POST GRADUATE SYLLABUS

(Prepared from ICAR PG Syllabus of Horticulture)

Degree to be awarded

M. Sc. in Forestry

Department of Forestry

FACULTY OF HORTICULTURE

UTTAR BANGA KRISHI VISWAVIDYALAYA

PUNDIBARI, COOCH BEHAR

Code Numbers

• All courses are divided into two series: 500-series courses pertain to Master's level, and 600- series to Doctoral level. A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's programme.
• Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
• Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:
• Objective – to elucidate the basic purpose.
• Theory units – to facilitate uniform coverage of syllabus for paper setting.
• Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
• A list of journals pertaining to the discipline is provided at the end which may be useful as study material for 600-series courses as well as research topics.
• E-Resources - for quick update on specific topics/events pertaining to the subject.
• Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Eligibility for Admission:

(a) Masters degree programme:

1.B.Sc. Forestry (4 years programme)/B.Sc. (Hons.) Forestry
2.In case B.Sc. Forestry/B.Sc. (Hons.) Forestry candidates are not available, B.Sc. Ag./B.Sc. Hort. may be considered.

(b) Doctoral degree programme:

Master's degree in Forestry

Minimum Credit Requirements

Major subject: The subject in which the student takes admission
Minor subject: In Forestry, the specialization within a major subject is taken as minor.
Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.

Subject	**Master's programme**	**Doctoral programme**
Major (Core)	22	15
Minor (Specialization)	12	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total Credits	**60**	**75**

M. Sc. FORESTRY

Course Structure – at a Glance

A. CORE COURSES (MAJOR)

CODE COURSE TITLE CREDITS

FOR 501 SILVICULTURE 2+0
FOR 502 FOREST BIOMETRY 1+1
FOR 503 FOREST MANAGEMENT 2+0
FOR 504 FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES 2+1
FOR 505 FOREST ECOLOGY AND BIODIVERSITY CONSERVATION 2+1
FOR 506 FOREST RESOURCE MANAGEMENT AND ECONOMICS 1+1
FOR 507 FOREST PROTECTION 1+1
FOR 508 FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS 2+0
FOR 509 TREE IMPROVEMENT 1+1
FOR 510 FORESTS AND PEOPLE 1+1

B. SUPPORTING COURSES

FOR 511 COMPUTER APPLICATION AND INFORMATION TECHNOLOGY 0+1
FOR 512 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM 1+1
FOR 513 GENERAL STATISTICAL METHODS AND RESEARCH METHODOLOGY 1+1

D. SPECIALIZATIONS (MINOR)

1. Wood Science and Technology

WST 521 WOOD IDENTIFICATION 0+2
WST 522 WOOD CHEMISTRY 1+1
WST 523 GENERAL PROPERTIES OF WOOD 1+1
WST 524 WOOD SEASONING & PRESERVATION 2+1
WST 525 PAPER & PULP TECHNOLOGY 2+1
WST 526 WOOD MODIFICATION & COMPOSITE WOOD 2+1

2. Medicinal and Aromatic Plants

MAP 521 BASICS OF PLANT PRODUCTION AND BREEDING TECHNIQUES 2+1
MAP 522 MEDICINAL CHEMISTRY & PROCESSING OF MAP'S 2+1
MAP 523 BIOTECHNOLOGICAL APPROACHES AND AGRO TECHNIQUES FOR MAP SPECIES.2+1
MAP 524 IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS 1+1
MAP 525 ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS2+0
MAP 526 PHARMACOGNOSY OF MAP'S 1+1
MAP 527 STUDY TOUR (Visit to Pharmaceutical and Processing Units) 0+1

3. Plantation Technology

PT 521 SEED COLLECTION, STORAGE AND TESTING 2+1
PT 522 MODERN NURSERY TECHNOLOGY 1+1
PT 523 NUTRIENT & WEED MANAGEMENT IN NURSERY & PLANTATION 2+1
PT 524 MANAGEMENT OF INSECT-PESTS AND DISEASES 1+1
PT 525 ENERGY PLANTATIONS AND BIO-FUELS 1+1
PT 526 PLANTATION FORESTRY 2+1

4. Watershed Management

WM 521 WATERSHED CONCEPTS, PROJECT FORMULATION AND PLANNING 2+1
WM 522 APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT1+1
WM 523 WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS2+1
WM 524 WATERSHED HYDROLOGY AND RESOURCES CONSERVATION 2+1
WM 525 PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED. 3+1
WM 526 PEOPLE'S PARTICIPATION AND IMPACT ANALYSIS IN WATERSHED 2+1

5. Eco-Tourism

ET 521 ECOTOURISM- CONCEPTS AND MODERN APPROACHES 2+2
ET 522 ECO SYSTEMS OF THE WORLD 2+0
ET 523 ECOTOURISM IN PROTECTED AREAS 2+1
ET 524 ECOTOURISM LANDSCAPING 2+1
ET 525 ECONOMICS OF ECOTOURISM 2+1
ET 526 DESIGN AND MANAGEMENT OF ECOTOURISM 2+1

6. Agro-Forestry

AF 521 AGROFORESTRY SYSTEMS 2+1
AF 522 SOIL AND WATER MANAGEMENT IN AGROFORESTRY 1+1
AF 523 CROPS AND ANIMALS PRODUCTION MANAGEMENT IN AGROFORESTRY 2+1
AF 524 FRUIT PLANTS, TREES & SHRUBS FOR AGROFORESTRY 2+1
AF 525 ECONOMICS OF AGROFORESTRY SYSTEMS 2+1
AF 526 RANGE LAND AND PASTURE MANAGEMENT 2+0

7. Forest Genetic Resources

FGR 521 BREEDING METHODS IN FOREST TREES 2+1
FGR 522 REPRODUCTIVE BIOLOGY OF FOREST TREES 2+1
FGR 523 TREE SEED ORCHARDS 2+1
FGR 524 QUANTITATIVE GENETICS IN FOREST TREE BREEDING 3+0
FGR 525 FOREST GENETIC DIVERSITY AND CONSERVATION 3+0

8. Forest Biotechnology

FB 521 BIOTECHNOLOGY APPROACHES IN FORESTRY 2+1
FB 522 PLANT TISSUE CULTURE 2+1
FB 523 MOLECULAR BIOLOGY 2+1
FB 524 PRINCIPLES & TECHNIQUES IN GENETIC ENGINEERING 2+1
FB 525 ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY 2+0

9. Environment Management

EM 521 INTRODUCTION TO ENVIRONMENTAL SCIENCES 2+0
EM 522 ENVIRONMENTAL POLLUTION 3+0
EM 523 ENVIRONMENTAL ANALYTICAL TECHNIQUES 2+0
EM 524 GLOBAL CLIMATIC CHANGES 2+0
EM 525 ENVIRONMENTAL POLICY LAW AND INTERNATIONAL CONVENTIONS 3+0
EM 526 ENVIRONMENTAL IMPACT ASSESSMENT 3+0

10. Forest Business Management

FBM 521 FOREST RESOURCE ANALYSIS 3+0
FBM 522 FINANCE AND MARKETING MANAGEMENT OF FOREST RESOURCES 2+1
FBM 523 FARM MANAGEMENT 3+0
FBM 524 PRODUCTION MANAGEMENT OF NURSERY AND PLANTATION FORESTRY 2+1
FBM 525 PROJECT PLANNING, MONITORING AND EVALUATION 2+1
FBM 526 MANAGERIAL ECONOMICS 3+0

M. Sc. FORESTRY
Course Contents

A. CORE COURSES (MAJOR)
A. CORE COURSES (MAJOR)
FOR 501 SILVICULTURE 2+0

Objective

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

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.
Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.
Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.
Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

FOR 502 FOREST BIOMETRY 1+1

Objective

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

Theory

UNIT I

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands,. Preparation of volume & its application, yield and stand tables.

UNIT II

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT III

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.
Ram Parkash 1983. *Forest Surveying*. International Book Distr. Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.
Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 503 FOREST MANAGEMENT 2+0

Objective

To provide knowledge about forest management, ecosystem management, site quality valuation, stand density & forest valuation.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies.

UNIT III

Forest valuation and appraisal in regulated forests.

Suggested Readings

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

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

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

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-applied Forest Ecology. John Wiley & Sons.

FOR 504 FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES 2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents – Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood, Visit to nearby forest based industries.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR.

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

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

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

FOR 505 FOREST ECOLOGY AND BIODIVERSITY CONSERVATION 2+1

Objective

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

Theory

UNIT I

Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

UNIT II

Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservations laws and acts. Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies.

