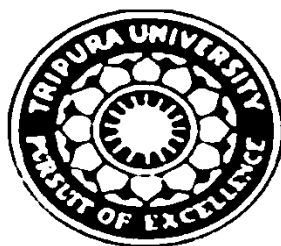


Approved Syllabus

M.Sc. FORESTRY AND BIODIVERSITY COURSE CURRICULUM

2020



**DEPARTMENT OF FORESTRY AND BIODIVERSITY
TRIPURA UNIVERSITY (A Central University)
SURYAMANINAGAR, AGARTALA – 799 022
TRIPURA, INDIA**

Programme Objective:

Post Graduate programme in Forestry and Biodiversity have been developed after identifying the needs of present Forestry and Biodiversity scenario and demand of professionals, having the understanding of special fields and subjects in forestry and biodiversity sector, including govt., corporate and private sectors. The package under core courses has been prepared keeping in view the production, management, conservation of forests, its rich biodiversity and plantations. The present syllabus is prepared to make it a professional programme with ample scope for specialization in the upcoming subject areas relevant for the sector, industries and other stake holders, thus broadening the scope and potential for employment for the Post Graduate students of Forestry and Biodiversity. The students will be given a set of twenty (20) courses (including practical Courses) which will be compulsory for undertaking the PG programme at Master level. The courses are called Core courses of Forestry and Biodiversity with specialized course called as elective course. These courses have been developed after identifying the needs of present Forestry and Biodiversity scenario and demand of professionals, having the understanding of special fields and subjects in forestry and biodiversity sector, including govt., corporate and private sectors. The package under core courses has been prepared keeping in view the production, management, conservation of forests, its rich biodiversity and plantations

Duration of Course and System of Education

The total duration of this programme shall be two years which will be covered in four semesters. The core courses and the foundation courses will be common for all students and the elective course (one in semester III) will have to be selected amongst the set of 4 courses by each student. The students will have to propose a research problem before the fourth semester in the form of synopsis which has to be approved by the students advisory committee. During the fourth semester the student has to complete the research work and by the end of the fourth Semester they have to prepare a Master's Thesis which will be mandatory for the partial fulfillment of the degree programme. The Master's thesis has to be prepared in consultation with the Major Advisor (mentor) and the students Advisory Committee and finally approved in the colloquium seminar which will be delivered by the student before the Advisory Committee in the presence of faculty members and students of the Department.

A mentor shall be allotted at the start of the 1st Semester to each M Sc Student by the DRC.

Examination and Evaluation System

It is proposed that this degree Programme will adopt the CBCS (semester) pattern as followed for other degree programmes in Tripura University.

There shall be minimum two internal evaluation of 30% marks (Internal) in the form of presentation, Viva Voce, Assignment or examination and final External theory examination of 70% marks (External). The syllabus of the concerned course shall be sent to the external examiners who shall set the question papers and also evaluate the answer books. The practical examination will be conducted internally by the course instructors and one external examiner nominated by the HOD or as desired by the COE/Hon'ble VC from time to time.

Programme structure:

The Programme consists of Core Courses, Foundation Courses, and other specialized requirements totaling to 96 credits. One credit is equivalent to one hour of teaching (lecture or term paper) or two hours of practical work/field work per week. Each semester consists of 18 weeks (approx.) of academic work equivalent to 90 actual teaching days. 3 credit hours of term Paper is allotted in 3 courses with the objective to develop the skill of research writing. In this course students have to review literature in their field of interest related to the topics of this course. They have to prepare a project report on a particular topic under the supervision of faculty and submit it.

The programme structure and respective credits are given below as:

Course Structure	Credit
Core courses	55
Elective (other Departments)	08
Elective (from Department)	04
Skill Course	03
Industrial Exposure	02
Master's thesis	16
Master thesis seminar	02
Total	90



TRIPURA UNIVERSITY
Department of Forestry and Biodiversity

SEMESTER I- 21Credits (Core Course (C): 17 Credits; Elective Course (F): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
FB 701C	Principles of Silviculture	3	0	1	04	100
FB 702C	Forest Biometry	2	0	1	03	100
FB 703C	Biodiversity and Conservation	3	0	1	04	100
FB 704C	Forest Ecology	2	0	1	03	100
FB 705C	Forest Protection	2	0	1	03	100
CSK-II-E	Computer Skills	4	0	-	04	100
Sub-Total		16	0	5	21	600

SEMESTER II- 26 Credits (Core Course (C): 22 Credits; Elective Course (F): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 801C	Forest Policy, Laws and International Conventions in Biodiversity Management	2	1	-	03	100
FB 802C	Forest Utilization & Forest based Industries	2	-	1	03	100
FB 803C	Biosystematics	3	-	1	04	100
FB 804C	Forest Genetics and Tree Improvement	2	-	1	03	100
FB 805C	Climate change and Forestry	2	1	-	03	100
FB 806C	Forest Biotechnology	2	-	1	03	100
FB 807C	Nursery Technology and Plantation Techniques (Skill Course)	1	-	2	03	100
STAT-E	Bio Statistics	4	-	-	04	100
Sub-Total		18	2	6	26	800

SEMESTER III- 25 Credits (Core Course (C): 21 Credits; Elective Course (E): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 901C	Forest Resource Management and Valuation	2	1	-	03	100
FB 902C	Medicinal and Aromatic plants	2	-	-	02	100
FB 903C	Wildlife Management and Eco-development	3	-	1	04	100
FB 904C	Forest Soil & Watershed Management	2	-	1	03	100
FB 905C	Wood Science and Technology	2	-	1	03	100
FB 906C/906E	Application of Remote Sensing and Geographic Information System in Forestry	2	-	2	04	100
FB 907C	Industrial Attachment (In between 2 nd Sem-3 rd Sem)	-	-	2	02	100
One Elective Course		3	-	1	04	100
Sub-Total		16	1	8	25	800

SEMESTER IV- 18 Credits (Core Course (C): 18 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 1001C	Master's Thesis	-	-	2	2	100
FB 1002C	Master Thesis Seminar	-	-	16	16	100
Sub-Total		-	-	18	18	200

LIST OF ELECTIVE COURSE

Course Code	Elective Course	Credit	
		Theory	Practical
FB 901E	Agroforestry	03	01
FB 902E	Reproductive Biology and Breeding Methods in Forest Trees	03	01
FB 903E	Environmental Impact Assessment	03	01
FB 904E	Forest Biology & Tree Physiology	03	01



TRIPURA UNIVERSITY
Department of Forestry and Biodiversity

M.Sc. Forestry and Biodiversity

Programme Specific Outcome

At the end of the programme student will be able to-

- Identify, review research literature, analyse problems and formulate research proposals to taking up research as a career
- Communicate in both oral and written form the forestry knowledge base, activities and the use of biological resources by demonstrating professional ethics
- Undertake field based surveys related to the conservation, utilization and sustainable management of Forest and other NTFP's
- Acquire advanced knowledge and use the modern tools by applying forestry and Biodiversity principles.
- Choose career options in environmental NGO's, Forest based industries, Administrative services of ministries dealing with Forest and environment, become independent consultant, or become entrepreneur with the knowledge of Forest resource utilization and management

SEMESTER I- 21Credits (Core Course (C): 17 Credits; Foundation Course (F): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
FB 701C	Silviculture	3	0	1	04	100
<p>UNIT: I Silviculture: Definition, history, objectives and scope, status of forest cover in India. Major forest types of India –forest composition and structure. Locality factors influencing forest growth and distribution in India. Seed production, seed periodicity, seed dispersal, seed collection and processing, seed dormancy, seed germination, methods of seed viability estimation and measurement of seed vigour; Regeneration: Natural and Artificial regeneration. General nursery techniques. Tending and cultural operations in forestry.</p> <p>UNIT: II Silvicultural system of management; Silvics of important tree species-Distribution, morphology, phenology, growth behaviour, silviculture characters, nursery techniques, , protection and utilization of the following tree species:<i>Cedrusdeodara, Pinus kesiya, Gmelina arborea, Shorearobusta, Tectonagrandis, Dalbergia sissoo, Acacia spp., Albizzia spp., Terminaliaspp., Dipterocarpus spp.</i>, Bamboospecies.</p> <p>Practical: 1. Study of Composition of nearby forest areas and to know the different species. 2. Phenological study of some important tree species.</p>						

3. Regeneration survey of mixed and pure forests
4. Identification on different types of coppices in the forest.
5. Visit to different sites to study silvicultural operations undertaken as part of forest management.
6. Identification of tree seeds and study of their physical characteristics such as seed moisture, weight, and purity analysis.
7. Study on germination behavior of tree seeds in seed body and controlled conditions.
8. Determination of seed viability and vigour tests.

Suggested Readings:

1. Baldwin, H. I. 1942. *Forest Tree Seeds of the North Temperate Region*. Periodical Experts Book Agency, New Delhi.
2. Champion, H.G. and Seth, S.K. 1968. *The revised survey of the forest types of India*. Manager of Publication, Govt. of India, Delhi.
3. Dwivedi, A.P. *A text book of Silviculture*. International Book Distributor, Dehra Dun.
4. Khanna, L. S. 1985. *Principal and practice of Silviculture*. International Book Distributor, Dehra Dun.
5. Negi, S.S. 1985. *General Silviculture*, Natraj Publication, Dehra Dun
6. Prakash, R. and Khanna, L. S. 1979. *Theory and Practice of Silvicultural Systems*. International Book Distributor, Dehra Dun.
7. Negi, S. S. 1998. *Forest Tree Seeds*. International Book Distributors, DehraDun.
8. Prasad, R. and Kandya, A. K. 1992. *Handling of Forestry Seeds in India*. Association Publishing Company, New Delhi.
9. Verma, M. M.; Arora, N. and Mirakhur, R. K. 1990. *Seed Analyst Manual*. Lad Computer Services Pvt. Ltd, New Delhi.

At the end of the course student will be able to...

- understand the concepts and general principles of silviculture
- know the species composition and structure existing in different forest types
- understand stand growth, development and provide knowledge regarding the application of silvicultural principles for the production and protection benefits from the forests
- understand the locality factors, silviculture of the species and can make a choice of species for specific site
- collect quality seeds and clonal propagules can raise nursery by sowing of seeds depending on the requirements
- apply tending and cultural operations in monoculture and mixed forests
- apply suitable silvicultural systems depending on the requirements of the species
- understand the growth and silvicultural characters of the species and would be able to propagate the same as per the silvics of the species

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
FB 702C	Forest Biometry	2	0	1	03	100

UNIT I

Measurement of tree parameters. Determination of tree age and dendrochronology for

growth history and climate change studies.

Estimation of volume, growth and yield of individual tree and forest stands. Volume tables, yield and stand tables.

UNIT II

Forest inventory, sampling methods adopted in forestry, Use of GIS in forest inventory. Quantification of regeneration and stand establishment. Measurement of crown density and crown ratios. Simulation techniques. Growth and yield prediction models – their preparation and applications.

Practical:

1. Application of different sampling methods.
2. Calculations of volume of felled as well as standing trees.
3. Volume table preparation.
4. Preparation of yield and stand table.
5. Quantification of regeneration and stand establishment.
6. Measurement of crown density and crown ratios.
7. Crown profiling of trees and stand.
8. Dendrochronological studies.

Suggested Readings

1. Avery, T. E. and Burkhart, H. E. 2002. Forest Measurements. 5th Edition. McGraw Hill, New York.
2. Beers, T. W. and Miller, C. I. 1973. Manual of Forest Mensuration. T & C Enterprises, West Lafayette, IN
3. Chapman, H. H. and Meyer, W. H. 1949. Forest Mensuration. McGraw-Hill, New York.
4. Chaturvedi ANand Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.
5. Hamilton, G. D. 1975. Forest Mensuration Hand Book. Her Majesty's Stationary office, London.
6. Husch, B.; Beers, T. W. and Kershaw, J. A. 2003. Forest Mensuration. 4th edition. John Wiley and Sons, INC, Hobokon, New Jersey.
7. Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

At the end of the course student will be able to...

- understand the concepts and principles of forest mensuration and its application in forestry
- measure the single tree parameters by using standard instruments and will be able to access the errors associated with these measurements
- familiar with the measurement of cross-sectional area
- know the standard tree stem form and can classify them
- estimate the volume of felled and standing trees
- Understand the preparation, use and application of yield and volume tables
- measure forest biomass and will be able to calculate the carbon stock
- access the age, increment, growth and volume of tree crops
- familiar with field inventorization and sampling

Course	Name of the Course	Credit Distribution	Total	Marks
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Code		L	T	P	Credit	(Scaled)
FB 703C	Biodiversity and Conservation	3	0	1	04	100
<p>Unit I</p> <p>Basic concepts of biodiversity, Biodiversity- definition, levels and types; Factors promote high diversity, latitudinal and altitudinal gradients of biodiversity; biodiversity extinctions; biodiversity values-evolutionary, economic, social, cultural and intrinsic values, threats to biodiversity-Indian context, important threatened/endemic plant and animal taxa of India, biodiversity and ecosystem services; Climate change and biodiversity; Biodiversity of Indian subcontinent: biodiversity hotspots, their characteristic flora and fauna, Biodiversity resources of north-east India, threatened vascular plant species in India, specially emphasize on North east India; Threatened categories, biological invasions and Biodiversity, Biodiversity and Biotechnology, Biopiracy.</p> <p>History of biodiversity conservation; Biodiversity conservation strategies: <i>in situ</i> conservation: Biosphere reserve, sanctuaries, national parks, <i>ex situ</i> conservation: botanical garden, zoological garden, <i>in vitro</i> conservation: germplasm or gene bank, tissue culture; Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity & ethnomedicinal resources, Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001, National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas in India, ecological sensitive zone; important protected areas of North East India; biodiversity conservation in North East India/Tripura- problems and prospects ethnobotany in the conservation of plant genetic resources; traditional knowledge digital library (TKDL).</p> <p>Unit II</p> <p>International programmes for biodiversity conservation, convention on biological diversity (CBD), CITES, ITTA, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands, Cartagena Protocol on Bio-Safety 2000 (CPB); The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal, The Montreal Protocol, IPR.</p> <p>Phytogeography and zoogeographical regions, Introduction of species, Theories of distribution, Endemism, Community concept; Community composition, qualitative and quantitative characters of community; methods of studying vegetation; Techniques for survey and assessment of endangered and threatened plant species, species diversity and stability relationship; Diversity indices, Plant and animal communities in forest, grassland, desert and mangrove ecosystems; high altitude communities; zonation and stratification of plant and animal communities.</p> <p>Practical:</p> <ol style="list-style-type: none"> 1. Determination of minimal quadrat size by the species area curve methods. 2. Study of vegetation by Line transect/belt transect/quadrat methods. 3. Determination of frequency/Density/Abundance/IVI of vegetation. 4. Determination of minimum number of quadrat to be laid down in the field under study. 5. Measurement of Different Biodiversity Indices (Simpson's Biodiversity Index, Shannon's index, Brillouin index) 6. Study of vegetation of the given area by physiognomic method – Biological spectrum method. 7. Estimation of plankton frequency in the aquatic system. 8. Ecological census techniques- wild animal census. 						

