

DEPARTMENT OF FORESTRY

Program Outcomes

Following completion of P.G. the students will have a comprehensive overview of Forestry. The student fraternity will be acquainted with the fundamental concepts in the discipline of Forestry. Cardinal focus is on Silviculture, Forest Mensuration, Forest Protection, Forest Ecosystems, Ecosystem Services, Forest Working Plans, Forest Management, Wood Chemistry, Forest Industries, Wildlife and Conservation Biology, Forest Utilization, Forest Bio-energy, Medicinal Plants, Forest Biotechnology etc.

The students will learn about biodiversity assessment, population structure studies, forest mensuration (tree measurements), biochemical (carbohydrate, protein, and lipid estimation), proximate analysis of biomass, biofuel synthesis, preparation of concoctions and decoctions, phytochemical and biochemical assays etc. which will enable them to have a sound practical foundation.

Special papers such as Forest Bio-energy, Forest Biotechnology and Medicinal & Aromatic plants will enable students to comprehend research problems from a higher perspective, besides setting the foundation for futuristic research. The 72 credit course will be conducive for students aspiring for competitive examinations such as NET, IFS (UPSC), Forest Services (state public service commission) etc.

Program Specific Outcomes

- 1) Students will have a very strong foundation pertaining to reconnaissance surveys and field surveys
- 2) Students will be able to conduct biodiversity assessment studies in a particular area
- 3) Students will have some foundation in Plant Taxonomy
- 4) Students will have some foundation in biochemical assays

- 5) Specific courses such as Forest bioenergy will enable students to have hands on training on biomass characterization, biomass processing, biochemical conversion (biodiesel synthesis) and thermo-chemical conversion (pyrolysis) etc.
- 6) Specific courses such as Medicinal & Aromatic Plants will enable students to scientifically document plants with therapeutic potential (inventory), preparation of medical concoctions, and decoctions, anti-microbial and phyto-chemical assays etc.
- 7) Papers as mentioned in Point No 5 & 6 would furnish a suitable platform to the aspirants for pursuing doctoral research in the specific (aforementioned) as well as allied disciplines.

Courses offering employability

Course Name	Course No	Activities having direct bearing on employability/entrepreneurship/skill development	Year of introduction
Forest Bio-energy	FS-403. B	Students opting for this paper coupled with M.Sc dissertation work will learn the below mentioned. Feedstock selection and characterization, Biomass processing, Selecting suitable conversion technologies, Biodiesel synthesis, Pyrolytic bio-oil synthesis, Fuel property assessment, Life cycle assessment, Anaerobic digestion (Bio-gas) etc. They will have knowledge on “Waste to Wealth” technology in lines parallel with the up-coming bio-refineries. This will serve as an incremental step in enhancing their employability in the biofuel industry and biomass processing plants.	2016 (in continuum)

DEPARTMENT OF FORESTRY
COURSE STRUCTURE FOR M.Sc. PROGRAMME
TOTAL CREDIT: 72, TOTAL MARKS: 1800

Total Marks=1800		Credit=72	
Semester	Course No.	Course Title	Course Outcome
I	FS-101	Silviculture	Students will have in-depth idea about Silviculture and its scope. They will learn about the forest ecosystems, forest regeneration, silvicultural systems in addition to the Silviculture of Indian trees
	FS-102	Forest Mensuration	The students will have in-depth knowledge of the scope of forest mensuration, tree height measurements, measurement of weight and biomass, GIS and Remote Sensing in Forestry based operations
	FS-103	Forest Management	The students will learn about the objectives of forest management and its scope, forestry organizations and their role in management of forest resources, forest certification, forest organization, yield regulations, forest working plans, private, public and commercial plantations etc.
	FS-104	Forest Products and Their Utilization-Chemistry and Industry	The students will learn about the various types of forest industries such as paper industry, match industry, sports industry, furniture industry etc. they will be able to perform SWOT analysis of the industrial forestry sector following completion of their course. They will also learn about various products of commerce from the forest sector such as resins, dyes, gums, pigments, katha, catch etc. Timber and non-timber based products have been specially taken into consideration in this paper in addition to lesser known timber species.