UNIT III

Documentation and evaluation of forests genetical resources (FGR), *in situ* and *ex situ* conservation of gene resources. Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

Practical

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis, Measurement of biomass and productivity, Quantification of litter production and decomposition, Visit to national parks, wldlife sanctuaries, botanical gardens and arboreta.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India.
Dhyani SN. 1994. *Wildlife Management*. Rawat Publ.
Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures*. Pointer Publ.
Kimmins JP. 1976. *Forest Ecology*. MacMillan.
Nautiyal S & KoulAK. 1999. *Forest Biodiversity and its Conservation Practices in India*. Oriental Enterprise.
Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*. Man and Biosphere Series. The Parthenon Publ. Group.

FOR 506 FOREST RESOURCE MANAGEMENT AND ECONOMICS 1+1

Objective

To develop understanding of students about forest resource management and economics management decisions, natural and environmental resource accounting.

Theory

UNIT I

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory.

UNIT II

Inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decisions. Externalities and property rights.

UNIT III

Natural and environmental resource accounting –methods and implications. 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 forest products. Exercises on financial and economic appraisal of forestry projects. Exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives.

Suggested Readings

FAO 1986. *Guidelines to Practical Project Appraisal*. Natraj Publ. Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxfrd & IBH.

Nautiyal JC. 1988. *Forest Economics – Principles and Applications*. Natraj Publications, Dehradun.

Sharma LC. 1980. *Forest Economics, Planning and Management*. International Book Distributors, Dehradun.

FOR 507 FOREST PROTECTION 1+1

Objective

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

Theory

UNIT I

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.

UNIT II

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.

UNIT III

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.

UNIT IV

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance 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 arbuscular mycorrhizal (AM) fungi from soil and assessment of mycrorrhizal root infection.

Suggested Readings

Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.
Jha LK & Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.
Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall.
Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.

FOR 508 FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS 2+0

Objective

To develop understanding of students about forest policy and laws and international conventions

Theory

UNIT I

Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988;

UNIT II

General principles of criminal law; Indian Penel Code, criminal procedure code; Indian evidence act applied to forestry matters.

UNIT III

Forest laws; Indian Forest Act –1927, general provision and detailed study; Forest Conservation Act 1980, Wildlife Protect Act 1972 Important Forest Rules and Guidelines.

UNIT IV

Important case studies and landmark judgments.

Suggested Readings

Indian Forest Acts (with short notes)1975. Allahabad Law Agency.
Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy.* Ashish Publ. House.
National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi.
National Forest Policy 1988. Ministry of Environment and Forests, New Delhi.
Negi SS. 1985. *Forest Law*. Natraj Publ.
Saharia VB. 1989. *Wildlife Law in India*. Natraj Publ.

FOR 509 TREE IMPROVEMENT 1+1

Objective

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

Theory

UNIT I

General concept of forest tree breeding, tree improvement and forest genetics.

UNIT II

Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms.

UNIT III

Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

UNIT IV

Seed, seed formation, dispersal, storage, stratification and seed dormancy.

UNIT V

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.

UNIT VI

Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT VII

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, acacias, pines and poplars.

UNIT VIII

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-weinberg law, null hypothesis, Wohlund's Principle.

UNIT IX

Biotechnology in tree improvement. Mutation breeding.

UNIT X

Economics of tree breeding.

Practical

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

Suggested Readings

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

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

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

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

FOR 510 FORESTS AND PEOPLE 2+0

Objective

It will help students to understand socio-economic, cultural and ecological relationship between forests and people. It will acquaint students with the role of people in forest management through analysis of need dependence and traditional interactions between forests and society.

Theory

UNIT I

Forests and its importance, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to eco-philosopy.

UNIT II

Afforestation programmes and forest conflicts, wildlife and human conflicts, important forest movements like Chipka Movement, Gender dimension of forest management, tribal economy and forests. Pastoralists and their dependence on forests. Forests and economic security of tribals.

UNIT III

Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and local development, land use change and forestry.

UNIT IV

Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams,

forests and resettlement of tribals and non-triabals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management.

Suggested readings

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

B. SUPPORTING COURSES

FOR 511 COMPUTER APPLICATION AND 0+1 INFORMATION TECHNOLOGY

Objective

To develop understanding about Computer based modeling, data base management and networking.

Practical

Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management programme. Use of electronic spread sheet and graphics. Use of SPSS statistical application packages. Working with MS-DOS. Database design. Data entry operation. Word processing: MS Office. Database management programme. Use of electronic spread sheet and graphics. Use of SPSS statistical application packages. Features of Information Technology: Introduction to Information Technology – Basis of computer networking - LAN, WAN – BUSTokening- star-internet, intranet – Basics of E-mail – Exposure to web browsing(structure of URL), Types of web sites – internet service provider – using internet news – scope of IT in forestry

Suggested Readings

Balaguruswamy E. 1998. *Programming with ANSI C*. Tata McGraw Hill.
Gottfried B. 1999. *Programming with C*. Schaum Outline Series. Tata McGraw Hill.
IASRI 1999. *Introduction to MS Office 97 and SPSS*. IASRI Publ.
Malvino AP & Brown JA. 1999. *Digital Computer Electronics*. Tata McGraw Hill.
Mano MM. 1999. *Digital Logic and Computer Design*. Prentice Hall of India.
Tanenbaum AS. 2003. *Computer Networks*. Prentice Hall of India.

FOR 512 REMOTE SENSING AND GEOGRAPHIC 1+1 INFORMATION SYSTEM

Objective

To acquaint with the use of imageries, GIS and simulation in forest survey and management.

Theory

UNIT I

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for georeferenced forest resources data and information.

UNIT II

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;

UNIT III

Future prospects of remote sensing in India; softwares used in remote sensing ; GIS versus remote sensing; GIS Software used in forestry and environments; Analysis of data; Application of GIS in forestry.

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.

Suggested Readings

Burrough PA. 1990. *Principles of GIS for Land Resources Assessment*. Oxford & IBH.
Lillsand TM. 1989. *Remote Sensing and Image Interpretation*. John Wiley.
Narayanan LRA. 1999. *Remote Sensing and its Application*. Universities Press (India) /Orient Longman.
Sharma NK. 1986. *Remote Sensing and Forest Survey*. International Book Distr.

FOR 513 GENERAL STATISTICAL METHODS & 1+1
RESEARCH METHODOLOGY

Objective

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

Theory

UNIT I

Introductory: Statistics scales of measurement, concept of graphical, exploratory and inferential data analysis, important variables of forestry sector

UNIT II

Probability and probability distributions: Review of probability theory, concept of random variable and expectation, probability distributions (Binomial, Poisson, Normal, Weibull)

UNIT III

Correlation and regression: Simple, Rank, Partial, Multiple, Infraclass correlations, Furnivall Index and coefficient of determination. Linear and nonlinear regressions, parabolic, exponential, power and logarithmic functions

UNIT IV

Estimation and Testing of Hypotheses, Concept of point and interval estimation, estimators and estimates, properties of good estimators – unbiasedness and minimum variance, tests of significance – t, F, z, and $\chi 2$, testing significance of correlation and regression coefficients, analysis of variance (ANOVA) – one way and two way classification with single and more than one cell frequency.

UNIT V

Design of Experiments. Principles of experimental designs, Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Row- Column (alpha) designs, Split Plot and Strip Plot Designs.

UNIT VI

Sampling – Theory and applications Why sample? Simple Random Sampling (with and without replacement), Stratified Random Sampling, Double sampling, Multistage sampling, Cluster sampling

UNIT VII

Multivariate statistical techniques Multivariate Analysis of Variance, Principal Component Analysis, Factor Analysis, Cluster Analysis.

Practical

Fitting of probability distributions, Computation of correlations and regressions, Tests of significance – t, F, z and $\chi 2$, Exposure to statistical packages SPSS and GENSTAT for ANOVA, multivariate analysis Laying out of designs in the field (i) Fan design, (ii) Latin

Square, (iii) Randomized block design, (iv) Split plot design, (v) Row-Column designs and (vi) Scattered block. Data analysis of the above designs.

Suggested Readings

Dear KBG, Mead R & Relay J. 1987. *Statistical Tools for Agro-Forestry Research – Bivariate Analysis for Intercropping Experiments*. ICRAF, Nairobi.

Matin J. 1976. *Principles of Database Management*. Prentice Hall. Pase UG & Sukhatme MU. 1978. *Statistical Methods for Agricultural Workers*. ICAR.

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

C. SPECIALIZATIONS (MINOR)

1. Wood Science and Technology

WST 521 WOOD IDENTIFICATION 0+2

Objective

The course deals with the use of anatomical features of wood in timber classification.

Practical

Planes of wood, Physical characteristics of important woods, Identification of different types of cells and tissues. Anatomical studies of reaction wood. Identification of different types of cells and tissues. Anatomical studies of reaction wood. Classification of timber using dichotomous and perforated card keys. Modern timber identification techniques

Suggested Readings

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

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

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

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

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

WST 522 WOOD CHEMISTRY 1+1

Objective

To impart knowledge about the chemical properties of wood, cell wall constituents and wood extractions.