Suggested Readings:

1. Gaston, K.J and Spicer, J.I. 2004. *Biodiversity: An Introduction*. Blackwell Publishing Company, USA.
2. Richard. B. Primack. 1998. *Essentials of conservation biology*. Sinauer Associates, Inc. USA.
3. Maiti P.K. and Maiti P. 2011. *Biodiversity Perception, Peril and Preservation*. PHI Learning Private Limited, New Delhi.
4. Ray S. and Ray A.K. 2010. *Biodiversity and biotechnology*. New central book Agency (P) Ltd. Kolkata.
5. Agarwal, S.K. 2002. *Biodiversity conservation*. Rohini Publishers, Jaipur.
6. Nautiyal, S and Kaul, A.K. 1999. *Forest Biodiversity and its conservation Practices in India*. Oriental Enterprises, Dehradun.
7. Ian. F. Spellberg. 1992. *Evaluation and Assessment for Conservation*. Chapman Hall, London, UK.
8. David, E.B. and Joel, T.C., 2003. *Monitoring Ecosystems*. Island Press, Washington, DC
9. Stanley, A.H., 2002. *Managing our wildlife resource*. Prentice-Hall, USA.
10. Benson, E.E., 1999. *Plant conservation Biotechnology*. Taylor and Francis Ltd. London.
11. Agrawal, K.C., 2000. *Wildlife of India: Conservation and Management*. Nidhi Publishers, India
12. Sinha, P.C., 1998. *Wildlife and forest conservation*. Anmol Publication Pvt. Ltd, New Delhi.
13. Edward, O.G., 2004. *Ex situ plant conservation*. Island Press, Washington, DC

At the end of the course student will be able to...

- Understand biodiversity resource utilization, benefit regeneration from organisms/various ecosystems to fulfil the daily requirement of human life.
- build mind setup about how high species diversity is important for the processes and functions of all ecosystems.
- Understand the dependency on biodiversity for clean air, food, pollination of crops, improvement of genetic diversity in agro-ecosystem and the regulation of pathogens, all of which are imperative for human standards of living and well-being.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
FB 704C	Forest Ecology	2	0	1	03	100

UNIT:I

Concept of forest ecosystem, Significance of forest, forest ecosystem structural and functioning, forest diversity indices (alpha diversity, beta diversity, gamma), Forest productivity (primary and secondary productivity), Measurement of forest productivity, Methods of developing allometric equations relating girth and biomass of trees, concept of succession

Nutrient cycling in forest: nutrient uptake, retention and return, source of nutrients. Nutrient input (wet, dry and weathering), accumulation and return through litter fall, acid precipitation, organic matter decomposition, nutrient release and output through runoff and leaching, nutrient conservation strategies in forest. Examples of forest Carbon and N cycles.

UNIT:II

Concept of global change ecology, major global change issues (increasing atmospheric CO₂ concentration, alterations in biogeochemistry of nitrogen, land use change and biodiversity),

impact of human activities on global change; Global cycles of carbon and nitrogen with emphasis on major pools, fluxes and transformations, perturbations in global carbon and nitrogen cycles, human influences on global carbon and nitrogen cycles, major impacts of global ecological changes on forests.

Practical:

1. Monitoring of micro-meteorological parameters
2. Determine the community structure of a forest stand.
3. Calculate the turnover rate of different plant components
4. Determine the litter accumulation/decomposition in a forest stand.
5. Determine the biomass of tree species by allometric method
6. Study the community structure of wetland ecosystem
7. Determine the net ecosystem productivity in forest ecosystem.
8. Estimation the carbon stock in forest ecosystem.

Suggested readings:

1. Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998). Forest ecology (4th edition). John Wiley and Sons
2. Burton V. Barnes, Donald R. Zak, Shirley R. Denton, Stephen H. Spurr. 1998. Forest Ecology. John Wiley & Sons
3. Champion, H.G. and Seth, S.K. (1968). A revised survey of the forest types of India (Reprinted 2004). Natraj Publication, Dehradun.
4. Kimmins, J.P. (2004). Forest ecology (2nd edition). Pearson Education.
5. Perry, DA, Oren, R and Hart, S.C. (2008). Forest Ecosystems (2nd edition) The John Hopkins University press , Baltimore

At the end of the course student will be able to...

- Develop the ability to understand the concept of forest ecosystems
- Understand the concept of nutrient cycling and its role in forest management
- acquire knowledge about global environmental issues
- Understand the ecological aspects in forest management.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
FB 705C	Forest Protection	2	0	1	03	100

UNIT: I

General Concept and Forest Fire; Factors affecting forest health; grazing & browsing, adverse climatic factors, acids rains & air pollutants, weeds and other invasive species. Forest fire (History, types, main causes, prevention and control), Evaluation of losses due to forest fire.

Forest Pathology; Concept of disease & Koch’s postulates. Biodegradation of wood; Heart rots; Important fungal diseases of seedlings in forest nursery, forest dieback, Role of mycorrhiza in tree health.

UNIT: II

Forest Entomology; Insect-plant relationship, population dynamics of forest insects, Insect feeding groups, Insect pests of Commercially important tree species.

Principal Methods of Pest Management; Chemical control; Biological control of insect pests and diseases of forest trees. Integrated Pest Management.

Practical:

1. Identification of diseases of forest nursery seedlings
2. Collection, identification and preservation of disease specimens of forest plants.
3. Collection and preservation of forest insects.
4. Familiarization with the meteorological and plant protection equipment.
5. Preparation of herbarium of forest weeds.
6. Laboratory tests for estimating decay resistance in wood.
7. Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil.
8. Isolation and identification of fungal flora in decayed wood.

Suggested Readings:

1. Agrios, G.N., 2005. *Plant Pathology*. Elsevier Academic Press, USA.
2. Bihari, B., 1992. *Forest Entomology*. Bishen Singh Mahendra Pal Singh, Dehradun.
3. Boyce, J.S., 1961. *Forest Pathology*. McGraw-Hill Book Co Inc, New York.
4. Brown, A.A. and Davis, K. P., 1973. *Forest Fire: Control and Use*. McGraw-Hill, Inc. USA
5. Dhaliwal, G.S and Arora, R., Principles of Insect Pest Management, Kalyani Publishers, Ludhiana.
6. Khanna, L.S., 1982. *Forest Protection*. Khanna Bhandu, Dehradun.
7. Negi, S.S., 1999. *Handbook of Forest Protection*. International Book Distributors, Dehradun.
8. Negi, S.S., 2002. *An Introduction to Forest Pathology*. International Book Distributors, Dehradun.
9. Pedigo, L.P., 2002. *Entomology and Pest Management*, Prentice-Hall of India, New Delhi.
10. Rawat, G.S and Nautiyal, S., 1999. *Forest Fire and its Control Measures*. Oriental Enterprises, Dehra Dun.
11. Speight, M.R and Wylie, F.R., 2001. *Insects Pests in Tropical Forestry*. CABI International, UK
12. Tery, A., 1984. *Diseases of Shade Trees*. Academic Press, Inc, London

At the end of the course student will be able to...

- Understand the objective and uses of forest protection
- acquire knowledge about forest protection from different factors
- Identify different diseases and their control measures
- Describe the technique for preserving and managing forests.

	Computer Skills	4	0	-	04	100
		Credit Distribution			Total Credit	Marks (Scaled)
		L	T	P		
	Sub-Total	16	0	5	21	600

SEMESTER II- 26 Credits (Core Course (C): 22 Credits; Foundation Course (F): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 801C	Policy, Law and International Conventions in Biodiversity Management	2	1	-	03	100
<p>UNIT I Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988; General principles of criminal law; Indian Panel Code, criminal procedure code; Indian evidence act applied to forestry matters. Forest laws; Indian Forest Act –1927, Forest Conservation Act 1980, Wildlife Protection Act 1972</p> <p>UNIT II Environmental protection Act 1986; Biodiversity Act, 2002, Schedules tribes (Recognition of forest rights), Act, 2007. Intellectual Property Rights; Important case studies and landmark judgments. International conventions of forestry issue. e.g. Role of international treaties like CITES, IUCN, RAMSER, CBD etc.</p> <p>Suggested Readings</p> <ol style="list-style-type: none"> 1. Divan S and Rosencranz A. 2002. <i>Environmental Law and Policy in India</i>. Oxford University Press, New Delhi. 2. <i>Indian Forest Acts</i> (with short notes) 1975. Allahabad Law Agency. 3. Jha L K. 1994. <i>Analysis and Appraisal of India's Forest Policy</i>. Ashish Publ. House. 4. National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi. 5. National Forest Policy 1988. Ministry of Environment and Forests, New Delhi. 6. Negi S S. 1985. <i>Forest Law</i>. Natraj Publishers. 7. Saharia V B. 1989. <i>Wildlife Law in India</i>. Natraj Publ. 8. Wilson B, Van Kooten G C, Vertinsky I, Arthur L. 1998. <i>Forest policy --- International case studies</i>. CABI publishing, UK. <p>At the end of the course student will be able to...</p> <ul style="list-style-type: none"> • understand the various forest Policies in vogue for India • Understand the principles of Law applied to forest, wildlife and biodiversity • know the relevant sections of importance in conservation, protection and management of Forest, wildlife and biodiversity • know the international conventions and their role in forestry and biodiversity 						
Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 802C	Forest Utilization & Forest based Industries	2	-	1	03	100
<p>UNIT I Non-timber forest products of India and Northeast India; plant based NTFP products, bamboo and Cane Utilization and Management, animal based NTFP products, mineral products, Trade and development of NTFP; Policy and legal issues, Management requirements, Methods of survey, classification, collection, processing and utilization of NTFPs. Forest harvesting practices; logging and extraction techniques, transportation,</p>						

storage and sale.

UNIT II

Description of different forestbased industries. Use of wood of lesser known forest species for commercial purposes, Importance of forest based industries in relation to Indian economy. Destructive distillation of wood. Saccharification of wood.

Cell wall constituents, Chemical composition of oleoresin and its importance; Structural difference among different gums; Chemical nature and uses of volatile oils, tannins, forest based dyes and pigments.

Practical:

1. Field study for NTFP collection and documentation.
2. Exposure to wood seasoning, preservation and composite wood preparation
3. Acquaintance with various felling and conversion tools and their maintenance.
4. Visit to nearby wood based industries Identification of various wood defects.
5. Determination of cell wall constituents of wood.
6. Determination of calorific value of wood.

Suggested Readings

Gupta T., Gularia A. 1992. Non Wood Forest products in India: Economic Potentials. Oxford and IBH publishing Co. New Delhi.

Nautiyal S and. Kaul A.K. 2003. Non-Timber Forest Products of India. Jyothi Publishers and Distributors, Dehra Dun.

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

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

At the end of the course student will be able to...

- know the NTFP's classification, collection, processing and their utilization
- understand the harvesting practices; logging and extraction techniques
- Know the methods of transportation, storage and its sale and their utilization and major forest based industries
- know the utilization of the major NTFPs and know the major forest based industries
- Understand the requirements of value addition of the major NTFPs

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 803C	Biosystematics	3	-	1	04	100

UNIT-I

Taxonomy of flowering Plants: Introduction: Concept of species, variation; Theory of plant taxonomy- Introduction to major plant groups and evolutionary relationships, History of plant taxonomy, Binomial nomenclature, Code of nomenclature, Systems of classification and their application, Biosystematics with use of ecology, palynology; Study of important plant families of flowering plants, Use of taxonomic literature, herbaria, cultures and databases; Documentation and dissemination- Collection and preservation techniques, Botanical Garden, Function of Botanical gardens, Recording information in field and laboratory, Photography, Illustration, Description of species, Referencing and citation, Preparation of keys, reports, Computerized database generation for dissemination, Modern taxonomy, Major groups in Gymnosperm, Reproduction in Gymnosperms.

Taxonomy of non-flowering Plants: Study of Identification-Morphology/characters of major groups in Algae, (Cyanophyta, Chlorophyta, Charophyta, Xanthophyta, Phaeophyta, Rhodophyta); Bryophytes and Pteridophytes; Structure and Reproduction in Bryophytes; Structure and Reproduction in Pteridophytes; Importance of Algae, algae, Bryophytes and Pteridophytes.

UNIT-II

Taxonomy of Microbes: Magnitude, occurrence and distribution, Outline classification of microorganisms;

Fungi- Criteria for classification and identification, Types of vegetative and reproductive forms, fruiting bodies, life cycles, Taxonomic keys and importance.

Bacteria- Occurrence, shape and arrangement of bacterial cells, Structure and multiplication of bacterial cell, classification as per Bergey's Manual of Systematic Bacteriology.

Virus-history of virology, General characteristics of viruses – size, shape and chemical composition, properties used for classification of viruses, isolation and identification of viruses.

Practical:

1. Study of the locally available plants based on Macro and Micromorphology
2. Description and identification at family, genus and species levels using standard taxonomic Keys (Floras).
3. Identification of key characters in a lower group of taxa and construction of keys.
4. Studies on Herbarium techniques
5. Identification of some locally available Bryophytes
6. Identification of some locally available Pteridophytes
7. Identification of the animals by use of Taxonomic Keys, morphological characters and other identifying features.
8. Preservation techniques of some animals for future studies.
9. Collection and identification of fungi from field.
10. Isolation of microorganisms through culture method.
11. Gram staining method for bacterial identification.

Suggested Readings:

1. V. N. Naik. *Taxonomy of Angiosperms*.
2. Heywood. *Families of Flowering plants*.
3. Pandey. *Angiosperms: Taxonomy, Anatomy, Economic Botany & Embryology*.
4. Sing, Jain. *Taxonomy of Angiosperms*.
5. Dr. S. G. Date. *Key to family of Angiosperms*.
6. *Burgey's manual of systematic bacteriology*
7. J. T. Bonner., *Researches on cellular slime moulds: selected papers*
8. Dr. M. G. Watve. *Microbiology: A practical approach*
9. Stanier et al., *General Microbiology*
10. Prescott et al., *Microbiology*
11. Pelczar., *Introduction to Microbiology*
12. Mueller, G.M., Bills, G.F., Foster, M.S. (2004) *Biodiversity of Fungi: Inventorying and monitoring methods*. Elsevier Academic Press Publication.
13. Burgey's manual of determinative bacteriology- 8th edition
14. Biswas, S.B. and Biswas, A (1976) *An introduction to Viruses*. Vikas Publishing House, new Delhi.

At the end of the course student will be able to...

- Understand the biodiversity status and identification techniques
- carry out enumeration of plants and animals using ecological methods
- study the vegetational diversity and know the measure the biodiversity indices of an area
- know the factors influencing the vegetation of a place
- Understand the technique for estimation and assessment of microorganisms.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 804C	Forest Genetics and Tree Improvement	2	-	1	03	100

UNIT: I

Basic genetics principles - genomes and genes, genome structure, genetic code and gene expression, sources of genetic variation, Population genetics – Hardy-Weinberg equilibrium, gene frequencies, factors affecting allele frequencies, inbreeding and forces of evolution.

Mating system of forest trees – Reproductive phenology, flowering, pollination vectors, threats to pollination, incompatibility mechanism, out crossing, selfing, pollen handling, pollen dispersion. Tree Breeding- Variation in trees. Natural variation, Geographic variation. Selection and management, species and provenance selection. Quantitative genetics.

