical: Preparation and storage of stock solutions, preparation of culture media. Collection, handling and pre-treatment of explants. | 2 |
| • Micro-propagation of crops via different routes. Ex vitro establishment of plantlets | 2 |
| • Production of somatic embryos. | 1 |
| • In vitro pollination and fertilization. | 1 |
| • Protoplast isolation and culture. Haploid culture. | 1 |
| • Components and preparation of culture medium. | 1 |
| • Collection, handling and surface sterilization of explants. | 1 |
| • Inoculation and incubation. Essential features of tissue culture laboratories. | 1 |
| • Practical: Preparation of in vitro cultures for short, medium and long term preservation. | 1 |
| • Practicing different protocols for conservation. | 1 |
| • Thawing and re-culture. | 1 |
| • Assessing the stability of regenerates. RFLP, RAPD and other techniques. | 2 |
| • Manipulation of culture media and conditions for prolonging the culture period. | 2 |

Suggested Readings:

1. Bajaj, Y.P.S. 1986. Biotechnology in Agriculture and Forestry Springer Verlag, New York.
2. Bonga, J.M. and Durjan, J. 1987. Cell and Tissue culture in Forestry Vol. I & II. Martinus Nijost Publishers, Dordrecht.
3. Burley, J. and B.T. Styles. 1976. Tropical trees: variation breeding and conservation. Academic Press, London.
4. F.A.O. 1985. Forest tree improvement. FAO Publication, Rome, Italy. 270 p.
5. Hainer, R. 1996. Biotechnology in Forest Tree Improvement. (FAO Bulletin 1994). International Book Distributors. Dehra Dun.

- 6.Hayer, H. and D. Smith. 1975. Methods of plant breeding. McGraw Hill Book Co., London.
- 7.Khosla, P.K. 1982. Improvement of forest biomass. Pragati Press, Delhi. 472 p.
- 8.Mandal, A.K. and G.L. Gibson. (eds.). 1997. Forest genetics and tree breeding. CBS Publ. & Distr., New Delhi. 268 p.
- 9.Murphy, T.M. and Thompson, W.F. 1988. Molecular plant Development Prentice Hall, Engleward, cliffe, New Jersey.
- 10.Pochlman, J.M. 2002. Breeding field crops. AVI Publishing Co., New York.
- 11.Richards, A.J. 1986. Plant breeding systems. George Allen and Urwin, London.
- 12.Roy, Darbeshwar. 2000. Plant breeding: Analysis and exploitation of variation. Narosa Publishing House, New Delhi. p. 701.
- 13.Russel, G.E. 1988. Biotechnology of Higher Plants. Intercept publishers, Nimborne, Dorset.
- 14.White, T.M. and G.R. Hodges. 1989. Predicting breeding values with application in forest improvement. Kluwar Publishing, Netherlands.
- 15.Wright, J.W. 1976. Introduction to forest genetics. Academic Press, New York. 463 p.
- 16.Zobel, B.J. and J. Talbert. 1984. Applied forest tree improvement. John Wiley & Sons, New York. p 505.

TBR-734 ADVANCES IN TREE IMPROVEMENT

(2+1)

General concepts of tree improvement - Variation in trees, importance and its causes, kinds and types - Natural variation as a basis for tree improvement - Variation in natural stands, species and provenance testing. Quantitative aspects of tree improvement - Statistical concepts Heritability and genetic gain - Selection methods – selection in natural stands, unimproved plantations, even and uneven aged stands - Selection strategies and choice of breeding methods - Selective breeding for wood quality, resistance to pest and disease, adverse environments - indirect selection for biotic and abiotic stresses. Heterosis breeding – inbreeding and hybrid vigor- manifestation and fixation of heterosis -Wood and tree improvement – wood properties and their genetic relationships - Exotic forestry and tree breeding- gains and risks - donor and receptor countries - genetic improvement of exotics - Land race concept. Seed production areas and seed orchards - types-functions, importance and management – Biochemistry, Physiology of seed development and seed germination – Seed storage – Seed management practices for wastelands. Bio technological approaches for Tree Breeding.

Practical

Problems in quantitative genetics - Selection criteria for timber trees, trees of agroforestry - Plus tree selection methodology - practical exercise - Visit to species, provenance and progeny trial - seed orchards and mating designs - visit to seed orchards - estimation of SCA, GCA, heritability and genetic gain. Estimation of pollen viability - pollen handling - Estimation of genetic correlation and juvenile-adult correlation - Preparation of tree improvement project - Seed physiological maturity and its assessment – Collection, extraction, processing and seed storage techniques.

Lecture Schedule

Theory

• Content	Lecture
• General concepts of tree improvement – breeding objectives – advantages and limitations of tree improvement	2
• Variations, its use and importance – causes, kinds and types – forces that shape variation	2
• Variation in natural stands – provenance, seed sources, clines and ecotypes	3
• Quantitative aspects of tree improvement – statistical concepts	2
• General and specific combining abilities – heritability and genetic gain	2
• Selection methods – selection for several traits - Selection in natural stands, unimproved plantations, even and uneven aged stands	2
• Selection strategies and choice of breeding methods – selective breeding	2
• Selection and selective breeding for wood quality, pest and disease resistance, adverse environments, etc	2
• Heterosis breeding – inbreeding and hybrid vigour – manifestation and fixation of heterosis	2
• Wood and tree improvement – wood properties and their genetic relationships	2
• Exotic forestry – gains and risks – donor and receptor countries – genetic improvement of exotics – advantages and limitations	2

- Seed Production – immediate and long term needs – seed production area 2
– seed orchard – types, functions, and management
- Biochemistry and physiology of seed development, seed germination and 2
seed storage
- Seed management practices for wasteland development 2
- Bio technological approaches for Tree Improvement – Advantages – 3
Various methods – Tissue culture – Genetic engineering – Metabolite
production
- Molecular markers – Types – Utility in Tree Breeding 2