Theory

UNIT I

Chemical composition of wood : Cell wall constituents- cellulose, lignin hemicellulose, peptic substances etc.

UNIT II

Cell Content :Volatile and extractive, cellulose derivatives and their application.

UNIT III

Hydrolysis and fermentation of lignocellulosic materials. Parolysis and gasification of wood.

Practical

Extraction of cellulose, hemicellulose, lignin, extractives and ash content of wood.

Suggested readings

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

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

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

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

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

WST 523 GENERAL PROPERTIES OF WOOD 1+1

Objective

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

Theory

UNIT I

Wood density, thermal, electrical and acoustics of wood.

UNIT II

Mechanics and Rheology of wood, elasticity, plasticity and creep (tensile compression and bending strength)

UNIT III

Toughness, torsion, shear, hardness and abression strength. Acoustic and acousto-ultrasonics, based non-destructive evaluation technique.

Practical

Determination of wood density, study of thermal, electrical and ecoustic properties of wood. Determination of tensile and bending properties of wood.

Suggested readings

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

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

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

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

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

WST 524 SEASONING AND PRESERVATION 2+1

Objective

To understand the importance of wood seasoning & preservation for utilizing secondary timber for multipurpose use.

Theory

UNIT I

Wood water relationship, absorption behaviour and wood drying, Refractory and non refractory behaviour of wood, Wood seasoning, types- air, kiln and special seasoning methods like steaming, chemical, high temperature drying, vacuum drying and water conditioning.

UNIT II

Defects of timber- natural, seasoning defects, defects due to external agencies, machining defects. Effect of defects on utilization.

UNIT III

Detection and diagnosis of discolouration and decay in wood : decaying agencies- fungi, insects, borer etc.

UNIT IV

Wood preservation : preservatives and treatment processes. Advantages and safety concern of wood preservatives.

Practical

Determination of moisture content and swelling coefficients of different woods. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters. Treatment of wood with different types of preservatives.

Suggested Readings

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

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

Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.
Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

WST 525 PULP AMD PAPER TECHNOLOGY 2+1

Objective

To acquaint with the resources and processes for making pulp and paper.

Theory

UNIT I

Raw materials used in pulp and paper industries and its characteristics and handling

UNIT II

Pulping process, mechanical, chemical, semi-chemical and biopulping. Pelp bleaching, pulp treatment, defibening, de-knotting, brown stock washing, screawing, cleaning, thickening.

UNIT III

Recycled fibers, supplementary pulp treatment and additive. Paper making, paper drying, calendaring, reeling, external sizing, coating etc.

UNIT IV

Structure of paper, its characterization and measuring strength method, optional and structural properties of paper. Type of paper coated paper, corrugated containers, printing quality of paper, ageing of paper. Rayon industry.

Practical

Study of raw materials techniques and pulp yield, making of paper and its quality determination, visit to nearby paper industry.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.
Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

WST 526 WOOD MODIFICATION AND COMPOSITE WOOD 2+1

Objective

To impart knowledge regarding the scope and processes for developing composite wood.

Theory

UNIT I

Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.)

UNIT II

Wood impregnation and compregnation, heat stabilization, wood densification.

UNIT III

Modern trends in composite wood. Wood adhesives – types, characteristics and application.

UNIT IV

Playwood, laminated wood and inorganic wood composites- their manufacture, characteristics and application.

Practical

Use of different adhesives in playwood, study of composite boards, study of antishrink efficiency of wood treated with different chemicals impregnation and compregnation of wood with chemicals.

Suggested Readings

Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.
Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

2. Medicinal and Aromatic Plants

MAP 521 BASICS OF PLANT PRODUCTION AND BREEDING TECHNIQUES **2+1**

Objective

To acquaint with the propagation, harvesting and quality improvement methods.

Theory

UNIT I

Mode of plant propagation technique. Factors influencing growth; role of macro and micro nutrients.

UNIT II

Nursery techniques, plant protection measures, methods of harvesting and post harvesting handling.

UNIT III

Role of genetics and related sciences in breeding of Medicinal herbs. Breeding methods, self and cross pollinating.

UNIT IV

Heterosis, sterility and self incompatibility in herbs; mutation and polyploidy breeding, wide hybridization; production and maintenance of pure seeds. Systems followed in the release of plant varieties.

Practical

Asexual vegetative reproduction techniques- cutting, budding, layering. Methods of seed collection and storage technique.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.
Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.
Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR. Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.
Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.
Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

MAP 522 MEDICINAL CHEMISTRY & PROCESSING OF MAP 2+1

Objective

To understand the dynamics of phytopharmaceuticals and their processing as industrial products.

Theory

UNIT I

Organic compounds and their classification such as aliphatic, aromatic, alkaloids, steroids, terpenoids, glycosides, phenolic compounds, heterocyclic compounds and carbohydrates.

UNIT II

Primary and Secondary plant metabolites and theurapeutical uses of phytoconstituents such as gums, anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids, alkaloids and terpenoids.

UNIT III

Basic principles of extracting different phytoconstituents.

UNIT IV

Post harvest processing-drying, grading and storage. Extraction of essential oils and their storage.

Practical

Use of thin layer and column chromatography during extraction and purification of phytopharmaceuticals. Preparation of active constituent enriched extracts. Extraction of Essential oils and their quality evaluation, preparation of concretes and absolutes.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

MAP 523 BIOTECHNOLOGICAL APPROACHES AND AGROTECHNIQUES FOR MAP SPECIES. **2+1**

Objective

To equip the student with the conventional and biotechnological procedures for production of medicinal species.

Theory

UNIT I

Scope of Biotechnology in MAP's, Tissue culture technique and in-vitro propagation of *Rauvolfia serpentina, Santalum album, Stevia rebaudiana, Andrographis paniculata, Hyocyamus niger, Carum carvi, Catharanthus roseus, Glycyrrhiza glabra, Atropa belladonna.*

UNIT II

Molecular characterization by RAPD, RFLP etc. Biotransformation, Transganic plants, use of Biotechnology in plant improvement.

UNIT III

Importance & need of cultivation of MAP's species. origin, distribution, morphological features, climate, soil requirement, nursery technique, transplantation, harvesting and post harvest handling of Important MAP's like *Picrorhiza kurrooa, Saussurea costus, Aconitum heterophyllum, Swertia chirayita, Valeriana jatamansi, Chlorophytum borivilianum, Stevia rebaudiana, Andrographis paniculata, Pelargonium graveolens, Rosa damacena* and other important species specific to the region.

UNIT IV

GAP in MAP, organic farming; Crop geometry and crop management.

Practical

Preparation and layout of nursery and field beds/ plots methods of seed sowing, preparation of shoot and root cuttings. Transplanting of seedling and rooted cuttings, irrigation technique,

hoeing, weeding and weed control. Raising and harvesting of at least on crop grown in the region.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR. Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

MAP 524 IMPROVEMENT OF MEDICINAL AND AROMATIC PLANTS **1+1**

Objective

To acquaint the student with the breeding procedures for quality improvement of important medicinal and aromatic plants.

Theory

UNIT I

Plant genetic resources- general perspective. Ecology and biology of plant resources of medicinal value. Medicinal and aromatic plant diversity in the Indian gene center. Plant exploration , introduction & exchange.

UNIT II

Conservation of medicinal and aromatic plants; its techniques- in-situ, ex-situ & biotechnological. Evaluation and breeding techniques of important medicinal and aromatic plants-*Picrorhiza kurrooa, Swertia chirayita, Valeriana jatamansi, Viola spp., Gloriosa superba, Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum sanctum, Withania somnifera.*

UNIT III

Distinctiveness, uniformity, stability testing. Drug descriptors for medicinal and aromatic plants

Practical

Identification based on morphological features; pollen viability and germination testing, stigma receptivity. Field practice in emasculation, crossing and selfing in *Hypericum perforatum, Matricaria chamomilla, Solanum spp., Ocimum spp., Gloriosa superba , Mucuna spp., Gentiana kurroo* and other species relevant to the region. Determination of mode of reproduction.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

MAP 525 ROLE OF MEDICINAL AND AROMATIC PLANTS IN HEALTH CARE SYSTEMS **2+0**

Objective

To acquaint the student with the importance of plants used in modern and AYUSH methods of treatment.

Theory

UNIT I

Concept of Health Care systems

UNIT II

Brief introduction to Ayurveda, Unani, Sidha, Homeopathy, allopoathy, naturopathy, electrohomoeopathy, etc.

UNIT III

Important medicinal plants used in treating various diseases in modern and complementary systems.

UNIT IV

Biological activity of selected medicinal plants. Methods of preparing poultices, decoctions, powders, tinctures, active content rich extracts.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

MAP 526 STUDY TOUR 0+1

(Visit to Pharmaceutical and Processing Units)

Objective

Visit and exposure of students in herbal product's manufacturing.

Practical

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.