UNIT: II

Seed orchard – types, establishment, management and records; Progeny trials; Genotype – environment interaction; Planning and strategies of a tree improvement programme. Breeding trees for specific purpose (Pest, disease and adverse environment). Species and racial hybridization and its application; Biotechnology for tree improvement; Seed technology and Certification

Practical:

1. Numerical analysis of population genetics questions
2. Plus tree selection
3. Variation analysis in a forest population.
4. Numerical questions on quantitative genetics,
5. Study of pollination system of some tree species.
6. Pollen viability and germination tests.
7. Visitation rate and foraging behavior of Pollinators.
8. Practice of cutting, grafting budding and air layering.

Suggested Readings:

1. Becker, W. A. 1975. *Manual of Quantitative Genetica*. Student Book Corporation, Washington State University, Pullman, Wash.
2. Boulter, S. L., Kitching, R. L., Zalucki, J. M. and Goodall, K. L. 2006. *Reproductive Biology and Pollination in Rainforest Trees: Techniques for a Community-level Approach*. Practical Manual. Cooperative Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC, Cairns, Australia
3. Mandal, A. K. and Gibson, G. L. (eds.) 1998. *Forest Genetics and Tree Breeding*. CBS Publishers and Distributers, New Delhi.

4. White, T.L., Adams, WT. and Neale, DB. 2007. *Forest Genetics* (Winner of a 2009 Outstanding Academic Title (OAT) award) CABI Publishing , Oxfordshire, UK.
5. Wright, J. W. 1976. *Introduction to Forest Genetics*. Academic press, New York.

At the end of the course student will be able to...

- know the concepts and principles of tree improvement and forest genetics.
- understand the quantitative parameters in inheritance and their application
- know the causes of variability existing in trees and in geographic regions and the ways to use them.
- understand the genetic basis of tree breeding and the selection methods practised in forest trees.
- understand and apply the short term and longterm breeding strategies
- manipulate flowering and strategise ways for controlled breeding of trees

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 805C	Forest and Climate change	2	1	-	03	100

UNIT I

Forests and climate change; Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, National action plan on Climate Change of India: aim and objectives. International climate negotiation, UNFCCC, IPCC, CoP :LULUCF, REDD++ and CDM.

Silviculture and sustainability-criteria and indicators for sustainable plantation forestry in India-CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change.

UNIT II

Deforestation and degradation trends at global, national and regional levels. Mega development projects, conservation of native and threatened species, management and rehabilitation plans.

Restoration forestry-silvicultural treatments for habitat restoration, catchment area treatments, Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Carbon sequestration potential of Trees Outside forests (TOFs), homegardens and urban forests.

Suggested Readings:

1. Anderson P and Palik B. 2011. *Silviculture for Climate Change*. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.
2. *Climate Change: Challenges To Sustainable Development in India*. 2008. Research UNIT (Larrdis) Rajya Sabha Secretariat, New Delhi.
3. *Greenhouse Gas Emission from Agricultural System*, Published by IPCC- USEPA *Climate change and global crop productivity* Ed. by K R Reddy and HF Hodges CABI Publishing.
4. IPCC Assessment Report. 2007. *Climate Change Journal Climate Change: Source, Impact and Policy*, Proceeding of 2nd World Climate Conference. Ed. by J Jager and HL. Ferguson, Cambridge University Press.
5. John Houghton. *Global Warming* (4th), Cambridge Press.
6. Robert M, Clausen and Henry L Gholz. *Carbon and Forest Management*. School of Forest Resources and Conservation. University of Florida, Gainesville, FL 32611, USA.

At the end of the course student will be able to...

- Understand the status of global climate change and their mitigation and adaptation measures.
- Develop carbon management strategies.
- Understand different techniques for restoration of degraded land.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 806C	Forest Biotechnology	2	-	1	03	100

UNIT-I

Principles and requirements of plant tissue culture; cellular totipotency, callus and multiple shoot induction, micro-propagation, protoplast isolation and fusion, cybrids, somaclonal variation, single and suspension cell cultures, somatic embryogenesis; meristem culture and virus free plants, haploid production, embryo rescue, acid and salt tolerant plants, artificial seed production and cryopreservation.

Introduction to nucleic acids-DNA and RNA as molecules of life, discovery, structural and functions of DNA, nucleotides and nucleosides; genetic code, replication, transcription and translation of DNA; molecular basis of mutation; chloroplast, mitochondrial and plasmid DNA-structure and functions; PCR, gel electrophoresis, SDS PAGE.

UNIT-II

Principles, tools & techniques in plant genetic engineering/ recombined DNA technology-vector and enzyme mediated transfer of plant genes, structure and function of Ti and Ri plasmids, reporter genes; direct gene transfer-electroporation, particle bombardment, biolistic gun; GMO; genetically modified forest crops-application in improving yield and quality, *Nif* gene in legume and non-legumes, stress tolerance, herbicide & disease resistance in forest crops.

Genetic diversity- concept, analysis of karyotype variation, genetic erosion, Techniques to assess genetic diversity- Molecular approaches to assessing genetic diversity, molecular maps and markers- RAPD, RFLP, AFLP, STS, microsatellites, etc.; Sampling strategies for genetic diversity assessment, sufficiency of sampling procedures, Effects of sampling on genetic diversity, Factor influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Introduction to bioinformatics, biological databases-characteristics and categories.

Practical:

- i) Demonstration of plant tissue culture methods
- i) Preparation of Reagent/stock solutions
- ii) Demonstration of various sterilization technique.
- iii) Preparation of Medium
- iv) Explant preparation
- v) Culture inoculation on culture medium
- vi) Sub-culturing.
- vii) Demonstration on gel electrophoresis

Suggested Readings

1. An Introduction to Plant Tissue Culture, 1st Edition (1992). K.K. De, New Central Book Agency, Kolkata.
2. Introduction to Plant Tissue Culture (2007) M.K. Razdan, India Book House Pvt.

Ltd., New D

3. DNA Fingerprinting in Plants-Principles, Methods and Applications, 2nd Edition (2009), K. Weising, H. Nybom, K. Wolf and G. Kahl, CRC Press (Taylor and Francis Group, Boca Raton (First Indian Reprint, Saurabhi Printers Pvt. Ltd.).
4. Gaston, K.G. (2004). *Biodiversity: an introduction* (2nd edition). Blackwell Science Ltd.
5. Geethabali, R.R. (2002). *Biodiversity: monitoring, management, conservation and enhancement*. APH Publishing, New Delhi.
6. B.G. Glick and J.J.(2001). *Molecular Biotechnology: Principles and applications of Recombinant DNA* (2nd Edition). Pasternak, ASM Press, Washington D.C. (First Indian Reprint, Replika Press Pvt. Ltd., New Delhi).
7. S. Mahesh, (2008). *Plant Molecular Biotechnology*. New Age International Publishers, New Delhi

At the end of the course student will be able to...

- generates knowledge about how we produce sufficient food for the world, to develop renewable fuels and to manage ecosystems in sustainable manner.
- Develop competence and skills to recognize, understand and find solutions to the present challenges of green energy production, natural resource utilization and sustainable development

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 807C	Plantation and Nursery Technology (Skill Course)	1	-	2	03	100

UNIT-I

Plantation forests; Plantation establishment; Planting; Beating up, Choice of species; Intercultural operations; Plantation maintenance; Thinning; Energy and industrial plantation species; Plantation economics.

UNIT-II

Nursery: Importance; Guidelines of good nursery; Certification related to nursery; Use of growth regulators; hardening of plants in nurseries. Propagation Structures Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, nursery (tools and implements)

Practical:

Plantation: Planting- layout, time of planting, planting pattern, spacing, gap filling, planting methods, direct seeding. Enrichment planting, nurse and cover crops. Intercultural operations; Plantation maintenance; Thinning - physiological and mensurational - on stand development. Exercise on Plantation economics.

Nursery:Nursery Record Management; Basics of Propagation; sexual and asexual methods; Nursery techniques. Use of growth regulators in seed and vegetative propagation,; selection and maintenance of mother trees, collection of scion wood stick; Micrografting, hardening of plants in nurseries. Insect/pest/disease control in nursery.Study of tools, materials and operations for establishment of plantations.

1. Site selection and site preparation.
2. Exercises on planting and tending.
3. Study of the special techniques for difficult sites.
4. Exercises on protection of plantations.
5. Exercise on plantation layout.

6. Collection of data for survival and growth performance.
7. Use of fertilizers, weedicides for plantation management
8. Media for propagation of plants in nursery beds, pot and mist chamber.
9. Preparation of nursery beds and sowing of seeds.
10. Raising of rootstock.
11. Seed treatments for breaking dormancy and inducing vigorous seedling growth.
12. Preparation of plant material for potting.
13. Hardening plants in the nursery.
14. Practicing different types of cuttings, layering, graftings and buddings etc.
15. Use of mist chamber in propagation and hardening of plants.
16. Preparation of plant growth regulators for seed germination and vegetative propagation.
17. Visit to a tissue culture laboratory.
18. Maintenance of nursery records.
19. Use of different types of nursery tools and implements for general nursery and bud wood certification.
20. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance.
21. Top grafting, bridge grafting and nursery management.
22. Nutrient and plant protection applications during nursery.

At the end of the course student will be able to...

- Acquire knowledge on different kinds of Plantation in forestry including the choice of species, cultural and tending operations etc.
- know different nursery practices of Forestry species
- Understand the structures viz. green houses, polyhouses, tools etc used in propagation of plants
- Practice artificial regeneration methods for raising forest trees both by seeds and vegetative methods.
- Prepare soil media, raise plants in nursery, use fertilizers, harden the plants and maintain the nursery.
- Apply plant protection measures in case of nursery plants.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 801F	Bio Statistics (preferably MOOC)	4	-	-	04	100
At the end of the course student...						
		Credit Distribution			Total Credit	Marks
		L	T	P		
Sub-Total		18	2	6	26	800

SEMESTER III- 25 Credits (Core Course (C): 21 Credits; Elective Course (E): 4 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 901C	Forest Resource Management and Economics	2	1	-	03	100

UNIT I

Principles and Peculiarities of forest management. Objects and purpose of management. Sustained yield; management and administrative units, Rotations, Normal forest. Estimation of growing stock and increment. Yield regulation, Working Plan Economics of nature of crop; Role of economics in forestry and its limitations in decision-making.

UNIT II

Economics of nature of crop; Role of economics in forestry and its limitations in decision-making. Application of microeconomics in solving forest resource problems. Demand and Supply- Concepts of forest products; Equilibrium point. Utility: concepts; Cost: Cost of production; Production Theory; Utility theory of production and marginal products in forestry. Market: Main features of market; Market of various forest products. Valuation of non-market goods services and economics of multiple-use, Eco-system Analysis; Economic and Financial Analysis of Forestry Projects

Suggested Readings

Davis, L.S. and K.N. Johnson. 1987. *Forest management*. Third Edition. McGraw Hill Book Company, New York. 790 p.

Desai, V. 1994. *Forest management in India - Issues and problems*. Himalayan Publi. House. Bombay. 358 p.

Jerram, M.R.K. 1982. *A textbook of forest management*, International Book Distributor, Dehradun.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxford & IBH.

Osmaston, F.C. 1984. *Management of forests*, International Book Distributor, Dehradun.

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

Ram Prakash. 1986. *Forest management*, International Book Distributor, Dehradun.

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

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

At the end of the course student will be able to...

- Understand the concepts and principles of forest management and their application

- know the concept of rotation and apply sustained yield concepts
- Estimate the increment and growing stock for effective yield regulation in even aged and uneven aged forest crop
- know the concepts and principles of Forest economics
- Understand the valuation techniques and project planning in forestry

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 902C	Medicinal and Aromatic plants	2	-	-	02	100

UNIT I

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India (emphasize will be given on North East India); Importance, origin, distribution, area, production, climate and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements.

Plant protection, harvesting and processing of important medicinal and aromatic plants of North East India. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Post-harvest handling – Drying, Processing, Grading, Packing and Storage, processing: Distillation methods, advanced methods, Solvent extraction process, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations, Institutional support and international promotion of essential oil and perfumery products; Drug adulteration.

UNIT II

Therapeutic and pharmaceutical uses of important Medicinal Plants: *Zanthoxylum*, *Curcuma caesia*, *Saracaasoca*, *Aconitum heterophyllum*, *Panax pseudoginseng* and *Swertiachirata*, *Sugandh mantra*, *Coleus*, Glory lily, Senna, Periwinkle, *Phyllanthus*, *Pyrethrum*, *Cinchona*, *Rauwolfia*, *Dioscorea*, Isabgol, *Aloe vera*, Belladonna, *Solanum viarum*, Mints, *Piper longum*, Ashwgandha, Guggul, Opium poppy, Java Citronella, Lemon grass, Palmarosa, Annatto, Vetiver, Rosemary, Gharu, Scented Geranium, Patchouli, Basil, Artemisia, Thyme, Ambrette, French Jasmine, Tuberose, Lavender and other species relevant to the North East India. Organic cultivation of medicinal plants, GAP for medicinal plants and Institutions involved in medicinal plants promotion, Endangered Medicinal Plants of India specially North East India, Post-harvest management model of commercially important medicinal crops in NER

Suggested Readings:

1. Cultivation of Medicinal and Aromatic Crops. (2004), Azhar Ali Farooqi, B. S. Sreeramu, Universities Press, Hyderabad, India.
2. Hand book of medicinal and aromatic plants: cultivation, utilisation and extraction processes. (2007), Engineers India Research Institute, New Delhi, India
3. Textbook of Medicinal and Aromatic Plants. (2018), Amritpal Singh Saroya, Indian Council of Agricultural Research, New Delhi.
4. Medicinal and Aromatic Crops at a Glance (2017), Mamta Dall, Kapil Sihag, Bhani Ram Dall, Jain Brothers, new Delhi, India.
5. Medicinal and Aromatic Plants with colour plates (2010), R. K. Gupta, CBS Publication and Distributors, New Delhi.

At the end of the course student...

- Students will learn how different ethos identify diseases and then exploit plants to treat them. Currently medicinal plant usage is relatively common, but how that use of medicinal plants is depends on the people where they are used.
- The course emphases on how people in different states use and control herbal medicines. Throughout the course students will learn how to evaluate, claims made of specific plants and herbal supplements. The student will also learn where to find reliable information about medicinal plant and their products.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 903C	Wildlife Management and Eco-development	3	-	1	04	100

UNIT I

Biodiversity and Wildlife. Principles of management, animal-habitat studies, conservation biology, management of animal communities, habitat management. Wildlife Management Plan

Wildlife behavior studies, Man animal conflict, Wildlife census; Captive wildlife; Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972; Forest Conservation Act, 1980; FCA in relevance to Wildlife areas;

UNIT II

Conservation strategy and life support systems, protected area network, agencies for conservation of Wildlife, human dimension, wildlife in managed forests; Eco development in support of conservation & protected area management, animal habitat studies, Scope of eco development, thrust areas in eco development, planning and implementation; Eco development: Macro and micro planning, Case studies

Practical:

1. Field Visits and Field Exercises
2. Audio video Demonstrations
3. Case studies related to man animal conflict, habitat development and biodiversity conservation

Suggested Readings

Berwick SH and Saharia VB. 1995. *Wildlife Research and Management*. OUP, New.
 Dasmann RF. 1982. *Wildlife Biology*.
 Karanth KU and Nichols JD. 2002. *Monitoring Tigers and Their Prey: A Manual for Researchers, Managers, and Conservationists in Tropical Asia*. Bangalore, India: Centre for Wildlife Studies.
 Krebs C and Davis N. 1978. *Introduction to Behavioral Ecology*. Oxford University Press
 Lever C. 1985. *Naturalised Mammals of the World*. John Wiley, London.
 Mills LS. 2013. *Conservation of Wildlife Populations Demography, Genetics and Management* (Ed.2). Wiley-Blackwell.
 Rajesh G. *Fundamentals of Wildlife Management*, Justice Home, Allahabad.
 Reena Mathur. 1985. *Animal Behaviour*. OUP, Delhi.
 Wodroffe G. 1981. *Wildlife conservation and Modern Zoo*. Saiga Publishing Co., England.