Practical

- | ● Content | Lecture |
|--|----------------|
| ● Problems in quantitative genetics | 1 |
| ● Estimation of variability | 1 |
| ● Estimation of selection differential | 1 |
| ● Selection criteria for timber trees | 1 |
| ● Selection criteria for trees of Agro forestry utility | 1 |
| ● Exercise in plus tree selection | 1 |
| ● Seed orchards and mating designs | 1 |
| ● Estimation of General and Specific Combining Abilities | 1 |
| ● Estimation of heritability and genetic gain | 1 |
| ● Estimation of genetic correlation | 1 |
| ● Juvenile adult correlation | 1 |
| ● Preparation of a tree improvement project | 1 |
| ● Estimation of pollen viability and pollen handling techniques | 1 |
| ● Seed physiological maturity – maturity indices – assessment of 1
physiological maturity | |
| ● Seed collection, extraction and processing | 1 |
| ● Seed storage techniques | 1 |
| ● Final Practical Examination | 1 |

Suggested Readings:

- 1.FAO. 1985. *Forest Tree Improvement*, FAO Publication, Rome, Italy. 270p.
- 2.Faulkner, R. 1975. *Seed Orchard* Forestry Commission Bulletin No.34. 149p.
- 3.Fins, L., Friedman, S.T. and Brotschol, J.V. 1992. *Handbook of Quantitative Forest Genetics*, Klumer Academy, Dordrach, London.
- 4.Khosla, P.K. 1981. *Advances in Forest Genetics*. Ambika Publisher, New Delhi. 375p.
- 5.Khosla, P.K. 1982. *Improvementof Forest Biomass*. Pragati Press, Delhi. 472p.
- 6.Mandal, A.K. and Gibson, G.L.(eds)1997. *Forest Genetics and Tree Breeding*. CBS Publi. & Distr., New Delhi 268p.
- 7.Wright, J.W. 1976. *Introduction to Forest Genetics*. Academic Press, New York. 463p.
- 8.Zobel, B.J. and Talbert, J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons, New York. 505p.
- 9.Zobel, B.J. Wyh, G.V. and Stahl, P. 1987. *Growing Exotic Foreste*. John Wiley & Sons, New York. 508p.

TBR -735 ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY (2+0)

Environment: Basic concepts and issues. Environmental Pollution: Types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations Air pollution and its control through Biotechnology.

Water Pollution and its Control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment-physical, chemical and biological treatment processes Microbiology of Waste Water Treatments, Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes: Anaerobic digestion, anaerobic filters. Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

Microbiology of degradation of Xenobiotics in Environment - Ecological consideration, - decay behavior & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. Bioremediation of contaminated soils and waste lands. Biopesticides in integrated pest management.

Solid waste: sources and management (composting, wormy culture and methane production). Global Environmental Problems: Ozone depletion, UV-6, green-house effect and acid rain, their impact and biotechnological approaches for management. Bioleaching, Bio-fertilizer for sustainable agriculture & environment (AMF, ECM, PGPRs, PSBs, with special reference to low input agriculture).

Lecture Schedule

Theory

Content	Lecture
• Environment: Basic concepts and issues.	2
• Environmental Pollution: Types of pollution,	2
• Methods for the measurement of pollution;	2
• Methodology of environmental management - the problem solving approach, its limitations Air pollution and its control through Biotechnology.	3
• Water Pollution and its Control: Water as a scarce natural resource, Need for water management,	2
• Measurement of water pollution, sources of water pollution,	2
• Waste water collection, Waste water treatment-physical, chemical and biological treatment processes	2
• Microbiology of Waste Water Treatments,	2
• Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds	2
• Anaerobic Processes: Anaerobic digestion, anaerobic filters.	2
• Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.	2
• Microbiology of degradation of Xenobiotics in Environment - Ecological consideration, - decay behavior & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.	3
• Bioremediation of contaminated soils and waste lands. Biopesticides in	2

integrated pest management.

- Solid waste: sources and management (composting, wormy culture and methane production)
- Global Environmental Problems: Ozone depletion, UV-B, green-house effect and acid rain, their impact and biotechnological approaches for management.
- Bioleaching, Bio-fertilizer for sustainable agriculture & environment (AMF, ECM, PGPRs, PSBs, with special reference to low input agriculture).

Suggested Reading:

1. Environmental Biotechnology, Jogdand, S.N. 1995. Himalaya Publishing House, Mumbai.
2. Handbook on Anaerobic fermentations, Erickson, L.E. and D.Y. Fung. 1988. Marcel and Dekker Inc. New York.
3. Working with anaerobes: Methanogens, Ramasamy, K., G.Kalaichelvan and B.Nagamani. 1992. Fermentation Laboratory, TNAU, Coimbatore.
4. Methods for General and Molecular Bacteriology, Gerhardt, P., R.G.E.Murray, W.A.Wood and N.R.Krieg. 1994 ASM Publications, Washington.
5. Bioremediation - Principles and Applications, Crawford, R.L. and D.L.Crawford. 1996, Cambridge University Press, London.
6. Environmental Biotechnology, M. H. Fulekar, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Principles of Biochemistry 1st Indian Edition – Lehninger A. L. (1984) LBS Publishers and Distributors Pvt. Ltd., New Delhi
8. Manual on sewerage & sewage treatment, Ministry of works & housing, New Delhi.
9. Waste water engineering, Met Calf & Eddy ;INC, Tata mcGraw Hill.
10. Physico-chemical; Process of water quality control, W. J. Webber, Wiley inter-science.
11. Waste water treatment for pollution control, Dr. Arceivala, Tata Mc Graw Hill.
12. Liquid Waste of Industry Theory, Practice and Treatment. Nelson L. Memerow. Adison Wasley Publishing Co.
13. Treatment of Industrial Effluent A.B. Calleyl, D.A. Stafford.
14. Industrial Water Pollution Control. W.W. Wasley Mc Graw Hill Publication.
15. Industrial Pollution Control Issues and Technology.Nancy, J. Bell. Elsevier Scientific Publishing Co.,
16. Industrial Waste Water Management. Studies in Environmental Science- 5. Elsevier Scientific Publishing Co.,
17. A Text Book of Environmental Sciences, S. S. Purohit, Q. J. Shammi and A.K. Agarwal, Student Edition (Agrobios), Jodhpur.
18. A Text Book of Environmental Studies, D. K. Asthana and Meera Asthana,S. Chand & Co., New Delhi.
19. Air Pollution, M.N. Rao and H.V.N. Rao, Tata McGraw Hill, New Delhi.
20. An Introduction to Air Pollution, R. K. Trivedy and P. K. Goel, B. S.Publications, Hyderabad.