MAP 527 PHARMOCOGNOSY OF MEDICINAL AND AROMATIC PLANTS 1+1

Objective

To develop understanding about microscopical, macroscopical and hemical methods of drug identification.

Theory

UNIT I

History and scope of pharmacognosy, Pharmaceutical products. Classification of natural drugs. Chemical nature of drugs. Pharmacognostic analysis of drug plants based on botanical, chemical and histological features.

UNIT II

Evaluation based on pharmacopoeial standards for both single drugs and compound formulations most commonly used in different systems of medicines.

UNIT III

Pharmacognostic features of Sarpagandha, Jatamansi, Ashwagandha, Turmeric, Punarnava, Ephedra, Gymnema, Senna, Amla, Gokhru, Issabgol, Black pepper, Banafsha, Arjun or any other commercially species specific to the region.

Practical

Identification of drugs by morphological characters. Physical and chemical tests for evaluation of drugs. Gross anatomical studies of Ginger, Ashwagandha, Senna, Gentiana, Kalmegh, Sarpagandha, Mulhathi, Aconitum species or any other important species relevant to the region.

Suggested Readings

Alikhan I & Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publ.

Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI. *Medicinal and Aromatic Plants.* Malhotra Publ. House.

Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR.

Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.

Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

3. Plantation Technology

PT 521 SEED COLLECTION, STORAGE AND TESTING 2+1

Objective

To impart knowledge and develop understand about seed development in tropical, sub-tropical and temperate region, testing & certification.

Theory

UNIT I

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problemslimiting actors in tree propagation and afforestation.

UNIT II

Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/ fruit.

UNIT III

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.

UNIT IV

Seed certification.

UNIT V

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/ fruit. Tests of viability viz., cutting, hydrogen peroxide, excised tetrozolium, 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 of seed treatment.

Suggested Readings

Khullar P 2003. *Forest Seed*. ICFRE Publication, Dehradun.
Lars Schmidt. 2000. *Guide to Handling of Tropical and Sub tropical Forest Seeds*. Danida Forest Seed Center, Denmark.
Singh V. 2003. *Forestry Seed and Nursery Management*. Bishen Singh & Mahendra Pal Singh, Dehradun.
Willan RL. 1985. *A Guide to Forest Seed Handling*. FAO.

PT 522 MODERN NURSERY TECHNOLOGY 1+1

Objective

To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use.

Theory

UNIT I

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery.

UNIT II

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 outplanting.

UNIT III

Containerized nursery - Type and size of container including root trainers, selection of growing medium.

UNIT IV

Types of green house and mist chamber for propagation. Vegetative propagation - importance, selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering. Factors affecting rooting of cuttings.

UNIT V

Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.

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 such as budding, grafting and layering. Precaution required in vegetative propagation, use of plant bio-regulators for rooting Maintenance of nursery records. Identification of nursery insects and diseased and their control measures. Visit to nurseries.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.
Dwivedi AP. 1993. *Forestry in India.* Suya Publ.
Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.
Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

PT 523 NUTRIENT AND WEED MANAGEMENT 2+1
IN NURSERY AND PLANTATION

Objective

To disseminate knowledge about managing nurseries and plantations under optimal conditions.

Theory

UNIT I

History of nutrient management in forest nurseries and plantation. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ Interactions. Concept of nutrient availability.

UNIT II

Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors.

UNIT III

Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers.

UNIT IV

Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable waste and their recycling.

UNIT V

Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weed side classification, properties and their application.

Practical

Principles and methods of soil and plant analysis. Preparation of nutrient solutions. Practical application of fertilizers. Study of fertilizer response and diagnosis of deficiency symptoms. Fertilizer testing and pot experiments. Nursery inoculation techniques of bio-fertilizers. Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods.

Suggested Readings

Allen V & Barker 2007. *Handbook of Plant Nutrition*. Pilbeam London.

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Singh O & Negi M. 1993. *Bibliography on Biomass and Nutrient Cycling of Forest Species*. FRI Dehradun.

PT 524 MANAGEMENT OF INSECT-PESTS AND DISEASES 1+1

Objective

To impart knowledge about maintaining plantations and forests under disease free conditions.

Theory

UNIT I

Principles and methods of integrated pests management – physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques.

UNIT II

Diseases of forest nurseries and plantations. Abiotic agents of tree diseases and their relationship with hosts. Methods of disease control – exclusion, cultural, biological and chemical.

UNIT III

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 Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation

Suggested Readings

Evane JW. 1989. *Insect Pest and their Control*. Samir Book Center, Delhi.
Phillip DM. 1982. *Diseases of Forest and Ornamental Trees*. MacMilan.
Speight MR. 2000. *Insect Pest in Tropical Forestry*. RoseWilley Publ..

PT 525 ENERGY PLANTATIONS AND BIO-FUELS 1+1

Objective

To develop understanding about the scope and advantages of using and raising bio-energy plantations.

Theory

UNIT I

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy.

UNIT II

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 bio energy. Impact of energy efficiency in power sector.

UNIT III

Need for research and development on environment friendly and socio economical relevant technologies. Energy from plants-problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation.

UNIT IV

Recent energy technologies in the product of bio-fuels.

Practical

Identification of important fuel woods and petro-crops. Study on 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 Bio-energy units.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.
Kumar V. 1999. *Nursery and Plantation Practice in Forestry*. Scientific Publ.
Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

PT 526 PLANTATION FORESTRY 2+1

Objective

To acquaint with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations.

Theory

UNIT I

Role of plantation forestry in meeting the wood demand – Plantation forestry in India and abroad, Purpose of plantation, Factors determining scale and rate of plantation, Land suitability and choice of plantation species

UNIT II

Production technology for quality planting stock, preliminary site preparation for establishing plantation, Planting programme, time of planting, planting pattern, spacing, plating method.

UNIT III

Nutritional dynamics and irrigation of plantation, Mechanization in plantation, Protection and after care of plantation, Pruning and thinning ofplantation for quality wood production, Rotation in plantation, Failure of plantations, Impact of interaction and integration of plantation forestry, Protective Afforestation, afforestation of inhospitable sites, Ecological factors and long term productivity, Sustainable yield from plantation.

UNIT IV

Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias, Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc.

UNIT V

Wasteland plantation

UNIT VI

Industrial Plantation

Practical

Analysis of plantation problems in Asia and India – Preparation of plantation calendar – Preliminary arrangement for a plantation programme – Planting geometry and calculation of planting stock – Study of different cultural operations and site preparation for plantation – Studies on wood based industries – Problems and prospects – Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and Bamboo plantations – Production technology for energy plantations – INM in plantations – Irrigation and plantations – Economics of pulpwood, timber and energy plantations.

Suggested Readings.

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

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.

Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

4. Watershed Management

WM 521 WATERSHED CONCEPTS, PROJECT 2+1

FORMULATION AND PLANNING

Objective

To impart knowledge on watershed characteristics, watershed project planning, impact assessment techniques and impart practical training on survey of watershed, economic profitability of various land based enterprises bases in cost and revenue concepts.

Theory

UNIT I

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT II

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.

UNIT III

Valuing Inputs and Outputs Introduction –Approach, Using Market Prices in the Financial Analysis, Estimating Future Prices – Treatment of Inflation, Estimating Relative Price Changes.

UNIT IV

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.

UNIT V

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.

Suggested Readings

Datta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

WM 522 APPLICATIONS OF REMOTE SENSING AND GIS IN WATERSHED MANAGEMENT **1+1**

Objective

To disseminate knowledge on techniques of remote sensing and Geographic Information Systems (GIS), Preparation of thematic layers and their digitization. Software package, Interpretation of satellite data and Digital Image Processing.

Theory

UNIT I

Basic concepts of remote sensing and geographic information systems (GIS), Determination of geo-morphological, physiological, vegetation, soil, land use, parameters of a watershed.

UNIT II

Spatial and non-spatial data analysis. Preparation of thematic layers and their digitization.

Practical

Thematic layers build up, overlaying and their integration using ERDAS and ARCINFO Software package. Interpretation of satellite data and digital image processing. Preparation of thematic maps.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

WM 523 WATERSHED SURVEY, MAPPING AND STRUCTURAL ENGINEERING DESIGNS **2+1**

Objective

To impart knowledge and develop understanding of students about watershed survey, leveling, contour maps, design of soil and water conservation structures and water harvesting.

Theory

UNIT I

Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed.

UNIT II

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.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.

Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.

Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

WM 524 WATERSHED HYDROLOGY AND RESOURCES CONSERVATION **2+1**

Objective

To impart knowledge and understanding among the students on hydrological cycle, resource inventory of soil, land use planning, pressurized irrigation, surface runoff, hydrograph, rain water budgeting, wildlife role and conservation.

Theory

UNIT I

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.

UNIT II

Resources inventory soil, land, water and Biota. 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.