At the end of the course student will be able to ...

- understand the principles, practices and the values associated with wildlife and their

management

- know the habitat requirements of different wildlife with respect to their ecology
- familiar with the biological basis of wildlife and will be able to prescribe habitat improvement measures
- manage the wildlife populations and prepare management plans specific to PA's
- understand the reasons for wildlife conflict and manage them
- Know the importance of ecotourism and community participation in wildlife management
- know the policy and acts related to management of wildlife
- know the agencies and their role in wildlife conservation and management

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 904C	Forest Soil & Watershed Management	2	-	1	03	100

UNIT I

Concepts of soil and soil science, Composition of Earth crust and its relationship with soils. Weathering and Soil formation, soil classification; Forest soils – distinguishing features; soil physical and chemical properties; Forest soil organic matter; Decomposition, nutrient cycling.

Soil biota, Soil fertility, Essential plant nutrients, Nitrogen and Carbon cycle; Mycorrhizal associations in forest soils, soil degradation, management interventions of forest soils.

UNIT II

Watershed management- History, Concept, Identification, Objectives and Principles of Watershed Management, Physiographic features of watersheds, ground water recharge, evapo-transpiration and stream flow. Hydrological cycle and characteristics of small and medium watersheds precipitation.

Water resource development, Forest features of hydrologic significance,. Hydrological evaluation of land treatment; water conservation and water harvesting - principles and important techniques, structures – types & design. Sedimentation- sources, estimation, sediment bank treatment techniques.

Suggested Readings

Brady N.C., and Weil R.R. 2007. *The Nature and Properties of Soils*. 14th Ed., Prentice Hall, New Jersey Santhi and Sellamuthu (2008) *Fundamentals of forest soils*, Satish serial publishing house, Delhi.

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

Hewlett, JD and Nutter, WL 1969. *An outline of forest hydrology*. University of Georgia Press, Athens.

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

Murty JVS 1995. *Watershed Management in India*. Wiley Eastern, New Delhi.

Practical:

1. Soil Field Excursion and study on soil profile.
2. Processing of soil samples for analysis, estimation of pH, bulk density, porosity, moisture, texture, nitrogen, phosphorus, potassium, organic carbon and organic matter.
3. Identification of common microorganisms in different ecosystems.
4. Field visit to study various engineering measures for soil and water conservation.
5. Preparation of an integrated watershed development project for a micro/macro watershed in co-ordination with concerned department for identified area.

6. Measurement of slope and identification of contour points in a field with simple and low cost methods.

7. Socio-economic and resource survey for a small watershed.

At the end of the course student will be able to...

- understand the soil types, properties of soils and forest soil fertility evaluation.
- Understanding the technique of soil management
- Acquire knowledge of watershed characteristics and hydrological processes.
- Understand the needs of watershed management

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 905C	Wood Science and Technology	2	-	1	03	100

UNIT: I

Kinds of woods; Wood properties - gross anatomical features of wood, physical features of wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood; natural characteristics affecting mechanical properties of wood, reaction wood, fire performance characteristics of wood. Suitability of wood for various uses; Extractives in wood

UNIT: II

Wood Water relations- Drying/seasoning of Wood, Refractory classes of timbers, Classification of timbers based on durability. Defects of timber- natural and seasoning defects, bio-deterioration of wood, wood preservation; Wood machining. Dimensional stabilization of wood.

Important qualities and examples of structural and specific utility timbers. Composite wood- Plywood, Particle board, Laminated wood, Block board, Fiber board manufacture and utility. Improved wood- compreg, impregnated wood, heat stabilized wood; Synthetic wood technology-Wood plastic composites.

Practical:

1. Different kinds and types of wood available as raw material.
2. Determination of moisture content and shrinkage of different wood species.
3. Determination of specific gravity and bending properties of various wood species.
4. Analysis of biodeterioration of wood, treatment of wood with different preservatives.
5. Collection wood samples of various species and identification of their anatomical features and physical features.
6. Timber identification. Procedures for field identification of timbers.
7. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood.
8. Visit to Saw mill and wood workshops to know the machinery and equipments; storage; various sawn forms.

Suggested Readings:

1. Anon, 1972. *Indian Forest Utilization* Vol 1&2, FRI, Dehra Dun.
2. Anon, 1996. *Wood Preservation Manual*. FAO, Rome
3. Mehta, Tribhawan., 1981. *A handbook of Forest Utilization*. International Book Distributors, Dehra Dun.
4. Rao, K.Ramesh and Juneja, K.B.S, 1992. *Field Identification of fifty important timbers of*

India. ICFRE, Dehra Dun. 123p.

5. Simpson, W.T.1989. *Drying wood: a review. Drying Technology*. An International Journal, Pt. 1, 2(2): 235–265, Pt. 2, 2(3): 353–368.
6. Eaton, R.A.; Hale, M.D.C. 1993. *Wood: decay, pests and protection*. New York, NY: Chapman & Hall.
7. Hunt, G.M.; Garratt, G.A.1967. *Wood preservation*. 3rd Edition. The American Forestry Series. New York, NY: McGraw–Hill.
8. Bodig J and Benjamin AJ. 1993. *Mechanics of Woods and Woods Composites*. Krieger Publish Company.
9. Brown HP. 1925. *An Elementary Manual on Indian Wood technology*. Central Publication Branch, Government of India, Calcutta.
10. Brown HP. 1985. *Manual of Indian Wood Technology*. International Books and Periodicals Supply Service, New Delhi.
11. Hill CAS. 2006. *Wood Modification: Chemical, Thermal and other Processes*. John Wiley and Sons Ltd.
12. Hoadley B. 2000. *Understanding Wood: A Craftsman’s Guide to Wood Technology*. Taunton Press. Newtown, USA.
13. Kollmann FFP and Cote WAJ. 1968. *Principle of Wood Science and Technology*. Vol I, Solid wood. George Allen and Unwin Ltd London, Springer-Verlag, Berlin, Heidelberg, New York.
14. Panshin AJ and De ZC. 1980. *Textbook of Wood Technology*, 4th Ed. McGraw-Hill. New York.
15. Walker, J.C.F., Butterfield B.G., Langrish T.A.G., Harris J.M., Uprichard J.M. 1993. *Primary wood processing-principles and practices*. Chapman and Hall, London.595 pp.
16. Pandey C.N. and Jain V.K. 1992. *Wood Science and Technology*. ICFRE [Indian Council of Forestry Research and Education],FRI, Dehradun.144 pp.
17. Kumar S. and Dev I.1993. *Wood Preservation in India*. ICFRE [Indian Council of Forestry Research and Education],FRI, Dehradun.262 pp.
18. Rajput S.S., Shukla, N.K., Gupta, V.K and Jain J.D. 1996. *Timber mechanics-strength,classification and grading of timber*. . ICFRE [Indian Council of Forestry Research and Education],FRI, Dehradun.189 pp.
19. Thyagarajan C. 2010. *A text book of an insight into wood processing technology*. AWTC, IWST, Bangalore.254 pp.

At the end of the course student will be able to ...

- Understand and identify different kinds and types of wood and their composition.
- Determine the different physical and mechanical properties of wood.
- Practice seasoning of different classes of timber.
- Undertand the defects in wood and the methods to avoid them.
- Practice wood preservation of different types of wood.
- Know the important qualities of specific utility timbers and modified woods like composite and improved wood.

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		

FB 906C/906E	Remote Sensing and Geographic Information System	2	-	2	04	100
<p>UNIT I Satellite remote sensing and recent developments in geomatics, different satellite missions of India and abroad. Spatial and spectral resolution of different data products and applications. Geo-referencing of topo-sheets and satellite imageries, Satellite Image Interpretation, Digital Image Processing (DIP); RS softwares, Application of Remote Sensing in forest resource management.</p> <p>UNIT II: GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information. 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. GIS application in FRM.</p> <p>Practical 1. Thematic layers build up, overlaying and their integration using software package, Interpretation of satellite data and digital image processing. 2. Preparation of thematic maps. 3. Preparation forest biomass and carbon map, fire affected areas assessment, Preparation of change detection map, classification of LULC using softwares.</p> <p>Suggested Readings 1. A Preliminary Overview. <i>Journal of Latin American Geography</i>. BolstadP.2005. <i>GIS Fundamentals: Afirsttexton Geographic Information Systems, Second Edition</i>.WhiteBearLake,MN:EiderPress. 2. Buzai GD and Robinson D. 2010. <i>Geographical Information Systems in Latin America</i>, 1987-2010. 3. Campbell JB and Randolph HW. 2011. <i>Introduction to Remote Sensing</i>. Fifth Edition, The Guild Press, New York. 4. Chang K. 2007. <i>Introduction to Geographic Information System, 4thEdition</i>. McGraw Hill. 5. ElangovanN. 2006. <i>GIS Fundamentals, applications and implementation</i>. New India Publ.Agency, New Delhi. 6. Gurugnanam B. 2009.<i>Geographic Information System</i>. New India Publ. Agency, New Delhi. 7. Harvey and Francis. 2008. <i>A Primer of GIS, Fundamental geographic and cartographic concepts</i>. The Guilford Press. 8. Jackson MJ. 1992. <i>Integrated Geographical Information Systems</i>. International Journal of Remote Sensing. 9. Joseph G. 2005. <i>Fundamentals of Remote Sensing</i>, Second edition. Universities Press. 10. Lillesand TM and Kiefer WR. 1994.<i>Remote sensing and Image Interpretation</i>, Fourth edition. John Wiley & Sons, Inc., USA. 11. Reddy AM. 2014. <i>Text book of Remote Sensing and Geographic Information System</i>. 4th edition, BS Publication, Hyderabad.</p> <p>At the end of the course student will be able to...</p> <ul style="list-style-type: none"> • understand the principles, concepts and application of remote sensing and GIS in forestry and biodiversity 						

- to know the importance of types, scales and resolution of aerial photographs and their interpretation
- to know the satellite based remote sensing with its image processing
- to understand components of GIS with the use and application of spatial and non-spatial data

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 907C	Industrial Attachment (In between 2 nd Sem-3 rd Sem)	-	-	2	02	100
<p>The students will be divided into various groups comprising 5 students per group based. Each group will be attached with a forest based industry/Institutes. After the completion of the attachment, the students should prepare a Report describing the activities exposed to during the period of his/her attachment. Each of the students must make a presentation his/her report in front of the Examiners for final evaluation.</p> <p>At the end of the course student will be able to...</p> <ul style="list-style-type: none"> • develop skills and knowledge of the practical experiences in forest stand management and development • know the ways in which nurseries are managed and the technologies adopted in nursery practices • know the value addition practices of NTFP and other forest resources by their exposure to forest based industries and institutes of repute • know the ecotourism and community participatory practices in forest management • know the wildlife conservation and management practices w.r.t. PA's and Zoos 						
One Elective Course		3	-	1	04	100
Name of the Course		Credit Distribution			Total Credit	Marks
		L	T	P		
Sub-Total		16	1	8	25	800

SEMESTER IV- 18 Credits (Core Course (C): 18 Credits)

Course Code	Name of the Course	Credit Distribution			Total Credit	Marks
		L	T	P		
FB 1001C	Synopsis	-	-	2	2	100
<p>The DRC will allot the supervisors at the end of the 2nd Semester for the Master's Thesis. There can also be a co-supervisor from outside the department if the expertise required is not available within the department.</p> <p>The Synopsis on the thesis should be on a prescribed format and should be forwarded by the Supervisor. The synopsis seminar has to be delivered by the M Sc student before submission of the synopsis in front of the DRC. The date of seminar for project planning and synopsis submission shall be fixed by the Supervisor. The approved problem of research as finalized by the DRC i.e. title of the proposed research and objectives shall be final. If the synopsis is not submitted as mentioned above, the student shall not be allowed to register for Research Credits.</p>						
FB 1002C	Master's Thesis	-	-	14	14	100
<p>Requirements for the M Sc degree shall include successful completion of scientific investigation and creditable research to be submitted in the form of a thesis, which must be an original contribution to knowledge characterized either by the discovery of facts and their significance or by a new interpretation of facts or theories. In either case, it should evince the candidate's capacity for critical examination and sound judgement. The topic of thesis should be distributed among the students from diverse areas of study.</p> <p>Right from the initiation of the project work, each candidate will have to periodically present progress report in form of seminar in addition to regular discussion with the supervisor, which will be considered for Internal Evaluation under FB 1003C: MASTER THESIS SEMINAR before the members of Student Advisor Committee and all the faculty members and students of the Department.</p> <p>The final thesis submitted by the students will be evaluated by an external examiner (from outside the University).</p> <p>A Postgraduate student should submit 3 copies of the thesis and soft copy along with the plagiarism check report duly signed by the candidate and supervisor. Acceptance of the thesis for evaluation shall be governed by the regulation related to plagiarism issued by the UGC from time to time. The HOD will forward the soft copy to the External Examiner at least one week before the date fixed for evaluation by the Examiners. One copy of the thesis shall be kept with the supervisor, second copy will be given to the students and the 3rd Copy will be retained by the HOD. On successful pass of the examination all the thesis shall be sent for uploading in the departmental website.</p> <p>At the end of the course student will be able to...</p> <ul style="list-style-type: none"> • Understand formulate research based on specific problems in Forestry and Biodiversity • know how to prepare hypothesis and ask research questions • Know how to review literature from a specific field of research • Know how to devise methodology based on different studies 						

<ul style="list-style-type: none"> • Know how to carry out research based on suitable statistical methods • Know how to analyse the data w.r.t the data derived • Know how to write the results of the study and discuss w.r.t similar studies • Know how to write the report in the form of dissertation 						
FB 1003C	Master Thesis Seminar	-	-	2	2	100
The student has to deliver a seminar before the DRC, faculty members and students (M Sc and Ph D) of the Department where he/she will make a presentation of the research work including methodology, outcomes, recommendations, conclusions etc as per the date of examination notified by the Controller of Examination, Tripura University.						
			Credit Distribution		Total Credit	Marks
Sub-Total			-	-	18	18
						300

LIST OF ELECTIVE COURSE

Course Code	Elective Course	Credit	
		Theory	Practical
FB 901E	Agroforestry	03	01
<p>UNIT I Definition and concepts of Agroforestry; Agroforestry research and development; Goals, objectives and strategies of National Agroforestry Policy 2014; Classification of agroforestry systems; Benefits and constrains of agroforestry; Agroforestry practices and systems in different agro-ecological zones of India; Shifting cultivation, Taungya, Homegarden, Alley cropping, Plantation crop combinations, Homegarden, Traditional agroforestry systems of northeast India. Characteristics of agro forestry trees; General principles of plant productivity; Component interactions; Concept of allelopathy and its impact on agroforestry; Tree Domestication in Agroforestry; Plant management practices in agroforestry; Forage and fodder production through agroforestry; Resource use-efficiency in agroforestry.</p> <p>UNIT II Nutrient cycling in agroforestry; Land capability classification and land evaluation; Biomass production; Carbon sequestration potential in agroforestry. Phyto-remedial potential of agroforestry. Criteria of an ideal agroforestry design, productivity, sustainability and adoptability; The Diagnosis and Design (D & D) methodology, Field experiments in agroforestry, Ecological basis of Agroforestry, Economic analysis of agroforestry system, Sociocultural considerations, Pest and disease management, Evaluation of agroforestry systems.</p> <p>Practical: 1. Visit to agroforestry sites to study different crop combinations 2. Structural analysis and plant composition in different agroforestry systems 3. Economic evaluation of agroforestry systems 4. Sociocultural evaluation of agroforestry systems 5. Field exercise on plot demonstration showing root distribution of different plants. 6. Identification and characterization of manures and fertilizers.</p>			

7. Effect of different cropping systems on soil erosion and water quality.

Suggested Readings

1. Dwivedi A.P. (1992) Agroforestry: Principles and Practices. Oxford & IBH.
2. Jha, L. K. (2009) Advances in Agroforestry, APH Publishing Corporation, New Delhi.
3. Nair P.K.R., Rai M.R. & Buck LE. (2004) New Vistas in Agroforestry. Kluwer.
4. Nair P.K.R. (1993) An Introduction to Agroforestry. Kluwer.
5. Ong C.K. & Huxley P.K. (1996) Tree Crop Interactions – A Physiological Approach, ICRAF.
6. Young A. (1997) Agroforestry for Soil Management, CABI.