21. Standard Methods for the Examination of Water and Wastewaters, American Public Health Association, Washington, DC.
22. Water Pollution: Causes, Effects and Control, P. K. Goel, New Age International Publishers, New Delhi.

ENV-731 ENVIRONMENTAL POLLUTION

(3+0)

Definition of pollution, Causes of Pollution of the biosphere, classification of pollutants, National and International Environmental Standards of important Pollutants.

Air Pollution: Types and major sources of air pollutants, dispersal and deposition, response of biotic. and abiotic ecosystem components to pollutants. Ionizing radiation, acid rain- causes and consequences. Monitoring of gaseous pollutants and particulate matter. Air pollution mitigation and control. Vehicular Pollution monitoring and abatement technologies. Biological abatement of air pollution, Development of green belt.

Water Pollution: Important pollutants, sources and transformation in nature, eutrophication effects of organic pollutants on organisms and communities. Impact of heavy metals, halogens, and radio-nuclides on aquatic flora and fauna treatment technologies for industrial effluents/ wastewater. Monitoring water pollution and water quality studies. The pollution problem-pollution categorization, sewage, infectious agents, nutrients, chemicals, organic and inorganic sediments, radioactive materials, heat. Causes, consequences and control of eutrophication. Biomanipulation and eco-restoration of lakes: Top-down and Bottom-up approaches. Environmental Health and sanitation

Soil Pollution: Types and sources of soil pollution. Solid waste generation, soil pollutants. Heavy metal toxicity in soil. Hazardous wastes and their Management. Impact of pesticides, industrial waste and fertilizers on soil physico-chemical properties monitoring soil pollution.

Noise Pollution: Causes and consequences of noise pollution. Monitoring and abatement techniques.

Lecture Schedule

Theory

• Content	Lecture
• Definition of pollution, Causes of Pollution of the biosphere, classification of pollutants, National and International Environmental Standards of important Pollutants.	5
• Air Pollution: Types and major sources of air pollutants, dispersal and deposition, response of biotic. and abiotic ecosystem components to pollutants.	4
• Ionizing radiation, acid rain- causes and consequences. Monitoring of gaseous pollutants and particulate matter.	3
• Air pollution mitigation and control. Vehicular Pollution monitoring and abatement technologies.	3
• Biological abatement of air pollution, Development of green belt.	3
• Water Pollution: Important pollutants, sources and transformation in nature, eutrophication effects of organic pollutants on organisms and communities.	4
• Impact of heavy metals, halogens, and radio-nuclides on aquatic flora and fauna treatment technologies for industrial effluents/ wastewater.	4
• Monitoring water pollution and water quality studies.	3
• The pollution problem-pollution categorization, sewage, infectious agents, nutrients, chemicals, organic and inorganic sediments, radioactive materials, heat.	4

- Causes, consequences and control of eutrophication. Biomanipulation and eco-restoration of lakes: Top-down and Bottom-up approaches. Environmental Health and sanitation 4
- Soil Pollution: Types and sources of soil pollution. 2
- Solid waste generation, soil pollutants. 2
- Heavy metal toxicity in soil. 2
- Hazardous wastes and their Management. 2
- Impact of pesticides, industrial waste and fertilizers on soil physico-chemical properties monitoring soil pollution. 3
- Noise Pollution: Causes and consequences of noise pollution. Monitoring and abatement techniques. 4

Suggested Reading :

1. Manual on sewerage & sewage treatment, Ministry of works & housing, New Delhi.
2. Waste water engineering, Met Calf & Eddy ;INC, Tata mcGraw Hill.
3. Physico-chemical; Process of water quality control, W. J. Webber, Wiley inter-science.
4. Waste water treatment for pollution control, Dr. Arceivala, Tata Mc Graw Hill.
5. Liquid Waste of Industry Theory, Practice and Treatment. Nelson L. Memerow. Adison Wasley Publishing Co.
6. Treatment of Industrial Effluent A.B. Calleyl, D.A. Stafford.
7. Industrial Water Pollution Control. W.W. Wasley Mc Graw Hill Publication.
8. Industrial Pollution Control Issues and Technology.Nancy, J. Bell. Elsevier Scientific Publishing Co.,
9. Industrial Waste Water Management. Studies in Environmental Science- 5. Elsevier Scientific Publishing Co.,
10. A Text Book of Environmental Sciences, S. S. Purohit, Q. J. Shammi and A.K. Agarwal, Student Edition (Agrobios), Jodhpur.
11. A Text Book of Environmental Studies, D. K. Asthana and Meera Asthana,S. Chand & Co., New Delhi.
12. Air Pollution, M.N. Rao and H.V.N. Rao, Tata McGraw Hill, New Delhi.
13. An Introduction to Air Pollution, R. K. Trivedy and P. K. Goel, B. S.Publications, Hyderabad.
14. Standard Methods for the Examination of Water and Wastewaters,American Public Health Association, Washington, DC.
15. Water Pollution: Causes, Effects and Control, P. K. Goel, New Age International Publishers, New Delhi.

Conceptual of Environmental Impact Assessment - frame work of environmental assessment - description of environmental setting - simple methods for impact identification - matrices, networks, and checklists - background information - interaction matrix methodologies - network methodologies - checklist methodologies, Prediction and assessment of impact of air, water (surface and ground), biological, socio-economic environment - Basic information and issues - regulations - conceptual approach - identification of the types and quantities of pollutants - existing quality conditions - procurement of relevant quality standards and regulations - impact prediction - assessment of impact significance - identification and incorporation of mitigation measures.