UNIT III

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.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.
Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.
Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.
Moorthy VVN. 1990. *Land and Water Management*. Kalyani.
Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.
Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

WM 525 PRODUCTION SYSTEM AND BIO-DIVERSITY IN WATERSHED **3+1**

Objective

To develop awareness among the students on cultural practices in rainfed areas on production of fruits, vegetable, and medicinal plants:, afforestation, agroforestry and biodiversity. Identification of medicinal and aromatic plants, plantation models, management of tree, shrubs and grasses in watershed areas.

Theory

UNIT I

Importance of climate, soil requirement and cultural practices for fruits, vegetables, cereals, oil seed, pulses and medicinal plants grown in watershed areas. Area production, economic importance and export potentials of tropical and subtropical fruit, vegetable and medicinal plants. Manuring and irrigation. Methods of plant protection. Nursery practices for fruit and vegetable crops.

UNIT II

Afforestation, reforestation constraints, scope, basic principles and Environmental benefits. Agro forestry- Definition, its role in water development, Diagnosis and design, Agro forestry models for different land types arable, pastures and wastelands. Alley cropping, silvi-pastoral system, high density short rotation plantations/energy plantation. Agrihorticulture and horti-slivimedicinal systems.

UNIT III

Concepts of biodiversity in watershed, threat biodiversity. Biodiversity conservation-*In-situ* conservation and *Ex-situ* conservation. *In-situ* conservation- Natural preservation, standard stand. *Ex-situ* conservationclone banks/ seedling bank, breeding seed orchard, botanical garden, seed banks, pollen banks, *in vitro* conservation. Tree spp. for watershed. Identification of tree, shrubs and grass for watershed areas. Production and management of important fodder spp.

Practical

Identification of important varieties, species and rootstock. Acquaintance with crop production practices, herbicides, their application and equipment. Identification and description of tropical and subtropical vegetable crops. Visit to nearly watershed areas; collection and identification of medicinal and aromatic plants in that area. Selection of nursery site, preparation of nursery beds and nursery raising. Field planting techniques. Cultivation, harvesting and processing of at least one medicinal or aromatic crop. Preparation of site for planting, planting layout pattern. Layout of different soil working techniques for hill slopes. Preparation of suitable plantation models for farmlands and catchements area,

identification of tree spp. grasses, shrub. Establishment of vegetative barrier in watershed area. Management of tree, shrubs and grasses in watershed areas.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.
Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.
Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.
Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.
Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

WM 526 PEOPLE'S PARTICIPATION AND IMPACT 2+1
ANALYSIS IN WATERSHED MANAGEMENT

Objective

To make the students aware of people's participation concept, impact analysis and financial analysis in watershed management.

Theory

UNIT I

Community organizations – Definition, Principles advantages, Types and formation processes. Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies.

UNIT II

People's movements for social change. Gender analysis framework. Adoption process.

UNIT III

Participation-meaning scope, objectives, principles and historical perspective. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches.

UNIT IV

Socio economic impact analysis, financial analysis.

Practical

Study of social organization and their formation processes. Community mobilization for watershed management. Application of Gender Analysis in watershed management. Identification of adaptors categories and factors influencing adoption process. Visit to selected watersheds for understanding concepts of people's participation. Application of participatory research approaches – review and analysis of selected cases. Need assessment, withdrawal strategies benefit sharing mechanism.

Suggested Readings

Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.
Hamilton IS. 1987. *Forest and Watershed Development and Conservation in Asia and the Pacific*. International Book Distributors, Dehra Dun.
Hamilton IS. 1988. *Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation*. International Book Distributors, Dehra Dun.
Moorthy VVN. 1990. *Land and Water Management*. Kalyani.
Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture), Associated Publishing Co., New Delhi.
Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
Rama Rao. 1980. *Soil Conservation*. Standard Book Depot, Bangalore.

5. Eco-Tourism

ET 521 ECOTOURISM - CONCEPT AND APPROACHES 2+2

Objective

To acquaint about the impact of tourism on ecology.

Theory

UNIT I

Eco tourism - study history of tourism, identify various forms of tourism and evolution of ecotourism. Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism.

UNIT II

Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Quebec declaration. Different forms of ecotourism like hard and soft ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries.

UNIT III

Organized tours and Free Independent Travelers. World Tourism Organization. Problems with definition of ecotourism and criticisms.

UNIT IV

International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism.

Practical

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Debate on the concept to reach the most viable. Once they agree on a concept, then the debate. Problems on common property resources and facilitate group discussion for recommendations. Discuss the merits and demerits of the recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Soared groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 522 ECOSYSTEMS OF THE WORLD 2+0

Objective

To impart knowledge about ecosystem dynamics especially of tourist spots.

Theory

UNIT I

Major ecosystems of the world - definitions of a typical ecosystemsconcepts and approaches of Odum -Arctic tundra eco system, northern and southern hemisphere ecosystems, coniferous forests, temperate ecosystems, savanna –grass land, tropical rain forests,

deciduous forest ecosystemscoastal systems mangroves etc, important features, faunal and floral populations

UNIT II

Adaptations and modifications threat to ecosystems-conservation and preservation-new approaches.

UNIT III

Influence of anthropogenic factors on the adaptation of different ecosystems.

UNIT IV

Studies on localized niches of potential tourist spots.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 523 ECOTOURISM IN PROTECTED AREAS 2+1

Objective

To develop understanding of students about ecology of tourist spots in protected area.

Theory

UNIT I

Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context.

UNIT II

Planning ecotourism in protected areas. Visitor management in ecotourism areas – zoning, carrying capacity. Participation of local people in ecotourism. Conflicts in PA's. Ecotourism for sustainable development of PA's.

UNIT III

New directions in ecotourism industry. Ecotourism in practice in important PA's of India – case studies of Periyar Tiger Reserve, Keoladeo National Park, Kanha National Park and Jim Corbet National Park, Project Tiger Research, Betla and Sunderbans Tiger Reserve. Limitations and problems of ecotourism.

UNIT IV

Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agropasturatism.

Practical

Visits to surrounding ecotourism destinations- prepare ecotourism activity maps- Preparation of route maps to important National parks and sanctuaries of India. Preparation of information procedure about forest tourist spots in India. Exercises on the preparation of location-specific model eco-tourism plans.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 524 ECOTOURISM LANDSCAPING 2+1

Objective

To impart understanding about developing and protecting landscapes of ecotourist spots.

Theory

UNIT I

Introduction - definition and historical background - Components and elements in landscaping - Principles of landscaping - landscape architecture for ecotourism- Landscape ecology with special reference to ecotourism.

UNIT II

walkwaysropeways- turfs, topiaries, live hedges-pergolas, carpets, lawn etc. Urban ecotourism -importance -history of urban planting in India - Planning and planting programmes for institution and industrial complexes

UNIT III

Importance of arboriculture in ecotourism. Landscaping- Management of trees - planning of roads, bridges, parking area.

UNIT IV

Planting methods - balanced lines - unbalanced line and sporadic system – formal and informal planting methods.

Practical

Preparation, planning and designing of recreation parks, thematic parks, practice on topiary, arboriculture, preparation of planting pattern for avenue planting, national highways and village roads.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 525 ECONOMICS OF ECOTOURISM 2+1

Objective

To develop understanding about impact of ecotourism on local economics.

Theory

UNIT I

Ecotourism as a business opportunity- market demand for ecotourism - analysis of ecosystem market demand in India- marketing issues- Investment of international agencies like World Bank in ecotourism projects.

UNIT II

Ecotourism economics at macro and micro economic level in developing countries. Ecotourism as a green business and role of green consumerism. Business plans. Identifying unique selling points for marketing. Potential of internet in marketing ecotourism. Economic valuation of ecotourism sites (based on methods like travel cost method).

UNIT III

Environmental Impact Assessment. Payments for Environmental services and role of ecotourism. Multiplier effects, opportunity costs and leakage in ecotourism industry. Sharing ecotourism revenues among stakeholders

UNIT IV

Training in ecotourism to deliver quality service- Practical exercise on the economic inflow-out flow in the selection ecotourism area- impact on the economic well being of the local population.

UNIT V

Potential of eco-tourism in the sustainable management of local livelihood. Impact of eco-tourism on the income of local inhabitants. Feasibility plans for effective eco-tourism. Eco-tourism based capacity building.

Practical

Economic analysis of tourism components- case study of some important ecotourism destinations- analysis of primary and secondary beneficiariesreport preparation. Exercises on feasibility studies, environmental impact assessment and economic valuation of natural resources need to be included

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.
Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.
Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies* Channel View Publ.
Neale G. 1999. *Green Travel Guide*. Earth Scan.

ET 526 DESIGN AND MANAGEMENT OF ECOTOURISM 2+1

Objective

To impart knowledge regarding regulating ecotourism within sustainable imits.