	FS-105	Practical - I and Field Study	Students will learn about various sampling techniques. They will be able to use a GPS, and interpret visual and digital images. They will have in-depth knowledge about cell wall components besides extraction procedures of the same (basically essential oils, resins, tannins etc). They will be able to identify important tree species and also assess their utility index
II	FS-201	Forest Ecology	Students will learn about the core concepts in Ecology. They will have in-depth knowledge on forest ecosystem, forest diversity indices, genetic diversity, forest productivity, forest types, ecological succession etc.
	FS-202	Biodiversity Conservation	The students in this paper will learn about the core concepts in biodiversity, biodiversity levels, ecosystem diversity etc. They will have sound knowledge on hotspots, national parks, wildlife sanctuaries etc. Additionally, they will have in-depth knowledge on climate change, biodiversity conventions, ecosystem services, germplasm conservation, quarantine laws and genetic exchanges, Intellectual Property Rights etc.
	FS-203	Forest Resource Management and Economics	The student will have knowledge on production economics, micro-economics, market and marketing, capital in forests, forest god valuation, international trade in forest products, forest certification, financial and economic consideration etc.
	FS-204	Forest Protection and Integrated Pest Management	The student will have in-depth idea about the diseases of forest trees and their management. They will be acquainted with Integrated Pest Management approaches for dealing with pest infestations.

			Forest fires, wood degradation, weed management, wildlife damage to plantations etc. are some of the other thrust areas in this paper.
	FS-205	Practical - II and Field Study	This paper will furnish practical knowledge on measurement of biomass productivity, vegetation analysis, pest-specimen collection approaches, assessment of forest community structure, biodiversity indices, herbarium preparation etc.
III	FS-301	Forest Policy, Laws and International Conventions	This paper will acquaint the student fraternity with the various policies undertaken by the Ministry of Environment, Forest and Climate Change in addition to various international conventions (specifically addressing the biodiversity issues)
	FS-302	Forest Biotechnology and Tree Improvement	This paper will enable students to learn the various plant breeding techniques. The students will be taught to carry out mutation breeding. Biotechnological (tissue culture, molecular biology and genetic engineering) approaches for tree improvement will be further dealt in this paper.
	FS-303	Wood Science and Technology	The students will learn about the structure, properties and chemical composition of wood. They will learn about the various wood seasoning and wood preservation techniques. They will be further acquainted with the various wood biomass conversion techniques (destructive distillation, pyrolysis, bio-refining etc.). The students will have solid foundation on energy and commercial forestry upon completion of this paper.
	FS-304	Practical-III and Field Study	This paper will furnish practical knowledge on properties of wood, ultimate and proximate analysis of woody biomass, wood boring

			insect (identification and collection), preparatory breeding experiments, plant genetics experiments and software usage in data analysis for forestry based operations/studies.
IV	FS-401	Forest and People	This paper will educate the student fraternity about the importance of forests, socio-economic benefits of forest resources, livestock economy, various afforestation programs, man-animal conflicts, tribal economy, forest rights, eco-tourism, community based forest management etc.
	FS-402	Wildlife and Conservation Biology	This paper will provide in-depth knowledge to the students about the basics of wildlife, its significance, and the various diseases of wild animals, community participation in wildlife management, ecological monitoring, eco-development, wild life census and wildlife trade. The paper will additionally provide knowledge on various conservation projects undertaken by the Central Govt.
	FS-403	*CBCP A. Medicinal and Aromatic Plants	This special paper deals with many important aspects in Medicinal Plants such as documentation of plants with therapeutic potential, natural products, good collection practices, high value bio-actives from plants and their extraction. The paper also deals with the ethnobotany and ethnomedecine. Alternative therapy such as aromatherapy have been given special importance in this paper.
		B. Forest Biotechnology	This paper focuses specifically on the applied aspect of modern forestry. Upon completion of this paper the students will have an in-