Practicals

Study of flora and fauna of dam ecosystem, Erosion and soil structure pattern at hydel power stations – impact of power stations on plant, microorganisms, animals and soil ecosystems - Impact of coal mining and mining dumps on the soil physical, chemical and biological properties – reclamation of mining wastes using microorganisms – crop plants and tree systems – bioaccumulation of metals by microorganisms.
 Assessment of environmental impact in selected villages due to industries – Awareness of environmental regulations and control measures

Theory

Content	Lecture
• Concept of Environmental Impact Assessment	2
• Frame work of environmental assessment description of environmental setting	2
• Simple methods for impact identification	3
• Matrices, networks, and checklists	6
• Background information - interaction matrix methodologies - network methodologies - checklist methodologies	5
• Prediction and assessment of impact of air, water (surface and ground), biological, socio-economic environment	6
• Basic information and issues - regulations - conceptual approach	2
• Identification of the types and quantities of pollutants	2
• Existing quality conditions - procurement of relevant quality standards and regulations - impact prediction - assessment of impact significance	4
• Identification and incorporation of mitigation measures	2

Practical

Content	Lecture
• Study of flora of Dam ecosystems	1
• Study of fauna of Dam ecosystems	1
• EIA of polluted river ecosystem	1
• Study of erosion at hydal power systems	1

- Study of erosion control structures at tidal power systems 1
- Impact of particulate matter on environment 1
- Impact of coal mining on environment 1
- Impact of cement pollution on environment 1
- Impact of metal ore mining on environment 1
- Effect of effluent from several industries on environment 1
- Reclamation of mining wastes with microorganisms 1
- Reclamation of mining wastes with crop plants and trees 1
- Visit to mining dump sites 1
- Bio-accumulation studies on metals by microorganisms 1
- Assessment of environmental impact on polluted sites of current importance 1
- Assessment of noise pollution in and around factories and in urban environment 1
- Assessing the awareness of environmental regulation and control methods 1

Suggested Readings:

1. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication, New York.
2. Proceedings Indo-US Workshop on environmental impact analysis & assessment (1980), NEERI, Nagpur.
3. Environmental & social impact assessment, Vanclay F., Bronstein DA (1995), John Wiley & Sons, New York.
4. EIA – A Biography, B. D. Clark, B. D. Bissel, P. Watheam.

ENV-733 GLOBAL CLIMATIC CHANGES

(2+0)

Earth's climate systems, major green house gases, future climatic predictions, adaptability and vulnerability of predictions, adaptability and vulnerability of forest and aquatic eco'systems, responses of biotic communities and changes in reproductive biology of flora and fauna. Ozone depletion and UV radiation hazards, El Nino effect

Lecture Schedule

Theory

• Content	Lecture
• Earth's climate systems,	5
• Major green house gases	5
• Future climatic predictions, adaptability and vulnerability of predictions	4
• Adaptability and vulnerability of forest and aquatic ecosystems.	4
• Responses of biotic communities and changes in reproductive biology of flora and fauna.	6
• Ozone depletion and UV radiation hazards, El Nino effect	8

Suggested Reading:

1. Indian Forester – June and July Issue of 2003.
2. Iyer, C.S.P. 2001. Emerging trends in environmental science. Asiatech Publishers Inc., New Delhi. P.304.
3. Peter Thompson. 1991. Global warming – The debate. Strategy Europe Ltd., London, U.K. p. 130.
4. Satish Tiwari. 2000. Environment and Forest. Anmol Publication Pvt. Ltd., New Delhi. P.302.
5. Sunit Gupta. 2000. Global Environment – Current Status. Sarup & Sons., New Delhi. P.508.

ENV-734 ENVIRONMENTAL POLLUTION AND WILDLIFE HEALTH 3(2+1)

Environmental pollutants and toxins. Environmental toxicology; Heavy metal toxicity in animals – Case reports. Drug toxicity in animals and birds. Environmental (Protection) Act 1986. Pollution policy in practice, Environmental quality standards, Environmental Guidelines, Regulations and Rules Important case studies relating to Acts above stated with preliminary idea of Indian Penal code, Cr P.C and other enactments in India. Evaluation of environmental impacts on wildlife species and habitats, determination of impact significance criteria.

Practicals:

Study of flora and fauna in nearby ecosystem. Impact of power stations on plant, microorganisms, animals and soil ecosystems. Case reports on the drug and heavy metal toxicities in animals and birds.

Lecture Schedule

Theory

Content	Lecture
• Environmental pollutants and toxins.	4
• Environmental toxicology; Heavy metal toxicity in animals – Case reports.	5
• Drug toxicity in animals and birds.	5
• Environmental (Protection) Act 1986.	2
• Pollution policy in practice, Environmental quality standards, Environmental Guidelines, Regulations and Rules Important case studies relating to Acts above stated with preliminary idea of Indian Penal code, Cr P.C and other enactments in India.	8
• Evaluation of environmental impacts on wildlife species and habitats, determination of impact significance criteria.	8

Practical

Content	Lecture
• Study of flora and fauna in nearby ecosystem.	4
• Impact of power stations on plant, microorganisms, animals and soil ecosystems.	6
• Case reports on the drug and heavy metal toxicities in animals and birds.	7

Suggested Reading:

1. Indian Wildlife Diseases and Disorders, 1st Edition, Year 2003-04. Association of Indian Zoo and Wildlife Veterinarians. Bareilly.,
2. Manual on sewerage & sewage treatment, Ministry of works & housing, New Delhi.
3. Waste water engineering, Met Calf & Eddy ;INC, Tata mcGraw Hill.
4. Physico-chemical; Process of water quality control, W. J. Webber, Wiley inter-science.
5. Waste water treatment for pollution control, Dr. Arceivala, Tata Mc Graw Hill.
6. Liquid Waste of Industry Theory, Practice and Treatment. Nelson L. Memerow. Adison Wasley Publishing Co.