Theory

UNIT I

Ecotourism plans and management of visitors and other resources including human and natural resources. Types of eco-tourists - commercial ecotourist – nature tour operators - Quality control, codes of conduct etc. Use of GIS and ICT for effectively managing and planning ecotourism.

UNIT II

Criteria and indicators for sustainable management and monitoring. Charter for Sustainable Tourism. Sustainability issues in ecotourism management and ecotourism certification

UNIT III

Role of socioeconomic factors in decision making. Designing ecotourism products using local technologies. Carrying capacity considerations. Use of GIS in ecotourism design- Existing ecotourism markets and ecotourism market segmentation.

UNIT IV

Paradigm shifts possible due to climate change and its potential influence of carbon economy on existing ecotourism markets. Role of local institutes and other grass-root agencies in the design and managerial of specific ecotourism plans.

UNIT V

The genders dimensions of designing and management of eco-tourism and management of eco-tourism.

Practical

Mapping of major ecotourism destinations with GIS intervention- Identify one area of ecotourism potential – assess the carrying capacity- design suitable ecotourism activities

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.
Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.
Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.
Neale G. 1999. *Green Travel Guide*. Earth Scan.

6. Agro-Forestry

AF 521 AGROFORESTRY SYSTEMS 2+1

Objective

To impart knowledge on the concept of agroforestry land use including diagnosis & design methodologies.

Theory

UNIT I

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.

UNIT II

Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Productin potential of different silvi-pasture system.

UNIT III

Concepts of community forestry and social forestry, linear strip plantations.

UNIT IV

Diagnosis and Design – Trends in Agroforestry systems research and development.

Practical

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

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH. Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

AF 522 SOIL AND WATER MANAGEMENT IN AGROFORESTRY 1+1

Objective

To impart knowledge on soil and water management in agroforestry including biogeochemical cycling of nutrients.

Theory

UNIT I

Soil and water management –objectives and scope in relation to agroforestry systems. Soil and water conservation , land classification and carrying capacity. Irrigation potential and methods. Optimization of waters use in agroforestry systems and dry land farming .

UNIT II

Soil water relations, moisture regimes and management techniques. Problem soils and their management, soil organisms and nitrogen fixation.

UNIT III

Biogeochemical cycling of nutrients including organic matter decomposition. Nutrients budgeting and soil productivity under different agroforestry systems.

Practical

Calculation of water storage and fluxes in the soil. Determination of “insitu infiltration rate of soils. Measurement and estimation of run-off . Mineral nutrient analysis of soil and plants. Study of biogeochemical cycles in agro-forestry systems.

Suggested Readings

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

Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.

Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI.

AF 523 CROPS AND ANIMALS PRODUCTION 2+1
MANAGEMENT IN AGROFORESTRY

Objective

To impart knowledge on interactions between tree and live stock including their management, principles of crops and fodder production in agroforestry

Theory

UNIT I

Choice of inter-crops for different tree species, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions

UNIT II

Role of tree architecture and its management on system's productivity. Production potentials of fodder based agroforestry system in different agro climatic conditions. Crop combination, crop combination interactions in crop mixtures. Importance of cattle –sheep and goat vis-à-vis agro-forestry systems. Feed and fodder resources in agro-forestry systems and live stock management.

UNIT III

Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with agroforestry forages and tree leaves. Forage and tree leaves preservation.

UNIT IV

Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing.

UNIT V

Integrated Agroforestry Farming System

. **Practical**

Measurement of crop growth rates. Study of tree crop association and management methods. Quantitative evaluation of tree-crop, livestock. Analysis of forages and feeds for mineral and incrementing constituents. Digestibility of some agro-forestry forages. Preparation of leaf meal and forage conservation. Familiarity with common veterinary instruments, AI equipments and common feeds and fodders & Field visits.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI

AF 524 FRUIT PLANTS, TREES AND SHRUBS 2+1
FOR AGROFORESTRY

Objective

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for agorforestry.

Theory

UNIT I

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques.

UNIT II

Fruits crop and their need and relevance in Agroforestry fruits tree suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertility management, yield and quality improvement.

UNIT III

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

Practical

Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of tree, shrubs and fruit trees for enhancing production in Agroforestry system.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI.

AF 525 ECONOMICS OF AGROFORESTRY SYSTEMS 2+1

Objective

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems.

Theory

UNIT I

Basic principles of economics applied to agro-forestry. Optimization techniques- Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making.

UNIT II

Financial and socio-economic analysis of agro-forestry projects.

UNIT III

Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

Practical

Exercises on agro-forestry production relationships. Preparation of enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestry products.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI.

AF 526 RANGE LAND AND PARTIAL MANAGEMENT 2+0

Objective

To develop understanding of students about watershed management and Range Land Management.

Theory

UNIT I

Concept of watershed management. Ideo-types of watershed development plans and activities for the watershed. Criterion for watershed size determination.

UNIT II

Principles and practices of range land management. Improvement of range productivity by vegetation manipulation through control of undesirable vegetation, burning, fertilization, soil and water conservation and protection. Range improvement and livestock management.

UNIT III

Feeding habits and grazing behavior of range livestock. Optimal livestock and range utilization, fodder from trees/shrubs and their nutritive values, propagation techniques, Micro climatic studies, root behavior, crown architecture including methods for minimizing unfavorable interactions.

UNIT IV

Production potential of different silvi-pasture systems.

UNIT V

Characteristics of a watershed and their role in watershed management. Quantification of the benefits and effectiveness of the package of practices adopted for management of watershed, Dynamics vis-à-vis plant growth and post harvest processing for evaluation of chemical constituents.

UNIT VI

Biological and engineering approach in the management of degraded and denuded habitats as an integrated and multiple approach. SPP Testing. Provenance trials. Seed certification and storage. Elite trees selection.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.
Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
Young A. 1997. *Agroforestry for Soil Management*. CABI.

7. Forest Genetic Resources

FGR 521 BREEDING METHODS IN FOREST TREES 2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection.

UNIT V

Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance.

UNIT VI

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

Practical

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

Suggested Readings

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

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

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

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

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

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

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

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

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

FGR 522 REPRODUCTIVE BIOLOGY OF FOREST TREES 2+1

Objective

To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding, sex expression.

Theory

UNIT I

Importance and application of reproductive biology in tree breeding.

UNIT II

Modes of reproduction: sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecy and its evolution.

UNIT III

Out-crossing mechanism in forest trees.

UNIT IV

Environmental effects on sex expression. Floral biology. Initiation and development. Modes of pollination; Self and out-crossing.

UNIT V

Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

Practical

Sex expression in forest trees. Out crossing mechanisms in forest trees. Measurement of pollen flow in wind-pollinated and insect-pollinated species. Pollen viability and fertility. Seed dispersal mechanism.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.
Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.
Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FGR 523 TREE SEED ORCHARDS 2+1

Objective

To develop understanding of students about tree seed orchards.

Theory

UNIT I

Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply of superior seed.

UNIT II

Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones.

UNIT III

Seed orchard: need, evolving seed orchards, containerized seed, hybrid and research seed orchards; first, second and advanced generation seed. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortet age and its effect on seed production.

UNIT IV

Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield.

UNIT V

Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

Visits and study of seed orchard designs. Estimation of overlap in flowering among genotypes. Study of inter and intra-clonal variation in floral, seed characters. Effect of girdling on flowering. Plant growth regulator application for flower induction. Pollen viability/fertility. Assessment of pollen dispersal. Supplemental mass-pollination. Effects of foliar application of fertilizers on seed set. Estimation of genetic parameters for a few traits. Estimation of parental balance.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.
Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.
Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.

Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FGR 524 QUANTITATIVE GENETICS IN FOREST 3+0
TREE BREEDING

Objective

To impart knowledge in the field of biometry as applied to breeding, population, provinces and making experiment in forest genetics and tree breeding.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

UNIT VII

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

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.
Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.
Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FGR 525 FOREST GENETIC DIVERSITY AND CONSERVATION 3+0

Objective

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

Theory

UNIT I

Biological diversity-concept, levels ecosystem. Genetic diversity and differentiation-definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation.

UNIT II

Molecular approaches for assessing genetic diversity. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts.

UNIT III

Effects of sampling on genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Global and local initiations for bio chemistry conservation.

UNIT IV

Laws and policies. Methods for maintenance of conservation: Gene banks, arboreta, gardens, breeding populations as repositories of gene conservation. Rare, endangered and endemise plants (IUCN).

UNIT V

Techniques for survey and assessment of endangered plants. Rarity patterns and endemism. Concept of island biogeography. Managing corridors and natural habitat fragments.

UNIT VI

Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora tourism impacts and urbanization of rare plants. Implications of rarity.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.
Faulkner R. 1975. *Seed Orchard* Forestry. Commission Bull. No.34.
Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

8. Forest Biotechnology

FB 521 FOREST BIOTECHNOLOGY 2+1

Objective

To imbibe an understanding of scope, potential and techniques in forest biotechnology and to prepare them for experimentation in the discipline.