At the end of the course student will be able to...

- Develop the knowledge of agroforestry as a sustainable land use practice
- Explore the potentiality of agroforestry systems
- Develop the ability to understand the tree-crop interaction in agroforestry systems
- To know various agroforestry intervention methods including diagnosis & design methodologies

Course Code	Elective Course	Credit	
		Theory	Practical
FB 902E	Reproductive Biology and Breeding Methods in Forest Trees	03	01

UNIT I

Reproductive biology in forest trees; pollination syndromes; Modes of reproduction and their breeding systems and sex expression. Out-crossing mechanism in forest trees; Environmental effects on sex expression. Floral biology. Initiation and development. Modes of pollination; Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

UNIT II

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes. Long-term and short-term breeding populations. Selective breeding methods; Grading system and regression systems, mother tree selection, subjective evaluation. Selection for different traits.

Genetic testing programmes – mating designs. Improvement through progeny testing; Experimental designs in genetic testing. Breeding methods for wood quality, diseases and pest resistance, drought and salt resistance. Marker assisted selection.

Practical

1. Sex expression in forest trees.
2. Out crossing mechanisms in forest trees.
3. Measurement of pollen flow in wind-pollinated and insect-pollinated species.
4. Pollen viability and fertility.
5. Seed dispersal mechanism.
6. Grading system of plus trees in natural stands.

7. Mating designs

8. Selection for biotic and abiotic stresses.

Suggested Readings

1. Acquaah G. 2012. *Principal of Plant Genetics and Breeding*. John Wiley & Sons, Ltd, UK.
2. Almeida OJG, Cota K Sánchez JH and Paoli AAS. 2013. *The systematic significance of floral morphology, nectaries and sugar nectar concentration in epiphytic cacti of tribes Hylocereeae and Rhipsalideae*(Cactaceae). *Persp. Plant Ecol. Evol. Syst.* 15: 255-268.
3. Barrett SCH. 2006. *Ecology and Evolution of Flowers* [electronic resource]. (Eds.) L.D. Harder SCH. Barrett. Oxford Univ. Press, New York, U.S.A.
4. Bawa KS and Hadley M. 1990. *Reproductive Ecology of Tropical Forest Plants*. UNESCO Man and Biosphere Series.
5. Briggs and Walters SM. 1984. *Plant Variation and Evolution*.
6. CláudiaInês da Silva and Helena Maura TorezanSilingardi. 2006. *Reproductive Biology of Tropical Plants* - International Commission On Tropical Biology and Natural Resources. Encyclopedia of Life Support Systems (EOLSS)
7. Falconer DS and Mackay TFC. 1995. *Introduction to Quantitative Genetics*. 4th edition. Longman, Essex
8. FAO. 1985. *Forest Tree Improvement*, FAO Publication.
9. Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
10. Mandal AK and Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
11. Sedgley and Griffin. 1989. *Sexual Reproduction of Tree Crops*.
12. Spencer C H, Barrett, Robert I, Colautti and Christopher G Eckert. 2007. *Plant Reproductive Systems and Evolution during Biological Invasion*. Wiley Online Library. ([https://doi.org/ 10.1111/ j.1365-294X.2007.03503.x](https://doi.org/10.1111/j.1365-294X.2007.03503.x)).

At the end of the course student will be able to...

- know the concepts and understand the reproductive biology in forest trees
- familiar with the modes of reproduction, the existing breeding systems and sex expression in forest trees
- acquire knowledge on polination mechanisms and the role of pollinators and will understand the pollen handling techniques
- Know the genetic constitution of tree populations with familiarity on gene frequency
- familiar with the selective breeding methods used in natural stands and plantations
- know the genetic testing programmes and experimental designs in genetic testing
- understand the breeding methods/selection methods for specific resistance

Course Code	Elective Course	Credit	
		Theory	Practical
FB 903E	Environmental Impact Assessment	03	01

UNIT I

Elaboration of steps in traditional EIA process; The importance of SEA as a tool for assessing impacts of policy, plan and programmes. Relevance of SEA as a global tool for addressing cumulative, regional and landscape level impacts.Examples of SEA and SEA like approaches from India; Key example of good SEAs from around the world.

Introduction to tools and techniques.

UNIT II

Introduction to some recent approaches of economic valuation of impacts and their application in impact assessment and presentation of case studies. Principles and concepts of offsets, type of offsets, examples of bio-banking and wetland banking and market based mitigation strategies. Comparison of EIA approaches in other countries in South Asia. Life Cycle Assessment Approach in Impact assessment. Impact Assessment for addressing climate change.

Practical:

1. Scoping for Hypothetical or real EIA study
2. Scoping based on scenario projection through visuals (Some select films can be used)
3. Review of EIA Reports and preparing comments for appraisal of project
4. Development of Alternatives based on details available for project planning to ensure least impact option
5. EIA Report writing with case studies
6. Seminar on select topics

At the end of the course student will be able to...

- know the steps and importance of EIA
- Carry out the process of EIA at the landscape level.
- Know the valuation of impacts and their application
- Assess the life cycle and the ways to address climate issues.

Course Code	Elective Course	Credit	
		Theory	Practical
FB 904E	Forest Biology & Tree Physiology	03	01

UNIT I

Plant Nutrients: Mineral nutrients- absorption, translocation and utilization of mineral salts, Nitrogen metabolism, Water relation, Transport and translocation of water and solute, Salt and drought tolerance physiology in relation to production of biomass. Transpiration and osmo-regulation in relation to stress physiology.

Plant biochemistry and metabolism: Photosynthesis: Carbon partitioning, light reactions. General concepts. Organization of light-absorbing Mechanisms of electron transport. The carbon reactions. The Calvin-Benson cycle. Inorganic carbon-concentrating mechanisms: the C₃, C₄ and CAM carbon cycle. The impact of environmental conditions on photosynthesis. Overview of plant respiration. Glycolysis. The citric acid cycle. The oxidative pentose phosphate pathway, mitochondrial electron transport and ATP synthesis. Respiration in intact plants and tissues. Photorespiration.

UNIT II

Growth, development and differentiation: Study of tree structure, study of secondary wood; growth, development and function, Factors affecting growth of trees, Phytohormones- Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic Acid, Phytochrome; their mechanism of action, Role of growth hormones in vegetative propagation. Signaling and integration: auxin and GA, Biosynthesis and elicitors: ethylene and ABA

Reproductive Physiology: Physiology of flowering, Regulation of sexuality, photoperiodism in trees relating to the growth and regeneration, Vernalisation, Physiology of Embryo growth, Fruit Development and Ripening, Seed physiology – Germination and seed dormancy, The mechanism and regulation of seed dormancy and germination, molecular dissection of seed quality, The biophysical basis of seed longevity, Bud dormancy, Abscission and senescence.

Suggested reading:

1. The Embryology of Angiosperm- S. P Bhatnagar, P K Dantu S. S Bhojwani,
2. The Plant Physiology – Ross and Salisbury
3. Textbook of Plant Physiology – C.P. Mallik and A.K. Srivastava, Kalyani Publisher, New Delhi
4. Physiology of Woody Plants – *Dr. Stephen G. Pallardy*, Science Direct
5. Tree Physiology - Meinzer, Frederick C., Niinemets, Ülo; Springer
6. Forest tree Physiology – E. Dreyer, Elsevier

Practical:

1. Separation of Plant pigments by chromatography
2. To study the effect of light intensity (by changing the distance) on the rate of carbon sequestration.
3. To study the effect of light quality on the rate of carbon sequestration.
4. Effect of sodium bicarbonate/temperature/pH on the rate of carbon sequestration
5. Studies on seed viability
6. Effect of water soaking of seeds on germination.
7. Effect of soaking of seeds in salt solution of different molarity on germination.
8. Demonstrate the effect of different chemicals on seed germination.

At the end of the course student will be able to ...

- Generate a brief concept about how the physiological processes are collectively affected or individually interact with environment and regulate the distribution of species on earth.
- Understand growth efficiency of a tree in a particular environment and factors affecting length of growing season of trees.
- Widen the possibilities for scientific management of forest tree species.

M.Sc. FORESTRY AND BIODIVERSITY COURSE CURRICULUM

2015



**DEPARTMENT OF FORESTRY AND BIODIVERSITY
TRIPURA UNIVERSITY (A Central University)
SURYAMANINAGAR, AGARTALA – 799 022
TRIPURA, INDIA**



Department of Forestry and Biodiversity

Code	Name of Course	Credit	Marks
I SEM		16 Credits (Core: 16 Credits)	
FRBD 701C	Silviculture	03	100
FRBD 702C	Forest Biometry	03	100
FRBD 703C	Biodiversity and Conservation	04	100
FRBD 704C	Forest Ecology	03	100
FRBD 705C	Practical approaches in Forestry & Biodiversity- I	03	100
Sub Total		16	500
II SEM		20 Credits (Core: 16 Credits; Compulsory foundation: 4 Credits)	
FRBD 801C	Biosystematics	04	100
FRBD 802C	Forest Genetics and Tree Improvement	03	100
FRBD 803C	Forest Resource Management	03	100
FRBD 804C	Forest and people	02	100
FRBD 805C	Practical approaches in Forestry & Biodiversity II	04	100
CS-II	Basic Computer (Computer Skills- II)	04	100
Sub Total		20	600
III SEM		20 Credits (Core 12 Credits; Elective 04 Credits; Compulsory foundation: 4 Credits)	
FRBD 901C	Forest Soil & watershed management	04	100
FRBD 902C	Forest Genetic Resource Conservation	02	100
FRBD 903C	Field attachment/Field Visit	02	100
FRBD 904C	Master's Research	04	100
FRBD 905E	Reproductive Biology and Breeding methods in Forest trees	04	100
FRBD 906E	Forest Biotechnology	04	
FRBD 907E	Medicinal and Aromatic plants	04	
FRBD 908E	Agroforestry	04	
STAT 704E	Basic Statistics	04	100
Sub Total		20	600
IV SEM		16 Credits (Core: 12 Credits; Elective: 04 Credits)	
FRBD 1001C	Forest Utilization & Forest based Industries	04	100
FRBD 1002C	Policy and legal issues in Forestry & Biodiversity	02	100
FRBD 1003C	Forest Protection	02	100
FRBD 1004C	Master's Research	04	100
FRBD 1005E	Remote Sensing & GIS	04	100
FRBD 1006E	Wildlife management	04	
FRBD 1007E	Forest Biology & Tree Physiology	04	
Sub Total		16	500
Grand Total		72	2200

Syllabus of First Semester

Unit I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India. Major forest types of India –forest composition and structure. Locality factors influencing forest growth and distribution in India. Need for forest conservation. Plant succession, competition and tolerance.

Unit II

Regeneration: Natural regeneration: definition. Advantages and disadvantages of natural regeneration. Techniques of obtaining natural regeneration. Artificial regeneration: definition and objectives, steps involved in artificial regeneration. General nursery techniques Silvicultural Practice: Thinning- ground thinning, silvicultural thinning, cleaning, pruning, girdling etc.

Unit III

Plantation forests. Plantation establishment, site selection. Site preparation. Planting. Choice of species on ecological aspects - afforestation of dry land, wet land, other adverse sites and taungya. Enrichment planting, nurse and cover crops. Intercultural operations. Plantation maintenance. Silvics of important tree species. Distribution, morphology, phenology, growth behavior, silviculture characters, nursery techniques, silvicultural system of management, protection and utilization of some important conifer and broadleaved tree species of India.

Unit IV

Silvicultural systems: Definition and types of silvicultural systems - clear-felling systems, shelter wood systems, selection systems, Indian Irregular shelter wood system, Accessory systems and Coppice systems. Conversion: objectives, scope and methods. Culm selection system in Bamboo.

Suggested reading:

1. Champion, H.G. and Seth, S.K. 1968. *The revised survey of the forest types of India*. Manager of Publication, Govt. of India, Delhi.
2. Dwivedi, A.P. *A text book of Silviculture*. International Book Distributor, Dehra Dun.
3. Khanna, L. 1985. *Principal and practice of Silviculture*. International Book Distributor, Dehra Dun.
4. Negi, S.S. 1985. *General Silviculture*, Natraj Publication, Dehra Dun
5. Prakesh, R. and Khanna, L. S. 1979. *Theory and Practice of Silvicultural Systems*. International Book Distributor, Dehra Dun.

Unit I

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement. Units of measurement, standards of accuracy implied in their expression. Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Calliper, Relaskop, Pentaprism. Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume.

Unit II

Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient. Volume estimation of felled and standing trees and formulae involved.

Unit III

Volume tables-definition and their classification. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Forest Biomass measurement. forest carbon sequestration, emission trading. Determination of age of trees. Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables.

Unit IV

Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry. Use of GPS in forest inventory. Measurement stand density. Simulation techniques. Growth and yield prediction models.

Suggested reading:

1. Avery, T. E. and Burkhart, H. E. 2002. *Forest Measurements*. 5th Edition. McGraw Hill, New York.
2. Beers, T. W. and Miller, C. I. 1973. *Manual of Forest Mensuration*. T & C Enterprises, West Lafayette, IN
3. Chapman, H. H. and Meyer, W. H. 1949. *Forest Mensuration*. McGraw-Hill, New York.
4. Chaturvedi, A. N. and Khanna, L. S. 1982. *Forest Mensuration*. International Book Distributors, Dehra Dun.
5. Hamilton, G. D. 1975. *Forest Mensuration Hand Book*. Her Majesty's Stationary office, London.
6. Husch, B.; Beers, T. W. and Kershaw, J. A. 2003. *Forest Mensuration*. 4th edition. John Wiley and Sons, INC, Hobokon, New Jersey.