7. Treatment of Industrial Effluent A.B. Calleyl, D.A. Stafford.
8. Industrial Water Pollution Control. W.W. Wasley Mc Graw Hill Publication.
9. Industrial Pollution Control Issues and Technology.Nancy, J. Bell. Elsevier Scientific Publishing Co.,
10. Industrial Waste Water Management. Studies in Environmental Science- 5. Elsevier Scientific Publishing Co.,
11. A Text Book of Environmental Sciences, S. S. Purohit, Q. J. Shammi and A.K. Agarwal, Student Edition (Agrobios), Jodhpur.
12. A Text Book of Environmental Studies, D. K. Asthana and Meera Asthana,S. Chand & Co., New Delhi.
13. Air Pollution, M.N. Rao and H.V.N. Rao, Tata McGraw Hill, New Delhi.
14. An Introduction to Air Pollution, R. K. Trivedy and P. K. Goel, B. S.Publications, Hyderabad.
15. Standard Methods for the Examination of Water and Wastewaters,American Public Health Association, Washington, DC.
16. Water Pollution: Causes, Effects and Control, P. K. Goel, New Age International Publishers, New Delhi.

ENV-735 ENVIRONMENTAL POLICY AND LAW (3+0)

Environment and Development Policies:

Land and agricultural Policies: Land Use Policy, Industrial Policy, Policy on resettlement and rehabilitation. Forest Policies in India; National Forest Policy 1952 and 1988.

National Environment Policy 2006 , Policy on abatement of Pollution, National Eco tourism Policy , National Tourism Policy , National Trade Policy, National Water Policy.

Bio-Diversity Related Laws:

The Indian Forest Act 1927 and subsequent amendments ; Forest Conservation Act, 1980 and Rules; Wild Life Protection Act 1972 and Rules, Wild Life Protection Amendment Act 2002, Biodiversity Act 2002 ,Biodiversity Rules 2004 ,National Biodiversity Strategic Action Plan, Plant Varieties Protection and Farmer's Rights Act, 2001, Geographical Indications of Goods Act, 1999.The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006,Case Law

Pollution Control Laws

Public Nuisance - S.I33 Cr.P.C; Law of Strict Liability, Public Liability Insurance Act, 1991. Water (Preventing and Control of Pollution) Act, 1974; Water Cess Act 1977; Air (Prevention and Control of Pollution) Act, 1981; Environment (Protection) Act 1986 and Rules 1987; Subsequent allied Rules Environment Impact Assessment, Quality Control and auto regulation and Environment Audit, Energy and Environment, Mining and Environment.

Lecture Schedule

Theory

	Lecture
• Content	5
• Environment and Development Policies:	5
Land and agricultural Policies: Land Use Policy, Industrial Policy, Policy on resettlement and rehabilitation.	
• Forest Policies in India; National Forest Policy 1952 and 1988.	3
• National Environment Policy 2006 , Policy on abatement of Pollution	3
• National Eco tourism Policy , National Tourism Policy , National Trade Policy, National Water Policy.	3
• Bio-Diversity Related Laws:	5
The Indian Forest Act 1927 and subsequent amendments ; Forest Conservation Act, 1980 and Rules;	
• Wild Life Protection Act 1972 and Rules, Wild Life Protection Amendment Act 2002,	3
• Biodiversity Act 2002 ,Biodiversity Rules 2004 ,	2
• National Biodiversity Strategic Action Plan,	2
• Plant Varieties Protection and Farmer's Rights Act, 2001,	3
• Geographical Indications of Goods Act, 1999.	2
• The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006,Case Law	4
• Pollution Control Laws	4
Public Nuisance - S.I33 Cr.P.C; Law of Strict Liability, Public Liability Insurance Act, 1991.	
• Water (Preventing and Control of Pollution) Act, 1974; Water Cess Act 1977; Air (Prevention and Control of Pollution) Act, 1981	4

- Environment (Protection) Act 1986 and Rules 1987; 3
- Subsequent allied Rules Environment Impact Assessment, Quality Control and auto regulation and Environment Audit, Energy and Environment, Mining and Environment 5

Suggested Readings:

1. Handbook of Environmental Laws, Acts, Rules, Guidelines, Compliances and Standards, Vol. I and II, BS Publications, Hyderabad.
2. Law on Protection of Environment and Prevention of Pollution (Central and States), R. G. Chaturvedy and M.M. Chaturvedy, The Law Book Co. (Pvt.) Ltd., Allahabad.
3. Introduction to Environmental Legislation, B.L.Chavan, A.R.Shahane and C.S. Rawandale, Asian Inst. Env. Law., Karmala.

ENV-736 NATURAL RESOURCE MANAGEMENT

Introduction to Forestry & Natural Resource Conservation

Introduction to forestry, concept of conservation with special reference to wildlife management and the management of forests in India. Philosophies of science, conservation and sustainable development. Philosophy of wildlife management, conservation versus preservation, valuing wildlife: the western viewpoint of wildlife management in India. Conservation project in India, Environmental movements, international conservation bodies; IUCN UNDP, FAO, WWF.

Conservation laws, national wildlife conservation policy and action plan, national forest policy, wildlife (protection) act, 1972, international conventions. Conservation and development; Conservation movement in India, socio-economic and political realities, different phases of the conservation and how it has impacted people at large. What is integrated conservation? Participation in conservation and development of linkages and interest groups.

Practicals: Class based discussion with faculty and a range of conservation activists. Review of literature. Preparation of conservation statements.