Theory

UNIT I

Historical development of biotechnology; scope of biotechnology in forestry; different methods of biotechnology related to forestry

UNIT II

Plant tissue culture and response pattern; application of plant tissue culture in tree improvement.

UNIT III

In vitro selection and micro propagation in forestry for conservation; gene regulation, genetic engineering techniques; basis of operation in DNA manipulation;

UNIT IV

Transgenic plants; molecular markers and its application in forestry; modification of plant species to practically desired products; biodegradation of forestry wastes through genetically engineered microbes.

Practical

Micro propagation technique, Preparation of MS media, collection of explants, acquaintance of different instruments use in biotechnology, visit to the laboratories.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.
Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.
Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.
Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FB 522 TISSUE CULTURE IN FOREST TREES 2+1

Objective

To develop faculties of students to explore and analyze the propagation techniques *in vitro* and to provide knowledge in the field with principles, techniques and progress achieved in the discipline.

Theory

UNIT I

Tissue culture-principles as applied to forest tree species, history, development, fields of application, progress and prospects with special reference to tree crops. Culture conditions. Stages of micro propagation.

UNIT II

In vitro propagation via enhanced release of auxiliary buds. Somatic organogenesis and somatic embryo genesis, leaf diseases, embryoid and synthetic seed production.

UNIT III

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.

UNIT IV

Haploid culture and production of homodiploids, Protoplast isolation,
culture and regeneration; Protoplast fusion for somatic hybridization and its
application.

UNIT V

Techniques for direct gene transfer to protoplasts.

UNIT VI

Need of in vitro conservation. Short and medium term conservation. Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, prefreezing treatments – use of cryo-protectants, dry freezing, incubation.

UNIT VII

Alteration/modifications in cell components during cryo-preservation. Recalcitrant species. Thawing and reculture. Survival of freeze preserved cells/tissues.

UNIT VIII

Clonal fidelity and karyotype stability of cryopreserved cultures and regenerates. Use of biochemical and molecular markers for testing the stability, Protocol development.

Practical

Preparation and storage of stock solutions, preparation of culture media. Collection, handling and pre-treatment of explants. Micro-propagation of tree species 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. Preparation of in vitro cultures for short, medium and long term preservation. Practicing different protocols for conservation. Thawing and reculture. Assessing the stability of regenerates. RFLP, RAPD and other techniques. Manipulation of culture media and conditions for prolonging the culture period. Essential features of tissue culture laboratories.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.

Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.

Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.

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

Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.

Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.

Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FB 523 MOLECULAR BIOLOGY 2+1

Objective

To develop understanding of students in field of molecular biology through imparting knowledge about the structure and function of RNA and DNA, its organization, isolation, extraction, assay and application.

Theory

UNIT I

History and development of Molecular Biology. Nucleic acids – DNA and RNA as genetic materials. Nucleosides and nucleotides, DNA double helix –properties of DNA – absorbance, ionic interaction, denaturation and renaturation, sedimentation.

UNIT II

Secondary structure of single stranded DNA – inverted repeat sequences, alternative structures of duplex DNA C value and concept of selfish DNA, cell organelle DNA Chloroplast and genes and mitochondrial DNA and genes. DNA replication – semi-onservative replication.

UNIT III

Organization in prokaryotes and eukaryotes. DNA polymerases, replicon, eyes, rolling circle and D-loops, nick translation, okazaki viruses. Reverse transcriptase, primase, helicase, topoisomerases, gyrases, methoylases and nucleases. DNA sequencing.

UNIT IV

Molecular breeding of Forest trees, Constructing molecular maps, Molecular tagging of genes/traits, Market-assisted selection of qualitative and quantitative traits, Physical maps of chromosomes, The concept of gene synteny, The concept of mapbased cloning. .

UNIT V

Basic structure of DNA, overview of genomics technology, concept of maps: Genetic maps, properties of marker used for creating genetic maps, Physical maps: STSs, ESTs Chromosome separation method, high resolution physical mapping approach, Automated sequencing, sequence annotation. Recent advances in molecular marker technique and genomics with special reference to tree.

UNIT VI

Micro arrays Application: gene expression, SNP detection, detection of environmental agents.

UNIT VII

Micro array design: cDNA micro array, oligonucleotide arrays. Micro array abrication. Detectin technology. Computational analysis of micro array data.

Practical

Estimation of DNA and RNA. Isolation of total nucleic acids from bacteria. Large-scale preparation of total plant DNA. Isolation of total RNA. Agarose gel electrophoresis. Denaturation of DNA. Ethidium fluorescent assay of nucleic acids. Estimation of C value. Binding of polyamines to DNA. Assay of DNA ploymerase. DNA sequencing. Isolation and quantification of plant DNA, PCR operation and gel electrophoresis, RAPD and ISSR, gene sequencing, sequence annotation.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.
Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.
Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.
Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FB 524 PRINCIPLES & TECHNIQUES OF GENETIC ENGINEERING 2+1

Objective

To acquaint students about the concepts of enzymes, vectors and techniques involved in DNA transferred technology.

Theory

UNIT I

Recombinant DNA Technology: Major events, Genomic and DNA clones, Different methodologies and rationale of cloning gene.

UNIT II

The Tools of Genetic Engineering: Concept of restriction and modification, Restriction endo-nucleases, Modifying enzymes, Ligases, Host-vector system, – Ecoli as a host.Different Kinds of vectors: Plasmids, phage vectors, M 13, cosmids, phagemids, YACS, BACS, PACS and expression vectors.

UNIT III

The Means of Ge netic Engineering: Different strategies of cloning, Ligationstrategies, Genomic libraries, cDNA libraries, Gene tagging, Introduction to molecular market technology.

UNIT IV

The product: Sub cloning, Nested deletions, Sequencing and sequence analysis, Site directed mutagenesis, Expression of cloned genes, Isolation and purification of the expressed product.
UNIT V
PCR Technology: Different types of PCR, Applications of PCR in cloning genes, promoters and flanking sequences. Utilizing PCR in the lab for preparation of probes, PCR on molecular marker technology.
UNIT VI
Cloning and Transformation in Prokaryotes, Vector preparations, Insert preparations, Legation.
UNIT VII
Transformation: Methods of direct transformation: PEG mediated, microinjection, particle bombardment, edlectoportation.
UNIT VIII
Method of indirect transformation: *Agrobacterium tumefaciens* and *A. rhizogenes*, Screening for recombinant clones, analysis of the recombinant DNA, Isolation of the recombinant plasmid, Restriction analysis, Excision of the insert, Restriction analysis of the excised insert, Sequence analysis of the insert, construction of Genomic and cDNA library, Gene isolation,
Promoter analysis, Gene expression. Genetic engineering for insect/disease resistance, Genetic engineering for wood quality improvement, high biomass, adoption to harsh sites and for incorporating male sterility and rooting of tree cutting.

Practical

Isolation of nucleic acids and their sequencing, Experiment with cloning vectors: pUC 18, pUC 19, pBR 322, phase etc. Extraction and purification of plasmid DNA restriction methylation and ligation reactions, preparation and transformation of competent E. coli. Agro-bacterium mediated genetic transformation, Antibiotic resistance, insertional inactivation. Estimation of proteins and enzymes involved in the defense mechanism-glucanase and chitinase activity, mRNA isolation after exposing the plant to stress
conditions. Evaluation of gene expression. Identification of recombinants.

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.
Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.
Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.
Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

FB 525 ENVIRONMENTAL POLLUTANTS AND BIOTECHNOLOGY 2+0

Objective

To provide the students with concepts and problems of how biotechnology help in solving these problems.

Theory

UNIT I
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.
UNIT II

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.

UNIT III

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).

Suggested Readings

Bajaj YPS. (Ed.). 1988. *Biotechnology in Agriculture and Forestry*. Springer Verlag.
Gupta PK. 2000. *Elements of Biotechnology*. Rastogi Publ.
Kumar S & Singh MP. 2008. *Plant Tessue Culture*. APH Publ.
Mandal AK & Gibson GL. (Ed.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Punia MS. 1998. *Plant Biotechnology and Molecular Biology*. Scientific Publ.
Singh BS & Singh MP. 2007. *Fundamental of Plant Biotechnology*. Sodesh Serial Publ.
Srivastava PS, Narula A & Srivastava S. (Ed.). 2004. *Plant Biotechnology and Molecular Markers*. Anamaya Publ.

9. Environment Management

EM 521 CONCEPT OF ENVIRONMENTAL SCIENCES 2+0

Objective

To develop understanding of students about environmental and climatic System.

Theory

UNIT I

Definitions and concepts in environmental sciences, components of atmosphere, hydrosphere, pedosphere, biosphere and their interactions.

UNIT II

Ecosystems of the world, energy flow in ecosystems, bio-geographic regions, biological building block, nutrients and nutrient cycling in different eco-systems.