Unit I

Basic concepts of biodiversity, Biodiversity- definition, levels and types; Factors promote high diversity, latitudinal and altitudinal gradients of biodiversity; biodiversity extinctions; biodiversity values-evolutionary, economic, social, cultural and intrinsic values, threats to biodiversity-Indian context, important threatened/endemic plant and animal taxa of India, biodiversity and ecosystem services; Climate change and biodiversity; Biodiversity of Indian subcontinent: biodiversity hotspots, their characteristic flora and fauna, Biodiversity resources of north-east India, threatened vascular plant species in India; Threatened categories, biological invasions and Biodiversity, Biodiversity and Biotechnology, Biopiracy.

Unit II

History of biodiversity conservation; Biodiversity conservation strategies: *in situ* conservation: Biosphere reserve, sanctuaries, national parks, *ex situ* conservation: botanical garden, zoological garden, *in vitro* conservation: germplasm or gene bank, tissue culture; Global approaches to biodiversity conservation, Indigenous approaches to biodiversity conservation, biodiversity & ethnomedicinal resources, Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), Plant Varieties Protection and Farmer's Rights Act, 2001, National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas in India, ecological sensitive zone; important protected areas of north east India; biodiversity conservation in North East India/Tripura- problems and prospects ethnobotany in the conservation of plant genetic resources; traditional knowledge digital library (TKDL).

Unit III

International programmes for biodiversity conservation, convention on biological diversity (CBD), CITES, ITTA, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands, Cartagena Protocol on Bio-Safety 2000 (CPB); The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal, The Montreal Protocol, IPR.

Unit IV

Phytogeography and zoogeographical regions, Introduction of species, Theories of distribution, Endemism, Community concept; Community composition, qualitative and quantitative characters of community; methods of studying vegetation; Techniques for survey and assessment of endangered and threatened plant species, species diversity and stability relationship; Diversity indices, Plant and animal communities in forest, grassland, desert and mangrove ecosystems; high altitude communities; zonation and stratification of plant and animal communities,

Suggested Readings:

1. Gaston, K.J and Spicer, J.I. 2004. *Biodiversity: An Introduction*. Blackwell Publishing Company, USA.
2. Richard. B. Primack. 1998. *Essentials of conservation biology*. Sinauer Associates, Inc. USA.
3. Maiti P.K. and Maiti P. 2011. *Biodiversity Perception, Peril and Preservation*. PHI Learning Private Limited, New Delhi.
4. Ray S. and Ray A.K. 2010. *Biodiversity and biotechnology*. New central book Agency (P) Ltd. Kolkata.

5. Agarwal, S.K. 2002. *Biodiversity conservation*. Rohini Publishers, Jaipur.
6. Nautiyal, S and Kaul, A.K. 1999. *Forest Biodiversity and its conservation Practices in India*. Oriental Enterprises, Dehradun.
7. Ian. F. Spellberg. 1992. *Evaluation and Assessment for Conservation*. Chapman Hall, London, UK.
8. David, E.B. and Joel, T.C., 2003. *Monitoring Ecosystems*. Island Press, Washington, DC
9. Stanley, A.H., 2002. *Managing our wildlife resource*. Prentice-Hall, USA.
10. Benson, E.E., 1999. *Plant conservation Biotechnology*. Taylor and Francis Ltd. London.
11. Agrawal, K.C., 2000. *Wildlife of India: Conservation and Management*. Nidhi Publishers, India
12. Sinha, P.C., 1998. *Wildlife and forest conservation*. Anmol Publication Pvt. Ltd, New Delhi.
13. Edward, O.G., 2004. *Ex situ plant conservation*. Island Press, Washington, DC

FRBD 704C

Forest Ecology

Credit: 3

Unit I

Forest and forest environment: Structure of forest ecosystem; forest microclimate; Major forest types of the world; forest types and forest cover of India with special reference to North East India; tree cover of India.

Unit II

Ecophysiology of forest trees: Characteristic of tropical trees; shoot growth in forest trees; phenology of trees; forest seed dormancy and germination; regeneration ecology of forest trees.

Unit III

Forest Ecosystem Function & Dynamics: Primary productivity of forest ecosystems; methods of measurement; productivity patterns; litter production and decomposition; nutrient cycling and nutrient conservation strategies; forest hydrology; Measurement of forest productivity; Ecological Succession; Forest disturbances; Forest fragmentation,

Unit IV

Forest ecosystem management: History of forest management in India; joint forest management; forest fire; plantation forestry; application of remote sensing technique in forest ecology; deforestation and approaches to forestry conservation; Changing climate and their impact on forest and soil health.

Suggested readings:

1. Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998). *Forest ecology* (4th edition). John Wiley and Sons
2. Burton V. Barnes, Donald R. Zak, Shirley R. Denton, Stephen H. Spurr. 1998. *Forest Ecology*. John Wiley & Sons

3. Champion, H.G. and Seth, S.K. (1968). *A revised survey of the forest types of India* (Reprinted 2004). Natraj Publicaiton, Dehradun.
4. FSI (2009). *State of forest report 2009*. Forest Survey of India, Dehradun.
5. Kimmins, J.P. (2004). *Forest ecology* (2nd edition). Pearson Education.
6. Ravindranath, N.H. (2004). *Joint forest management in India*. Oxford University Press.

FRBD 705C Practical approaches in Forestry & Biodiversity- I Credit: 3

(Based on Biodiversity and Conservation)

1. Plant/Tree/Wild Life enumeration in protected area/ National Parks/ Wild life sanctuaries.
2. Ecological census techniques- wild animal census.
3. Determination of minimal quadrat size by the species area curve methods.
4. Study of vegetation by Line transect/belt transect/quadrat methods.
5. Determination of frequency/Density/Abundance of vegetation.
6. Determination of minimum number of quadrat to be laid down in the field under study.
7. Measurement of Different Biodiversity Indices (Simpson's Biodiversity Index, Shannon's index, Brillouin index)
8. Study of vegetation of the given area by physiognomic method – Biological spectrum method.
9. Estimation of plankton frequency in the aquatic system.

(Based on Forest Ecology)

1. To determine the community structure of a forest stand.
2. To determine the biomass (AGB) of tree species by allometric method
3. To calculate the dry matter turnover rate and turnover time of different plant components by using provided data.
4. To determine the litter accumulation/decomposition in a forest stand.
5. To study the community structure of wetland ecosystem
6. To study the structure of agroforestry ecosystems

(Based on Silviculture and Forest Biometry)

1. Acquaintance with various technical terms.
2. Study of site factors like climatic, edaphic, physiographic and biotic.
3. Study of phenology and leafing pattern of trees.
4. Study of forest succession.
5. Visits to different forest areas/type/selected forest areas of the state.
6. Measuring the diameter, girth and height of trees by different methods.
7. Calculations of volume of felled as well as standing trees.
8. Volume table preparation
9. Determination of age of trees.
10. Determining the basal area of the stand.
11. Preparation of yield and stand table.
12. Handling of GPS

Syllabus of Second Semester

FRBD 801C Biosystematics

Credit: 04

Unit I

UNIT-I Plant Taxonomy and Diversity

Introduction: Concept of species, variation; Theory of plant taxonomy- Introduction to major plant groups and evolutionary relationships, History of plant taxonomy, Code of nomenclature, Systems of classification and their application, Biosystematics with use of ecology, palynology; Identification-Morphology of major plant groups (Bryophytes, Pteridophytes, Gymnosperms, Angiosperms), Study of identification characters, Study of important plant families of flowering plants, Use of taxonomic literature, herbaria, cultures and databases; Documentation and dissemination- Collection and preservation techniques, Recording information in field and laboratory, Photography, Illustration, Description of species, Referencing and citation, Preparation of keys, reports, Computerized database generation for dissemination

Unit II Animal Taxonomy and Diversity

Introduction- Principles and rules of Taxonomy, Zoological nomenclature, ICZN regulations, Taxonomical hierarchy (Linnean hierarchy), Concepts of Taxon, holotype, paratype, topotype etc.; Classification of Animal kingdom, Brief classification of animals up to class level for invertebrates, Brief classification of animals up to order level for vertebrates and minor phyla, Concept of phylogeny, Use of Taxonomic Keys for Identification of the animal specimen with emphasis on ; Amphibians, Reptiles, Fresh water mollusca, Insects.

Unit III Microbial Taxonomy and Diversity-I

Microbial diversity- Magnitude, occurrence and distribution, Outline classification of microorganisms; Fungi- Criteria for classification and identification, Types of vegetative forms, Types of spores, fruiting bodies, life cycles, Outline classification, Taxonomic keys, Identification keys, Species databases and identification software.

Unit IV Microbial Taxonomy and Diversity-II

Bacteria- Concept of species, Criteria for classification, Morphology in Actinomycetes, Cyanobacteria and Myxobacteria, Biochemical characterization- enteric bacteria, Serotyping, Phage typing, Major classes of bacteria of ecological, agricultural and environmental importance; Viruses- Outline classification; Chemical and biochemical methods- Cell wall composition analysis, Lipids and Fatty acid profile analysis, Protein profiles and isozymes analysis; Micro-organisms in extreme environments.

Suggested Readings

V. N. Naik. *Taxonomy of Angiosperms*.
Heywood. *Families of Flowering plants*.

Pandey. *Angiosperms : Taxonomy, Anatomy, Economic Botany & Embryology.*
 T. Cooke. *Flora of Bombay Presidency.*
Flora of Maharashtra. Botanical Survey of India.
 Talbot. *Flora of Bombat Presidency and Sind.*
 Sing, Jain. *Taxonomy of Angiosperms.*
 Dr. S. G. Date. *Key to family of Angiosperms.*
 M. A. Smith., *The fauna of British India (Reptilia and Amphibia- Vol. -III, Serpentes*
 Salim Ali., S. D. Ripley., *Handbook of birds of India and Pakistan (Vol. I, II, III)*
The MacDonaldd encyclopedia of Butterflies and Moths
 Salim Ali, S.D.Ripley, *A pictorial guide to the birds of Indian subcontinent.*
 S.H Prater, *The book of Indian animals*
 Preston et al., *Primates of the world*
 Kotpal, *Arthropoda*
 Kotpal., *Khetrpal., Invertebrata*
 Ashlock., *Principles of Animal Taxonomy*
 Burgey's *manual of determinative bacteriology- 8th edition*
 Burgey's *manual of systematic bacteriology*
 J. T. Bonner., *Researches on cellular slime moulds: selected papers*
 Dr. M. G. Watve., *Microbiology: A practical approach*
 Stanier et. al., *General Microbiology*
 Prescott et. al., *Microbiology*
 Pelczar., *Introduction to Microbiology*

FRBD 802C

Forest Genetics and Tree Improvement

Credit: 03

Unit I

Introduction, history and development of tree improvement, its relation to other disciplines for forest management. General concept of forest tree breeding, tree improvement and forest genetics. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding. Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees. Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races. Species and provenance trials in forest trees.

Unit II

Genetic basis of tree breeding; Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses. Progeny and clone testing. Seed orchards – type, functions and importance. Pollen handling; forced flowering for seed orchard manipulation. Vegetative propagation and tree improvement. Seed, seed formation, dispersal, storage, stratification and seed dormancy.

Unit III

Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties. Manifestation and

fixation of heterosis. Species and racial hybridization. Examples. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-Weinberg law, null hypothesis, Wohlund's Principle. Mutation breeding. Conservation of forest tree germplasm.

Unit IV

Biotechnology in tree improvement. Biotechnology: principles and techniques; Isolation, purification and quantification of DNA/RNA from plant materials. Application of molecular biotechnology in forest tree improvement: *In vitro* selection, transgenic Plants, Disease and Insect resistance etc., *In Vitro* and Micro-propagation techniques of forest trees: Somaclonal variation, Protoplast fusion, Embryo rescue, Artificial seeds, Haploid culture, Cryopreservation and *In Vitro* storage of plant materials. Recent techniques in tree improvement. Vegetative propagation and tree improvement. Economics of tree breeding. 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.

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

FRBD 803C

Forest Resource Management

Credit: 03

Unit I

Introduction: definition and scope. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section. Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Concept of Economic rotation- rotation of max. NPV Land Expectation Value (Faustman's formula). Normal forest: definition and concept.

Unit II

Evenaged and unevenaged models. Estimation of growing stock, density, quantity and increment. Yield regulation – general principles of even aged and unevenaged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees. Working Plan – definition, objects and necessity. Economics of nature of crop: Economics of monoculture, mosaic and mixed culture, species choice Protection, harvesting etc. Role of economics in forestry and its limitations in decision-making.

Unit III

Demand: Theory of demand; essential elements of demand; demand for forest products; demand schedule; elasticity of demand. Supply: Concepts; law of supply; essential elements of supply; supply of forest products; supply schedule; elasticity of supply. Equilibrium point. Utility: Basic concepts and definition; concepts of total and marginal utility; law of diminishing marginal utility: The indifference curve and indifference map. Consumption possibility line. Cost: Cost of production; i.e. concept of real, opportunity and money cost; total, average, and marginal cost.

Unit IV

Production Theory: Concepts of total, average and marginal products. Production function and laws of return i.e. increasing, constant and diminishing returns. Utility theory of production and marginal products in forestry. Market: Main features of market; Forms of market-Perfect, imperfect, monopoly market. Types of competition in the market. Market of various forest products. Valuation techniques. Project Planning, Evaluation and Analysis.

Suggested Readings

Davis, L.S. and K.N. Johnson. 1987. *Forest management*. Third Edition. McGraw Hill Book Company, New York. 790 p.

Desai, V. 1994. *Forest management in India - Issues and problems*. Himalayan Publi. House. Bombay. 358 p.

Jerram, M.R.K. 1982. *A textbook of forest management*, International Book Distributor, Dehradun.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxford & IBH.

Osmaston, F.C. 1984. *Management of forests*, International Book Distributor, Dehradun.

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

Ram Prakash. 1986. *Forest management*, International Book Distributor, Dehradun.

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

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

FRBD 804C Forest and people

Credit: 02

Unit I

Forests in rural development, 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 ecophilosophy, Forest and employment generation.

Unit II

Afforestation programmes and forest conflicts, wildlife and human conflicts, People's movement in forest conservation, Gender dimension of forest management, Pastoralists and their dependence on forests, Forest laws/policies and their effect on people, Forestry extension.

Unit III

Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, participation of local people in ecotourism, land use change and forestry.

Unit IV

Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, Social forestry programme, micro-level planning and participatory rural appraisal. Global environmental change and land use; poverty alleviation and forests, role of NGOs and other community based organizations 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.

FRBD 805C

Practical approaches in Forestry & Biodiversity- II

Credit: 04

Taxonomy - Field Methods -Morphology of major groups (Bryophytes, Pteridophytes, Gymnosperms and Angiosperms), Study of leaf and flower morphology, Study of fruits, Expected abilities: field identification of at least 100 species and identification up to family level for all common plants in the study area), Surveys, collection and preservation of different plant groups.