Lecture Schedule

Theory

• Content	No. of Classes
• Introduction to forestry, concept of conservation with special reference to wildlife management and the management of forests in India.	2
• Philosophies of science, conservation and sustainable development. Philosophy of wildlife management, conservation versus preservation, valuing wildlife: the western viewpoint of wildlife management in India.	4
• Conservation project in India, Environmental movements, international conservation bodies; IUCN UNDP, FAO, WWF.	3
• Conservation laws, national wildlife conservation policy and action plan, national forest policy, wildlife (protection) act, 1972, international conventions.	3
• Conservation and development; Conservation movement in India, socio-economic and political realities, different phases of the conservation and how it has impacted people at large.	3
• What is integrated conservation? Participation in conservation and development of linkages and interest groups.	2

Suggested Readings:

1. Fisher, A.C., *Resource and Environmental Economics* (New York: John Wiley & Sons), 1979.
2. Orris C. Herfindahl, *Natural Resource Information for Economic Development* (Baltimore: The Johns Hopkins University Press), 1969.
3. Sharma, S.D., *A New Approach to Linear Programming* (Meerut: Kedarnath, Ramnath and Co.), 1975.
4. Tony Prato, *Natural Resource and Environmental Economics* (Ames: Iowa State University Press), 1998.

FOR-780 SEMINAR-I
FOR-880 SEMINAR-II

MAS-711 STATISTICS-I

Analysis of variance: Definition and assumptions, one way classification, two way classification. Sampling Techniques: Simple random sampling, stratified random sampling, systematic sampling. Design Experiments: Randomized Block design, Latin Square design, Factorial design (2^2 , 2^3 , 3^2 , 3^3 factorials), Some P x Q experiments, Split Plot Experiments. Balanced Incomplete Block design

Practical

Analysis of variance, Randomized Block Design.

Theory

Content	Lecture
• Analysis of variance	2
• Definition and assumptions,	2
• one way classification,	2
• two way classification.	2
• Sampling Techniques	2
• Simple random sampling	2
• stratified random sampling	2
• systematic sampling.	2
• Design Experiments	2
• Randomized Block design	2
• Latin Square design	2
• Factorial design (2^2 , 2^3 , 3^2 , 3^3 factorials)	3
• Some P x Q experiments	3
• Split Plot Experiments	3
• Balanced Incomplete Block design	3

Practical

Content	Lecture
• Analysis of variance	6
• Randomized Block Design	11

Suggested Readings:

1. Bernard Ostle and R.W.Mensing, Statistics in Research.
2. C.H. Goulden, Method of Statistical Analysis.
3. G.W. Snedecor and W.G. Cochran, Statistical Methods.
4. R.G. Steel and J.H. Torrie, Principles and Procedures of Statistics (with special reference to Biological Sciences)
5. R.Rangaswamy, A Text Book of Agricultural Statistics.
6. Chandel S.R.S, A Text Book of Agricultural Statistics.
7. W.G. Cochran and G.M.Cox, Experimental Designs.

MAS-715 STATISTICS-II

Statistical Methods: Measures of Skewness and Kurtosis, standard error of mean, Coefficient of variation. Theory of Probability : Definitions, Additions and Multiplication rules of Probability, Conditional Probability. Probability distributions: Normal, Binomial and Poisson distributions. Correlation and Regression : Simple correlation, Rank correlation, Regression Coefficient, Multiple and Partial Correlation, Regression lines between two variables, Multiple Regression. Tests of Significance: X^2 - test, t - test one sample, two sample t – tests, paired t-test, F – test, Fisher’s 2 – transformation

Practical

Coefficient of variation, SE of mean, Skewness and Kurtosis. Fitting of Normal, Binomial and Poisson distribution. Simple Correlation, Multiple and Partial Correlation with three variables only. Regression lines between two variables. X^2 , t and F – tests

Theory

Content	Lecture
• Statistical Methods: Measures of Skewness and Kurtosis	2
• standard error of mean	2
• Coefficient of variation	2
• Theory of Probability : Definitions	2
• Additions and Multiplication rules of Probability	2
• Conditional Probability	2
• Probability distributions: Normal, Binomial and Poisson distributions	2
• Correlation and Regression : Simple correlation	2
• Rank correlation	2
• Regression Coefficient	2
• Multiple and Partial Correlation	3
• Regression lines between two variables	3
• Multiple Regression	3
• Tests of Significance: X^2 - test	3
• t - test one sample	2
• two sample t – tests	2
• paired t-test, F – test	2
• Fisher’s 2 – transformation	2

Practical

Content	Lecture
• Coefficient of variation	2
• SE of mean	1
• Skewness and Kurtosis	2
• Fitting of Normal	2
• Binomial and Poisson distribution	2
• Simple Correlation	2
• Multiple and Partial Correlation with three variables only	2

- Regression lines between two variables 2
- X^2 , t and F – tests 2

Suggested Readings:

1. C.H. Goulden, Method of Statistical Analysis.
2. Bernard Ostle and R.W.Mensing, Statistics in Research.
3. R.Rangaswamy, A Text Book of Agricultural Statistics.
4. Chandel S.R.S, A Text Book of Agricultural Statistics.
5. W.G. Cochran and G.M.Cox, Experimental Designs.

COMP-709 COMPUTER ORIENTATION

Introduction to multi programming and time sharing computers - Login and creation of files - Introduction to structured programming with reference to BASIC - Variables and constants, complex, double precision, logical, character - Arithmetic expressions, arrays, control statements (DO, IF, Computed GOTO) - Functions and subroutines - I/O statements - Elementary programming of algorithms.

Practical

Loading Windows and other features in Windows. MS Word – creation, editing of a document. Using features like underlining, bold, italics, spell check etc. and printing. Creation of excel sheet and processing for statistical analysis. Creation of a database in access - Mstat – creation of a data file. Internet – getting connected and email Internet – retrieval of information.