UNIT III

Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity, biotic and abiotic interactions, soil-plant-atmospheric interactions, agriculture and environment pollution, green house and global climatic changes, environmental issues.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. Of India, New Delhi.
Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA. Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell Science. Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe*. Biodiversity International, Rome, Italy.

EM 522 ENVIRONMENTAL POLLUTION 3+0

Objective

To develop understanding of students about sources, causes, monitoring and mitigation of environmental pollution.

Theory

UNIT I

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

UNIT II

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.

UNIT III

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.

UNIT IV

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.

UNIT V

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

Suggested Readings

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

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

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

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

EM 523 ENVIRONMENTAL ANALYTICAL TECHNIQUES 2+1

Objective

To develop understanding of students about environmental statistics

Theory

UNIT I

Introduction; Principles of physical, chemical and microbiological analysis of environmental pollutions. Sampling procedures for testing water, waste water, air and solid waste, sampling rules, sample collection and preservation.

UNIT II

Environmental chemical analysis; role and importance. Classical Methods; volumetric and gravimetric analysis, principles of filtration, distillation, paper chromatography, gas chromatography, etc.

UNIT III

Instrumental techniques using atomic absorption and emission spectrophotometery, Gas chromatography, etc. Assessment and interpretation of results using statistical tools.

Practical

Handling of the analytical equipments and analysis of particulate air pollutants and other environmental chemical.

Suggested Readings

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

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA. Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

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

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

EM 524 GLOBAL CLIMATIC CHANGES 2+0

Objective

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

Theory

UNIT I

Climate change: History and future - Earth's climate systems, major green house gases, future climatic predictions.

UNIT II

Adaptability and vulnerability of forest and aquatic ecosystems, responses of biotic communities and changes in reproductive biology of flora and fauna.

UNIT III

Ozone depletion and UV radiation effects interactions with weather.

Suggested Readings

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

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

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

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

EM 525 ENVIRONMENTAL POLICY, LAW AND
3+0 INTERNATIONAL CONVENTIONS

Objective

To impart knowledge about various legislations and acts concerning environmental policy, laws and conventions.

Theory

UNIT I

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 abetment of Pollution, National Eco tourism Policy ,National Tourism Policy, National Trade Policy, National Water Policy.

UNIT II

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.

UNIT III

Pollution Control Laws: Public Nuisance – S.133 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.

UNIT IV

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Ramsar Convention on Wet Lands, The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal , The Montreal Protocol ,International Tropical Timber Agreement.

UNIT V

Convention on Biological Diversity 1992 (CBD) Cartagena Protocol on Bio-Safety 2000 (CPB), United Nation Framework Convention on Climate Change, Kyoto Protocol, WTO and Environment, TRIP and Patenting Issues.

Suggested Readings

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

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

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

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

EM 526 ENVIRONMENTAL IMPACT ASSESSMENT 2+1

Objective

To train the students in planning and evaluation projects.

Theory

UNIT I

Introduction; Principles and purposes of IEE and EIA and its significance for the society, Cost and benefits of EIA; EIA involvement during project life cycle.

UNIT II

EIA management; principles & management of EIA, main stages in EIA processes; screening, scooping, prediction, mitigation and alternatives auditing.

UNIT III

EIA techniques, checklists, matrices, network method, remote sensing and GIS. Public consultation and participation in EIA process. EIA guidelines and review process. EIS formulation. New approaches to EIA and SEA (strategic environmental assessment).

Practical

Preparation of EIA & SEA reports.

Suggested Readings

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

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Committee on Abrupt Climate Change. 2002. *Abrupt Climate Change: Inevitable Surprises*. National Research Council, Ocean Studies Board, National Academics Press, Washington.

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

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

10. Forest Business Management

FBM 521 FOREST RESOURCE ANALYSIS 3+0

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Suggested Readings

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

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

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

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.
Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.
Makchau JP & Malcolm LR. 1986. *Economic of Tropical Farm Management.* Cambridge Univ. Press.
Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.
Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.
Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FBM 522 FINANCE AND MARKETING MANAGEMENT 2+1
OF FOREST RESOURCES

Objective

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

Theory

UNIT I

Finance- definition, aims and objective. Goals of financial management, organization of finance functions in business firms. Working capital management; need, concepts and sources of working capital. Gross and net working capital; factors influencing working capital requirements.

UNIT II

Importance and preparation of Financial Statements, Balance Sheet and Profit and Loss accounts. Ratio analysis. Sources of long term finance. Purpose and essentials of budgeting, important components of master budget, preparation of operation, responsibility, financial and capital budgets.

UNIT III

Market-concept, components and classification. Demand and supply and factors affecting the market. Simple market model and price determination. Market structure, conduct and performance.

UNIT IV

Market integration-meaning, types, degree, measurement and effects of market integration. Marketing cost, margin and price spered-concepts and applications. Marketing efficiency-definition, approaches to the assessment of marketing efficiency and empirical assessment of marketing efficiency. IPRs and their implications for forestry and allied sectors in the country.

Practical

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

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.
Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.
FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.
FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*. Kerr JM, Marothia DK,

Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*. Oxford & IBH.
Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.
Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.
Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.
Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FBM 523 FARM MANAGEMENT 3+0

Objective

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

Theory

UNIT I

Farm: Concept, present scenario, and business application. Nature, scope and functions of farm business management. Principles involved in farm management decision making.

UNIT II

Principles of farm planning and budgeting. Working out existing and alternative farm plans. Application of quantitative techniques in Forestry production. Importance of farm records, Types of physical and financial records. Farm business efficiency measures - Fundamentals of inventory control.

UNIT III

Management of special farm projects like, nursery, plantations, poultry, dairy, fishery, bee keeping, sericulture, mushrooms, etc. Managerial problems of farms.

UNIT IV

Farm labour and its problems. Labour measurement, work allocation, raising labour productivity. Staff control-work progress charts, supervisory management, leadership and leadership styles; good labour relations, training needs reward structure. Farm capital and its problems, farm machinery and its utilization.

Suggesting Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*. Prentice Hall.
Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.
FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.
FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.
Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997. *Natural Resource Economis – Theory and Application in India*.
Oxford & IBH. Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.
Nautiyal JC. 1988. *Forest Economics - Principles and Applications*. Natraj Publ.
Sharma LC. 1980. *Forest Economics – Principles and Applications*. Natraj Publ.
Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FBM 524 PRODUCTION MANAGEMENT IN NURSERY AND PLANTATION FORESTRY **2+1**

Objective

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

Theory

UNIT I

Introduction to production theory. Production concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of choice and resource allocation in nursery production, Resource combination and cost minimization, Resource allocation and enterprise combination. Technical and economic efficiency, Derivation of cost and supply functions from production functions, break-even analysis managing risk and uncertainty in nursery and plantation forestry.

UNIT II

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis.

UNIT III

Time value of money, Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period.

UNIT IV

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

Practical

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

Suggested Readings

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

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

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

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

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

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

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

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

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FBM 525 PROJECT PLANNING, MONITORING AND EVALUATION 2+1

Objective

To develop understanding of the students about fundamentals of project planning, monitoring and evaluation

Theory

UNIT I

Project – importance and steps in project formulation. Ex-ante, concurrent and expost project appraisal. Choice of discount rate. Financial feasibility of project, various techniques used.

UNIT II

Advantage and disadvantages of discounting and non-discounting feasibility criteria. Sensitivity analysis. Introduction of network scheduling techniques. Critical path methods, characteristics, use and preparation of critical path.

UNIT III

Monitoring and evaluation –definition, objectives and types. Project review meeting and preparation of project status reports. Fundamentals of environment impact assessment.

Practical

Project preparation. Application of various methods like Net Present Value, Internal Rate of Returns, Benefit Cost Ratio, annuity, payback period, CPM, PERT approach in the formulation and appraisal of various Agroforestry and forestry projects. Exercises on sensitivity analysis.

Suggested Readings

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

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

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

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

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

Upton M. 1976. *Agricultural Production and Resource Use*. Oxford Univ. Press.

FBM 526 MANAGERIAL ECONOMICS 3+0

Objective

To develop understanding of students about the managerial aspects of macroeconomic policies on the management of industrial farms.

Theory

UNIT I

Meaning, scope and nature of managerial economics. Business firm and its objectives.

UNIT II

Measurement of profit and profit maximizing hypothesis. Economic analysis of consumer behaviour.

UNIT III

Theories of demand and supply and equilibrium of the firm. The concept of elasticity and its significance.

UNIT IV

Theory of production and cost principles. Price and out-put determination under perfect and imperfect competition. Pricing practices – cost plus, marginal cost pricing and price determination (mark up) rule. Forecasting of demand, sales and profits.

UNIT V

The concept and measurement of national income. Theories of consumption. Saving and investment functions.

UNIT VI

Inflation – concept, consequences and cures. Theories of business cycles.

Suggested Readings

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

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

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