Identification using reference material, Visits to herbaria, gardens, culture collections, Photography and illustration in field and laboratory conditions Use of computers in analysis, documentation and dissemination of information. Morphology of Insects, Classification of insects (all major orders using key), Use of taxonomic literature and visit to local fish market for identification, morphometry, Methods of dry and wet preservation of animals, Dry preservation of insects for taxonomic studies, Study of traps

Taxonomy - Lab Methods- Cultivation and isolation of microorganisms, Nutritional requirements, Growth media and cultivation, Pure culture isolation, Enrichment, Maintenance and culture collection, Species databases, Methods of cultivation and characterization of Protozoa, Molecular methods of taxonomy and numerical taxonomy, Visit to culture collection centers

Tree Improvement: Floral biology & phenological observations in some important species. Manipulation of flowering through hormones. Estimation of pollen sterility and viability. Controlled pollination and pollen handling. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Recording observation in provenance trial of some important species-recording variation & working out coefficient of variation. Selection of superior phenotypes. Visit to species, provenance and progeny trials. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Induction of polyploidy through colchicine treatment.

Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forest products. Exercises on financial and economic appraisal of forest projects. Exercises on marketing of forest products and international trade competitiveness. Visits to different Forest areas including rural and Urban Forests and carry out exercises for planning and management.

Syllabus of Third Semester

FRBD 901C: FOREST SOIL AND WATERSHED MANAGEMENT

4 CREDITS

UNIT I

Forest soils – distinguishing features - soils and vegetation development, physical and chemical properties- Types and properties of soils under different forest ecosystems. Forest floor - Organic horizons- litter dynamics- humus – types- organic matter decomposition- mineralization and immobilization of organic matter- nutrient cycling significance of C:N ratio, soil pH.

UNIT II

Forest soil biology - soil fauna - nitrogen fixation – legume & non-legume symbiosis, nitrification and denitrification in forest ecosystems. Mycorrhizal associations in forest soils. Nursery soils, problem soils, mineral nutrition, acidic deposition effects, and management interventions of forest soils.

UNIT III

History of watershed management, Definition, Concept, Types, Characteristics, Priority Watershed Concept and their Identification, Objectives and Principles of Watershed Management, Attributes of water yield, rate regime, quality. Physiographic features of watersheds, soil water storage– pore space, available water, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water recharge, evapo-transpiration and stream flow. Hydrological cycle and characteristics of small and medium watersheds precipitation. 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. Forest features of hydrologic significance. Hydrological processes affected

by forest lands – storage and drainage, overland flow, erosion and sedimentation. Hydrological evaluation of land treatment.

UNIT IV

Forest Management and water yields. Stream zone management– temperature– buffer strips. Soil conservation in India – problem, programmes and achievements. Land management problems in India. Soil survey and capability maps – agronomical practices and land management, rotational grazing, dry land farming. Soil and water conservation and water harvesting - principles and important techniques, structures – types & design. Sedimentation- sources, estimation, sediment bank treatment techniques.

Suggested Readings

- Baumer 1989. Agroforestry for watershed management. ICRAF, Kenya
- Brady N.C., and Weil R.R. 2007. *The Nature and Properties of Soils*. 14th Ed., Prentice Hall, New Jersey, 980p.
- Dhruva Narayana VV 1993. Soil and water conservation research in India, ICAR, New Delhi
- Dutta SK. 1986. *Soil Conservation and Land Management*. International Book Distributors, Dehra Dun.
- Fisher R.F. and Binkley D. 2000. *Ecology and Management of Forest Soils*. John Wiley & Sons, Inc. New York, 489p.
- 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.
- Hewlett, JD and Nutter, WL 1969. An outline of forest hydrology. University of Georgia Press, Athens.
- Moorthy VVN. 1990. *Land and Water Management*. Kalyani Publishers.
- Morgan 1984. Soil Conservation. Nataraj Pub, Dehra Dun.
- Murty JVS 1995. Watershed Management in India. Wiley Eastern, New Delhi.
- 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.
- Satterlund, DR. 1972. Wildland watershed management. The Ronald Press Company, New York.
- Tisdale, L.S., Nelson, L.W. and Beaton, J.D. 1985. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York

FRBD 902C: FOREST GENETIC RESOURCE CONSERVATION 2 CREDITS

UNIT I

Overview: Basic Concepts: Definitions, Characteristics of forest genetic resources, Species diversity; Value and Importance of Forest Genetic Resources: Economic value, Environmental value, ecosystem services and resilience, Social, cultural, medicinal and scientific value, Preserving options for future development and adaptation; Conservation of Forest Genetic Resources: Management systems in the field (*in situ* and *circa situm* conservation), *Ex situ* conservation, Targeted species-based approach; Knowledge and Information on Forest Genetic

Resources; Drivers of Change: Drivers of change and trends affecting forest genetic resources; Global forest trends affecting forest genetic diversity

UNIT II

Current and emerging technologies: Trait-Based Knowledge of Tree Genetic Resources- Indigenous and traditional knowledge Classical tree improvement, Participatory tree domestication; Modern Advances-Population genetics based on molecular markers, Genomic advances, Combining molecular tools with tree improvement: marker-assisted selection, Genetic modification; Application of Genetic Knowledge in Forest Conservation: Combining spatial analysis with genetic markers to prioritize, conservation, Research on climate change and forest genetic resources, Genetic technologies for reducing illegal logging Characterization of Genetic Variability and Monitoring of Change.

UNIT III

State of forest genetic resources conservation and Management: Status of Forest Genetic Resources in India; Major Threats to Forest Genetic Resources; National Programmes for the Conservation and Management of Forest Genetic Resources: *Role of the organizations/Institutes in the Conservation of Forest Genetic Resources*; present level of production and use of genetically superior propagules; Management of Forest Genetic Resources; future requirements for superior propagules; Research and Development of Forest Genetic Resources: *National policies and legislations*- access to genetic resources; *National FGR conservation strategies*; *International collaboration and future initiatives*; Status of Medicinal Plants in India: Conservation and cultivation strategies for medicinal plants, Bamboo Diversity in India.

UNIT IV

Need for collection and conservation of germplasm, Strategies for conservation, *In situ* FGR conservation and management: Protected areas, *In situ* conservation outside protected areas, Formal *in situ* FGR conservation programmes, Forest restoration and FGR, Opportunities from climate change initiatives: restoration and connectivity for *in situ* FGR, *In situ* conservation through sustainable forest management; *Ex situ* conservation; genetic improvement and breeding programmes germplasm delivery and deployment: Uses of germplasm and plant materials, Demand for germplasm and planting materials, Actors involved in production, distribution and deployment, Production of germplasm and planting materials, Movement and transfer of genetic material, Information management in delivery and deployment of germplasm, International assistance; Institutional Framework for Conservation and Management of Forest Genetic Resources; Needs, challenges and required responses for the future: practices and technologies for improved management of forest genetic resources.

Suggested Readings

FAO, 2014 *The State of the World's Forest Genetic Resources*. Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of The United Nations. 276p.

FAO. 2007. *The State of the World's Animal Genetic Resources for Food and Agriculture*, edited by Barbara Rischkowsky & Dafydd Pilling. Rome.

FAO. 2015. *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*, edited by B.D. Scherf & D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome (available at <http://www.fao.org/3/a-i4787e/index.html>).

FRIM, Bioversity International and APAFRI, 2008 Forest Genetic Resources Conservation and Management: Proceedings of the Asia Pacific Forest Genetic Resources Programme (APFORGEN) National Coordinators Meeting and International Tropical Timber Organization (ITTO) Project PD 199/03 Rev.3 (F) Update, Dehradun, India, 15–16 April 2006 / editors L.T. Hong and H.C. Sim

State of Plant Genetic Resources for Food and Agriculture in India (1996- 2006): A Country Report. 2007. National Bureau of Plant Genetic Resources, (Indian Council of Agricultural Research), New Delhi. 70p

FAO, 2003. *State of the World's Forests 2003*; and to FAO, 2001. *Global Forest Resources Assessment 2000 (FRA 2000)*. FAO Forestry Paper No 140. Official information can also be found at the FAO Internet site (<http://www.fao.org/forestry/Forestry.asp>).

Puzone L & Th. Hazekamp 1996. Characterization and Documentation of Genetic Resources Utilizing Multimedia Database. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. Plant Genetic Resources, Documentation and Information Management. NBPGR, New Delhi.

Paroda RS & Arora RK. 1991. Plant Genetic Resources Conservation and Management Concepts and Approaches. IPGRI Regional office for South and South Asia, New Delhi.

Singh BP. 1993. Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management. Indo-US PGR Project Management.

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. Guide Book for Genetic Resources Documentation. IPGRI, Rome, Italy.

FRBD 903C: PROJECT-I- FIELD ATTACHMENT/FIELD VISIT 2 CREDITS

Field attachment/ Field Visit will be carried out as approved by the BPGS.

FRBD 904C: MASTER'S RESEARCH 4 CREDITS

The Students will be allocated a particular Research Topic by the respective mentor and the student has to prepare a research proposal and initiate the work by carrying out literature survey etc. The final submission of the completed Masters Research will be evaluated and submitted in the 4th/Final Semester.

FRBD 905E: REPRODUCTIVE BIOLOGY AND BREEDING 4 CREDITS **METHODS IN FOREST TREES**

UNIT I

Reproductive biology in forest trees – anthesis and pollination – their importance and application of reproductive biology in tree breeding; Modes of reproduction: sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecy and its evolution. Out-crossing

mechanism in forest trees; Environmental effects on sex expression. Floral biology. Initiation and development.

UNIT II

Modes of pollination; Self and out-crossing. Dimorphism, pollination mechanisms, Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Fertilization in hardwood and softwood species. Seed dispersal and gene flow.

UNIT III

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes. Long-term and short-term breeding populations. Selective breeding methods- mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, subjective evaluation. Selection for different traits.

UNIT IV

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. Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection. Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance. Tree improvement case histories. Calculating gene and genotype frequencies. Flow chart for different breeding methods.

Suggested Readings

- FAO. 1985. *Forest Tree Improvement*, FAO Publication.
- 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.

UNIT I

Principles and requirements of plant tissue culture; cellular totipotency, callus and multiple shoot induction, micro-propagation, protoplast isolation and fusion, cybrids, somaclonal variation, single and suspension cell cultures, somatic embryogenesis and PLBs; meristem culture and virus free plants, haploid production, embryo rescue, acid and salt tolerant plants, artificial seed production and cryopreservation.

UNIT II

Introduction to nucleic acids-DNA and RNA as molecules of life, discovery, structural elucidation and functions of DNA, nucleotides and nucleosides; synthesis, genetic code, transcription and translation of DNA; molecular basis of mutation; chloroplast, mitochondrial and plasmid DNA-structure and functions; PCR, gel electrophoresis, blotting techniques, SDS PAGE, DGGE/TGGE, genome sequencing-protein and nucleotides.

UNIT III

Principles, tools & techniques in cloning and plant genetic engineering/ recombinant DNA technology-vector and enzyme mediated transfer of plant genes, structure and function of Ti and Ri plasmids, reporter genes; direct gene transfer-electroporation, particle bombardment, biolistic gun; GMO; genetically modified forest crops-application in improving yield and quality, *Nif* gene in legume and non-legumes, stress tolerance, herbicide & disease resistance in forest crops.

UNIT IV

Genetic diversity- concept, analysis of karyotype variation, genetic erosion, Techniques to assess genetic diversity- Molecular approaches to assessing genetic diversity, molecular maps and markers- RAPD, RFLP, AFLP, STS, microsatellites, SCAR, SSCP, SNPs, QTL, ITS, etc.; Inventory and monitoring biodiversity, Sampling strategies for genetic diversity assessment, sufficiency of sampling procedures, Neutral allele model and optional allocation of sampling efforts. Effects of sampling on genetic diversity, Factor influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Global and local limitation for biodiversity conservation. Introduction to bioinformatics, biological databases-characteristics, categories, sequence analysis - pair wise and multiple sequence alignments, phylogenetic analysis, predicting structure and function of gene and proteins; Online biological databases-Catalogue of life, NCBI Entrez, EBI, DDBJ, Swiss Prot, Tree Genes, etc

Suggested Readings

An Introduction to Plant Tissue Culture, 1st Edition (1992). K.K. De, New Central Book Agency, Kolkata.

Introduction to Plant Tissue Culture (2007) M.K. Razdan, India Book House Pvt. Ltd., New D
DNA Fingerprinting in Plants-Principles, Methods and Applications, 2nd Edition (2009), K. Weising, H. Nybom, K. Wolf and G. Kahl, CRC Press (Taylor and Francis Group, Boca Raton (First Indian Reprint, Saurabhi Printers Pvt. Ltd.).

Gaston, K.G. (2004). *Biodiversity: an introduction* (2nd edition). Blackwell Science Ltd.

Geethabali, R.R. (2002). *Biodiversity: monitoring, management, conservation and enhancement*. APH Publishing, New Delhi.

B.G. Glick and J.J.(2001). Molecular Biotechnology: Principles and applications of Recombinant DNA (2nd Edition). Pasternak, ASM Press, Washington D.C. (First Indian Reprint, Replika Press Pvt. Ltd., New Delhi).

S. Mahesh, (2008). Plant Molecular Biotechnology. New Age International Publishers, New Delhi

FRBD 908E: AGROFORESTRY

4 CREDITS

UNIT I

Definition and concepts of Agroforestry; Agroforestry research and development; Classification of agroforestry systems; Benefits and constraints of agroforestry; Agroforestry practices and systems in different agro - ecological zones of India; Shifting cultivation, Taungya, Homegarden, Alley cropping, Plantation crop combinations, Homegarden, Social forestry, Other agroforestry systems and practices.

UNIT II

Multipurpose tree species and their characteristics suitable for agroforestry; General principles of plant productivity; Component interactions; Concept of allelopathy and its impact on agroforestry; Tree Domestication in Agroforestry; Plant management practices in agroforestry; Forage and fodder production through agroforestry; Resource use-efficiency in agroforestry.

UNIT III

Soil Productivity and Protection; Nutrient cycling in agroforestry; Soil organic matter; Nitrogen fixation; Soil conservation; Land capability classification and land evaluation; Biomass production; Carbon sequestration potential in agroforestry; Agroforestry and environmental conservation.

UNIT IV

Criteria of an ideal agroforestry design, productivity, sustainability and adoptability; The Diagnosis and Design (D & D) methodology, Field experiments in agroforestry, Ecological basis of Agroforestry, Economic analysis of agroforestry system, Sociocultural considerations, Evaluation of agroforestry systems.

Suggested Readings

Dwivedi A.P. (1992) Agroforestry: Principles and Practices. Oxford & IBH.

Jha, L. K. (2009) Advances in Agroforestry, APH Publishing Corporation, New Delhi.

Nair P.K.R., Rai M.R. & Buck LE. (2004) New Vistas in Agroforestry. Kluwer.

Nair P.K.R. (1993) An Introduction to Agroforestry. Kluwer.

Ong C.K. & Huxley P.K. (1996) Tree Crop Interactions – A Physiological Approach, ICRAF.

Young A. (1997) Agroforestry for Soil Management, CABI.