Theory

Content	Lecture
• Introduction to multi programming and time sharing computers	3
• Login and creation of files	3
• Introduction to structured programming with reference to BASIC	4
• Variables and constants	3
• Complex, double precision	3
• Logical, character	3
• Arithmetic expressions	3
• Arrays, control statements (DO, IF, Computed GOTO)	4
• Functions and subroutines - I/O statements	4
• Elementary programming of algorithms	4

Practical

Content	Lecture
• Loading Windows and other features in Windows	3
• MS Word – creation, editing of a document	2
• Using features like underlining, bold, italics, spell check etc. and printing	3
• Creation of excel sheet and processing for statistical analysis	2
• Creation of a database in access - Mstat – creation of a data file	3
• Internet – getting connected and email Internet – retrieval of information	3

Suggested Readings:

1. Chris Lewis, Essential Tips: Using the Internet
2. Gene Weisskopf, ABCs of Excel 97
3. Kenneth N.Berk, Introductory Statistics with Systat
4. Kris N, Advanced Data Analysis with Systat
5. Mark Wallace, Things to do on the Internet
6. Ron Mansfield, The Compact Guide to Microsoft Office

AGF-703 RESEARCH METHODOLOGY**1(0+1)**

Project formulation - Problem identification - formulation of objectives and technical program - data collection - data interpretation and deriving inferences and conclusions - literature collection - Review writing - Research article writing - Technical report preparation - Research abstracting - Research Scheme proposal.

Theory

Content	Lecture
• Project formulation	1
• Problem identification	1
• Formulation of objectives and technical program	1
• Data collection	2
• Data interpretation and deriving inferences and conclusions	2
• Literature collection	2
• Review writing	2
• Research article writing	2
• Technical report preparation	2
• Research abstracting	1
• Research Scheme proposal.	1

Suggested Readings:

1. Agarwal. S.K. 2003. Research Methodology. International Book Distributors, Dehradun.
2. Gupta. R.K. 2001. Research Methodology. IBH publications, New Delhi.
3. Gopal Lal Jain. 2003. Research Methodology – Methods, tools and techniques. Mangal Deep Publication, Jaipur. P.303.
4. Singh, V.P. 2003. Research Methodology. Scientific for Publication, New Delhi. P.300
5. Kothari, C.R. 1997. Research Methodology – Methods and Teaching. Pub: Wishwa Prakashm, New Delhi.

SVC-707 FOREST RESOURCE MANAGEMENT AND ECONOMICS (2+1)

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory, and inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decision. Valuation of non-market goods and economics of multiple-use, Eco-system Analysis and Modeling. Forest certification, eco-development planning, Sustainability Analysis, SWOT Analysis. Application of operations research tools in evaluating forest management alternatives in public and private forest planning.

Practical: Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forestry products. Exercises on financial and economic appraisal of forestry projects. Numerical exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives. El A study of a project.

Lecture Schedule

Theory

Content	Lecture
• Application of microeconomics in solving forest resource problems.	4
• Emphasis on forest products demand and supply analysis	3
• forest products marketing,	3
• Forest capital theory, and inter-regional and international trade in forest products.	4
• Impact of economics and physical variables upon forest appraisal and management decision.	4
• Valuation of non-market goods and economics of multiple-use	4
• Eco-system Analysis and Modeling.	3
• Forest certification, eco-development planning, Sustainability Analysis, SWOT Analysis.	4
• Application of operations research tools in evaluating forest management alternatives in public and private forest planning.	5

Practical

Content	Lecture
• Practical: Exercises on estimation of demand and supply functions;	2
• biodiversity valuation, valuation of non-marketed forestry products.	2
• Exercises on financial and economic appraisal of forestry projects.	3
• Numerical exercises on marketing of forest products and international trade competitiveness.	4
• Computer applications for using programming techniques in evaluating forest management alternatives.	4
• EIA study of a project.	2

Suggested Readings:

1. FERNANDES, W. & KULKARNI (1986), - Towards a new Forest Policy. Natral Publishers, Dehra Dun.
2. Forest Policy (1988), Government of India Publication, Delhi.
3. Indian Forest Acts with short Notes (1975), Allahabad Law Agency, Allahabad.

4. JHA, L.K. (1994), Analysis and Appraisal of India's Forest Policy , Ashish Publishing House, Delhi.
5. KHANNA, L.S., Wildlife (Protection) Act 1972 as amended upto date with commentary, Khanna Bandu, Dehra Dun.
6. NEGI, S.S. (1985), Forest Law, Natraj Publication, Dehra Dun.
7. PATIL, H.M. (1986), Policy for National Conservations, Natraj Publication, DehraDun.
8. SAHARIA, V.B (1989), Wildlife Law in India, Natraj Publication, Dehra Dun.
9. Handbook of Environment, Forest Wildlife Protection Laws in India, Natraj Publishers, Dehra Dun
10. Edwin S. Mills, Economic Analysis of Environmental Problems (New York: Columbia University Press), 1975.
11. Fisher, A.C., Resource and Environmental Economics (New York: John Wiley & Sons), 1979.
12. Orris C. Herfindahl, Natural Resource Information for Economic Development (Baltimore: The Johns Hopkins University Press), 1969.
13. Sharma, S.D., A New Approach to Linear Programming (Meerut: Kedarnath, Ramnath and Co.), 1975.
14. Tony Prato, Natural Resource and Environmental Economics (Ames: Iowa State University Press), 1998.

SVC-703 ADVANCED FOREST MANAGEMENT

(2+0)

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India. Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies, forest valuation and appraisal in regulated forests. Maximising present net value and benefits.

Lecture Schedule

Theory

• Content	Lecture
• Principles of forest management;	3
• Scope and object of forest management,	4
• Ecosystem management,	4
• development of forest management in India.	4
• Site quality evaluation and importance.	4
• Stand density, classical approaches to yield regulation in forest management, salient features and strategies,	6
• Forest valuation and appraisal in regulated forests.	5
• Maximising present net value and benefits.	4

Suggested Reading:

1. Ram Prakash. Forest management, 2006, IBD Publication, Dehradun
2. Osmaston, F.C. Management of Forests, 1984. IBD Publication, Dehradun
3. Speight, M.S. and D. Wainhouse 1989. Ecology and Management of Forest Insects. Clarendon Press, Oxford.
4. Brown, A. 1990. Forest Fire and its Control. Natraj Publishers, Dehra Dun.
5. Gupta, V.K. and N.K. Sharma. 1988. Tree Protection. Indian Society of Tree Scientists, Solan.
6. Edwin S. Mills, Economic Analysis of Environmental Problems (New York: Columbia University Press), 1975.
7. Fisher, A.C., Resource and Environmental Economics (New York: John Wiley & Sons), 1979.
8. Orris C. Herfindahl, Natural Resource Information for Economic Development (Baltimore: The Johns Hopkins University Press), 1969.
9. Sharma, S.D., A New Approach to Linear Programming (Meerut: Kedarnath, Ramnath and Co.), 1975.
10. Tony Prato, Natural Resource and Environmental Economics (Ames: Iowa State University Press), 1998.