Syllabus of Forth Semester

Objective

To provide knowledge about bio-resources derived from the forests and equip the students regarding forest based industries and how it is affecting the economy of the country.

Theory**UNIT I**

Non-Timber Forest Products (NTFPs) definition and scope Importance and nomenclature of non-timber forest produce (NTFP) – importance in state, national and International economy. Role of NTFP in industrial economy, as a source of revenue- NTFP for sustainable forestry- Trade and development of NTFP in India- Characteristics of NTFP- Policy and legal issues- Management requirements – research needs.

Methods of survey of NTFP –classification, collection, processing and methods of utilization of fibres, flosses, grasses, bamboo, canes, reed, fibres, oil seeds, nuts, rubber, medicinal plants, charcoal, lac and shellac, Katha and Bidi leaves – collection of fatty oils and waxes – nature and chemistry of essential oils, oleoresins, gums, resins etc. and their collection; processing and disposal.

UNIT II

Environmentally sound forest harvesting practices; logging and extraction techniques and principles, transportation system, storage and sale. Need and importance of wood seasoning and preservation; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. Anatomical structure of wood, defects and abnormalities of wood, timber identification – general principles.

Composite wood; adhesives-manufacture, properties, uses, plywood manufacture-properties, uses, fibre boards-manufacture properties, uses; particle boards manufacture; properties uses. Present status of composite wood industry in India in future expansion plans. Pulp-paper and rayon; present position of supply of raw material to industry, wood substitution, utilization of plantation wood; problems and possibilities.

UNIT III

Tannin and dye extraction – importance of medicinal plants – various types and classes – economic parts- extraction and isolation of active principles- edible plants – miscellaneous NTFP – animal products and mineral products. Use of wood of lesser known forest species for commercial purposes.

Importance of forest based industries in relation to Indian economy. Katha and catch. Description of different forest based industries.

UNIT IV

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood – water and organic soluble solvent. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth). Chemistry in relation to forest products. Chemical nature and uses of volatile oils, tannins, Chemical nature and uses of important forest based dyes and pigments.

Suggested Reading

- Gupta T., Gularia A. 1992. *Non Wood Forest products in India: Economic Potentials*. Oxford and IBH publishing Co. New Delhi.
- Mishra T.K, Banerjee, Pal, D.C. 2004. *An Omnibus of Non-Timber forest products of India, Prashant Gahlot at Valley*. Offset Printers and Publishers, Dehra Dun.
- Nautiyal S and. Kaul A.K. 2003. *Non-Timber Forest Products of India*. Jyothi Publishers and Distributors, Dehra Dun.
- 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.

FRBD 1002C

Policy and legal issues in Forestry & Biodiversity

Credit: 02

Objective

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

Theory

UNIT I

Forest Law: legal definition. Objects of special forest law. National Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988; National Environmental Policy 2006; National Eco tourism Policy

UNIT II

General principles of criminal law; Indian Penal Code, criminal procedure code; Indian evidence act applied to forestry matters. Forest laws; Indian Forest Act –1927 with recent amendments; Forest Conservation Act 1980 and Rules, Important Forest Rules and Guidelines.

UNIT III

Wildlife Protection Act 1972 with recent amendments, Biodiversity Act 2002, Plant Varieties Protection and Farmer's Rights Act 2001, The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006; Case Law.

UNIT IV

Brief description about other major forest policies & laws of regional, national and international significance. Traditional land and forest management procedures and customary laws, Intellectual Property Right and bioresource patenting. Important case studies and landmark judgments. National Green Tribunal.

FRBD 1003C

Forest Protection

Credit: 02

Unit 1

Definition, Principles of forest protection; factors affecting forest health; kinds of forest protection measures; history of forest protection in India. Important diseases of forests and their management.

Unit II

Concept of disease, sign & symptoms & Koch's postulates. Bacteria as an agent of tree disease. Fungi as an agent of tree disease; Biodegradation of wood-microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration; Role of Mycorrhiza in tree health.

Unit III

Insect-plant relationship, population dynamics of forest insects, Insect feeding groups; Insect pests of important forest tree species. Theories of natural regulation of insect populations.

Unit IV

Protection against injuries by Man, Animal, Insects, Diseases, plants and adverse climatic factor; Timber salvage operations; Plant quarantine, Integrated Pest Management.

Suggested reading

Agrios, G.N., 2005. Plant Pathology. Elsevier Academic Press, USA.

Bakshi BK, 1976 Forest Pathology. Controller of Publication, GOI.

Jha LK and Sen Sarna PK, 1994. Forest Entomology. Ashish Publ. House

Manion PD. 1991. Tree Diseases Concept. Prentice Hall.

Khanna, L.S., 1982. Foest Protection. Khanna Bhandu, Dehradun.

Pedigo, L.P., 2002. Entomology and Pest Management, Prentice-Hall of India, New Delhi.

FRBD 1004C

Master's Research

Credit: 04

Chang, Kang-tsung. 2002. Introduction to Geographic Information Systems. New Delhi: Tata McGraw-Hill Publishing Company Limited.

DeMers, Michael N. 2000. Fundamentals of Geographic Information Systems (2nd Ed.) (Wiley Student Edition). New York: John Wiley & Sons, Inc.

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

Jensen, J.R. (2006): Remote Sensing of the Environment: An Earth Resource Perspective (2nd Ed.), Prentice Hall, New Jersey, 608pp.

Konecny, G. (2003): Geoinformation: Remote sensing, Photogrammetry and Geographic Information Systems, Taylor & Francis, London, 266pp.

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

Lillesand, T.M., Kiefer, R.W., and Chipman, J.W. (2007): Remote Sensing and Image Interpretation (6th Ed.). Wiley, New Jersey, 804pp.

Morgan, D., and Falkner, E. (2001): Aerial Mapping: Methods and Applications (2nd Ed.), CRC Press, Boca Raton, Florida, 216pp.

FRBD 1006E

Wildlife management

Credit: 04

Unit 1

Principles and practices of wildlife management; Forest and wildlife management in India; History of Wildlife in India; Values of Wildlife : Ethical, cultural, scientific, economical, aesthetic & negative values; Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids;

Unit II

Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Zoogeographical regions (Animal Distribution) and biomes of the world; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Wildlife census; Habitat Improvement: Food, Water, Shelter improvement; Captive wildlife: Zoos and safari parks, Captive breeding for conservation, Central zoo authority of India

Unit III

Population Management: Capture, handling, bio-telemetry, reintroduction, prey-predator relationship; Species conservation projects: lion, elephant, rhino, crocodile, musk deer etc. Wildlife Management plan for Protected Areas; In-situ and Ex-situ management/ conservation

Unit IV

Man-animal conflict and its management; Red data book and IUCN; Wildlife Ecotourism: sustainable tourism and people's participation; Agencies in wildlife conservation: IUCN, CITES, WWF, IBWL; Community participation in wildlife management; Case studies; Wildlife policies and legislation, Wildlife (Protection) Act, 1972

Suggested reading

Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.

Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.

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

International Zoo Books, Published by New York Zoological Society, New York

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

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

Mathur R. 1985. Animal Behaviour. Oxford University Press

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

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

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

Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.

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

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

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

FRBD 1007E

Forest Biology & Tree Physiology

Credit: 04

Unit I: Plant Nutrients

Mineral nutrients- absorption, translocation and utilization of mineral salts, Nitrogen metabolism, Water relation, Transport and translocation of water and solute, Salt and drought tolerance physiology in relation to production of biomass. Transpiration and osmo-regulation in relation to stress physiology.

Unit II: Plant biochemistry and metabolism

Photosynthesis: Carbon partitioning, light reactions. General concepts. Organization of light-absorbing Mechanisms of electron transport. The carbon reactions. The Calvin-Benson cycle. Inorganic carbon-concentrating mechanisms: the C₃, C₄ and CAM carbon cycle. The impact of environmental conditions on photosynthesis. Overview of plant respiration. Glycolysis. The

citric acid cycle. The oxidative pentose phosphate pathway, Mitochondrial electron transport and ATP synthesis. Respiration in intact plants and tissues. Photorespiration.

Unit III: Growth, development and differentiation

Study of tree structure, growth, development and function, how these are related to the environment and to cultural practices, Factors affecting growth of trees, Phytohormones- Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic Acid, Phytochrome; their mechanism of action, Role of growth hormones in vegetative propagation. Signaling and integration: auxin and GA, Biosynthesis and elicitors: ethylene and ABA

Unit IV: Reproductive Physiology

Physiology of flowering, Pollen Biology, Regulation of sexuality, photoperiodism in trees relating to the growth and regeneration, Vernalisation, Physiology of Embryo growth, Fruit Development and Ripening, Seed physiology – Germination and seed dormancy, The mechanism and regulation of seed dormancy and germination, molecular dissection of seed quality, The biophysical basis of seed longevity Bud dormancy, Abscission and senescence.

Suggested reading:

The Embryology of Angiosperm- S. P Bhatnagar, P K Dantu S. S Bhojwani,

The Plant Physiology – Ross and Salisbury

Textbook of Plant Physiology – C.P. Mallik and A.K. Srivastava, Kalyani Publisher, New Delhi

Physiology of Woody Plants – *Dr. Stephen G. Pallardy*, Science Direct

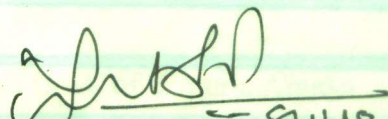
Tree Physiology - **Meinzer**, Frederick C., **Niinemets**, Ülo; Springer

Forest tree Physiology – E. Dreyer, Elsevier

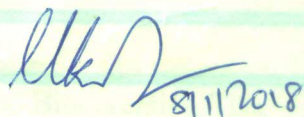
Proceedings of the 4th BPGS, Dept. of Forestry & Biodiversity held in the Chamber of the Head, Dept. of Forestry and Biodiversity, Tripura University on 8th Jan., 2018 at.

Members present:

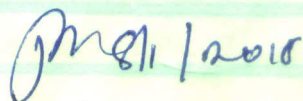
1. Dr A.K. GUPTA,


8/1/18

2. Prof. M.K. Singh


8/1/2018

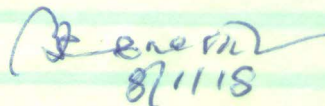
3. Priyaranjan Chakraborty


8/1/2018

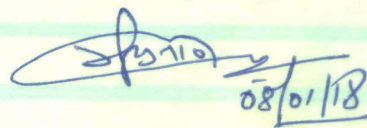
4. Rakesh Kumar Singh


8/1/18

5. Bimal Debnath


8/1/18

6. Dr. Sabyasachi Dasgupta


08/01/18

PROCEEDINGS OF THE 4th MEETING OF THE BOARD OF POST GRADUATE STUDIES OF THE DEPARTMENT OF FORESTRY AND BIODIVERSITY, TRIPURA UNIVERSITY

Venue: Department of Forestry and Biodiversity

Date: 08/01/2018

Time: 12:30 Hrs.

Members present:

1. Head, Department of Forestry and Biodiversity, Chairman
2. Dr A K Gupta IFS, PCCF (HoFF), Tripura Forest Department, Govt. of Tripura, Aranya Bhawan, Gurkhabasti, Agartala, Tripura., External Member
3. The Dean, Faculty of Science, TU., Special Invitee
4. Prof. R K Sinha, Department of Botany, TU., Member
5. Prof. Priyasankar Chaudhuri, Department of Zoology, TU., Member
6. Dr. Thiru Selvan, Assistant Professor, Department of Forestry and Biodiversity, TU., Member
7. Dr Bimal Debnath, Assistant Professor, Department of Forestry and Biodiversity, TU., Member

Agenda 0. Confirmation of Proceedings of the 3rd BPGS

Resolution: Approved

Agenda 1. To finalise the syllabus for Ph. D programme.

Resolution: Following courses has been finalized.

Course name	Title	Content
Research methodology-1	Research methodology-I	<ul style="list-style-type: none">• Approved as such. (Annexure-1)
Research methodology-2	Research methodology-II	<ul style="list-style-type: none">• Review and critics of published research in the field of forestry and biodiversity, training, fieldwork, communication skill etc.- will be finalized by respective RAC.
Advance area of research in the subject (Annexure-II)	Course 1: Biodiversity and biotechnology	<ul style="list-style-type: none">• Courses should be applied in Nature and Focus on local issues/species. Syllabus be
	Course 2: Forest Biology & Tree Physiology	

	Course 3: Silviculture	<p>prepared and circulated for taking the observation of the members present. The syllabus is approved subject to confirmation by the members.</p> <ul style="list-style-type: none"> • Thrust area of research to be finalized for the department and circulated among the members present in the meeting.
	Course 4: Tree improvement	
	Course 5: Forest ecology	
	Course 6: Advances in agroforestry	
	Course 7: Environmental impact assessment	
	Course 8: Ecosystem goods services and valuation	
	Course 9: Conservation ecology and sustainable development	
Seminar/Practical/Project & Assignment etc.	To be decided according to need of RAC	<ul style="list-style-type: none"> • Approved as such.

Agenda 2. To report the Modified Departmental Research Committee for research scholars.

Resolution:

In accordance with Rules and Regulations for Ph. D Programme-2016 the Departmental Research Committee (DRC) for the Department of Forestry and Biodiversity, Tripura University is approved as follows:

- | | |
|---|-------------|
| 1. HOD, Department of Forestry and Biodiversity, Tripura University | Chairperson |
| 2. Dr Sabyasachi Dasgupta, Associate Professor, Department of Forestry and Biodiversity, Tripura University | Member |
| 3. Dr Bimal Debnath, Assistant Professor, Department of Forestry and Biodiversity, Tripura University | Member |
| 4. Dr Sourabh Deb, Assistant Professor, Department of Forestry and Biodiversity, Tripura University | Member |
| 5. Dr Thiru Selvan, Assistant Professor, Department of Forestry and Biodiversity, Tripura University | Member |

Agenda 3. Approval of recommendation of RAC regarding changes in the synopsis of Mr Chiranjit Paul, Research Scholar of Dr Bimal Debnath, Assistant Professor, Department of Forestry and Biodiversity.

Resolution:

Approved the change in synopsis as recommended by the RAC of Mr Chiranjit Paul, Research Scholar of Dr Bimal Debnath, Assistant Professor, Department of Forestry and Biodiversity.

Agenda 4. To initiate MOU with Forest Department for allotment of land for Research trials and permanent plot monitoring station.

Resolution:

Recommended that there may be a MOU with the Department of Forest, Govt. of Tripura. It is suggested that the proposal be submitted through the competent authority of the University.

Agenda 5. Finalization of external paper setters/examiners/evaluators for M.Sc. and Ph D programme and list of subject experts.

Resolution:

External paper setters/examiners/evaluators for M.Sc. is approved as submitted. List of subject experts submitted is withdrawn.

Agenda 6. To finalise eligibility for admission to Masters and Ph D programme and the degree to be awarded.

Resolution:

Agenda is dropped. However, it was suggested to prepare the case in detail with supporting documents by the department.

Agenda 7. Miscellaneous

- Possibility of declaring Forestry as professional Degree and keeping one semester for Master's Thesis.
- Accreditation of courses and Department with ICFRE.

Resolution:

Agenda is dropped till the decision made on the agenda-6.



Chairman, BPGS,
Department of Forestry and Biodiversity,
Tripura University,