SVC-704 FOREST POLICY AND LEGISLATION

(2+0)

Forest policy - Relevance and scope; National Forest Policy - 1894, 1952 and 1988; General principles of criminal law; Indian Penal Code, criminal procedure code; Indian evidence act applied to forestry matters; Forest laws; Indian Forest Act - 1927, general provision and detailed study; Forest Conservation Act 1980, Wildlife Protection Act 1972 Important Forest Rules and Guidelines, Important case studies and landmark judgments.

Lecture Schedule

Theory

Content	Lecture
• Forest policy - Relevance and scope; National Forest Policy - 1894, 1952 and 1988;	5
• General principles of criminal law; Indian Penal Code, criminal procedure code;	5
• Indian evidence act applied to forestry matters;	4
• Forest laws; Indian Forest Act - 1927, general provision and detailed study;	5
• Forest Conservation Act 1980,	3
• Wildlife Protection Act 1972	3
• Important Forest Rules and Guidelines	4
• Important case studies and landmark judgments.	5

Suggested Reading:

1. FERNANDES, W. & KULKARNI (1986), - Towards a new Forest Policy. Natral Publishers, Dehra Dun.
2. Forest Policy (1988), Government of India Publication, Delhi.
3. Indian Forest Acts with short Notes (1975), Allahabad Law Agency, Allahabad.
4. JHA, L.K. (1994), Analysis and Appraisal of India's Forest Policy , Ashish Publishing House, Delhi.
5. KHANNA, L.S., Wildlife (Protection) Act 1972 as amended upto date with commentary, Khanna Bandu, Dehra Dun.
6. NEGI, S.S. (1985), Forest Law, Natraj Publication, Dehra Dun.
7. PATIL, H.M. (1986), Policy for National Conservations, Natraj Publication, DehraDun.
8. SAHARIA, V.B (1989), Wildlife Law in India, Natraj Publication, Dehra Dun.
9. Handbook of Environment, Forest Wildlife Protection Laws in India, Natraj Publishers, Dehra Dun

FBL-704 TREE PHYSIOLOGY 2+1

Factors affecting growth of trees. Photosynthesis, respiration, stomatal conductance, transpiration and osmo regulation in relation to stress physiology. Salt and drought tolerance physiology in relation to production of biomass. Role of nutrients in plant metabolism. Role of growth hormones in vegetative propagation. Vernalisation, seed dormancy and photoperiodism in trees relating the growth and regeneration.

Practical

Related to the topics described above depending upon the facilities available.

Lecture Schedule

Theory

Content	Lecture
• Factors affecting growth of trees.	3
• Photosynthesis	3
• Respiration,	3
• stomatal conductance,	3
• transpiration	3
• Osmo regulation in relation to stress physiology.	3
• Salt and drought tolerance physiology in relation to production of biomass.	4
• Role of nutrients in plant metabolism.	3
• Role of growth hormones in vegetative propagation.	4
• Vernalisation, seed dormancy and photoperiodism in trees relating the growth and regeneration.	5

Practical

Content	Lecture
• Related to the topics described above depending upon the facilities available.	17

Suggested Readings

Aspinall, D. and Papleg, L.G. (eds.) 1981. *Physiology and biochemistry of drought resistance in plants*. Academic Press, Sydney. Pp. 243-259.

Paul, J. Kumar - *Plant and soil water relationships: A modern synthesis*. Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Levitt, J. 1972. *Response of plants to environmental stress*. First ed. Academic Press, New York.

ENV-711 REMOTE SENSING AND GIS (1+1)

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-referenced forest resources data and information. Acquisition and interpretation of satellite data for forestry purpose. The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management; satellite systems; satellite imageries -techniques, uses and limitation; future prospects of remote sensing in India; softwares used in remote sensing ; GIS versus remote sensing.

Practical: Uses of various photogrammetry instruments; recognition and identification of objects on photography; compilation of maps and their interpretation. Hands on practice on remote sensing and GIS, software. Digital and visual interpretation of satellite image.

Lecture Schedule

Theory

Content	Lecture
• The use of aerial photography	1
• Satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-referenced forest resources data and information.	3
• Acquisition and interpretation of satellite data for forestry purpose.	2
• The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management;	4
• Satellite systems; satellite imageries -techniques, uses and limitation;	2
• Future prospects of remote sensing in India; softwares used in remote sensing	3
• GIS versus remote sensing.	2

Practical

Content	Lecture
• Uses of various photogrammetry instruments	3
• recognition and identification of objects on photography	4
• compilation of maps and their interpretation	3
• Hands on practice on remote sensing and GIS, software	4
• Digital and visual interpretation of satellite image	3

Suggested Readings:

1. Remote Sensing for Hazard Monitoring and Disaster Assessment, Barrett, E.C. and Anton Micallef (1991) Taylor and Francis,, London
2. Introduction to Geographic Information Systems, Tsung Chang – Kang, 2002, Tata McGraw -Hill Publishing Company Limited, New Delhi.
3. Aerial Photography and Image Interpretation for Resource Management, Paine, D.P., John Wiley and Sons.
4. Remote Sensing and Image Interpretation, Lilleand, T.M. and Kieffer,R.W., John Wiley and Sons.
5. Remote Sensing: Principles and Applications, Sabbins, F.E., Freeman.

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