			depth understanding of the core concepts in Plant Biotechnology & Genetic Engineering and their implications in the forestry sector. Additionally, the paper also focuses on Intellectual Property Rights (IPR).
		C. Forest Bio-energy	This special paper will provide in-depth knowledge to the student on the core concepts of Bio-energy. The student will learn about biomass production (commercial & energy forestry approaches), biomass stock assessment studies, biomass/feedstock selection and characterization, approaches to convert solid biomass to liquid and gaseous fuels, biomass value addition, platform bio-refineries etc.
	FS-404	Project Work and Dissertation Seminar	The project dissertation work will enable the student fraternity to learn about the various research/experimental approaches used in the subject domain. The dissertation work besides providing the fundamental concepts in the specific subject area will furnish a solid platform for futuristic doctoral research.
*A student will select any one of the choice based credit papers offered by the Department in the 4th Semester.			

DEPARTMENT OF FORESTRY
COURSE STRUCTURE FOR M.Sc. PROGRAMME
TOTAL CREDIT: 72, TOTAL MARKS: 1800

Total Marks=1800			Total Credit=72	
Semester	Course No.	Course Title	Credit	Marks
I	FS-101	Silviculture	4	100
	FS-102	Forest Mensuration	4	100
	FS-103	Forest Management	4	100
	FS-104	Forest Products and Their Utilization-Chemistry and Industry	4	100
	FS-105	Practical - I and Field Study	4	100
			20	500
II	FS-201	Forest Ecology	4	100
	FS-202	Biodiversity Conservation	4	100
	FS-203	Forest Resource Management and Economics	4	100
	FS-204	Forest Protection and Integrated Pest Management	4	100
	FS-205	Practical - II and Field Study	4	100
			20	500
III	FS-301	Forest Policy, Laws and International Conventions	4	100
	FS-302	Forest Biotechnology and Tree Improvement	4	100
	FS-303	Wood Science and Technology	4	100
	FS-304	Practical-III and Field Study	4	100
			16	400
IV	FS-401	Forest and People	4	100
	FS-402	Wildlife and Conservation Biology	4	100
	FS-403	*CBCP D. Medicinal and Aromatic Plants E. Forest Biotechnology F. Forest Bio-energy	4	100
	FS-404	Project Work and Dissertation Seminar	4	100
			16	400
*A student will select any one of the choice based credit papers offered by the Department in the 4 th Semester.				

[FS-101]: SILVICULTURE

Unit-1: Definition, history and scope of silviculture, status of forest cover in India with special reference to the state of Nagaland, major forest types of India and their distribution, Locality factors- climatic, edaphic, physiographic, biotic and their interactions. Forest ecosystem-significance, succession, competition and tolerance.

Unit-2: Forest regeneration: Natural and artificial, techniques of obtaining regeneration by seeds and coppice, regeneration survey in the forest, reforestation and afforestation, nursery management. Tending operations

Unit-3: Silvicultural System-definition, scope and classification. Silvicultural systems: Clear felling systems, Shelter wood systems, Selection systems, Accessory systems, Coppice systems, Conversion and its implications. plantation techniques in difficult areas (arid, coastal, hilly, water logged, cold deserts, ravines, saline/alkaline areas, sand dune areas, mining areas, salt affected sites, landslide prone areas)

Unit-4: Silviculture of Indian trees- origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economical importance of important conifer and broad leaved tree species of India with special reference to species of Nagaland.

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. Baldwin, H. I. 1942. *Forest Tree Seeds of the North Temperate Region*. Periodical Experts Book Agency, New Delhi.
3. Negi, S. S. 1998. *Forest Tree Seeds*. International Book Distributors, DehraDun.
4. Prasad, R. and Kandya, A. K. 1992. *Handling of Forestry Seeds in India*. Association Publishing Company, New Delhi.
5. Verma, M. M.; Arora, N. and Mirakhur, R. K. 1990. *Seed Analyst Manual*. Lad Computer Services Pvt. Ltd, New Delhi.

[FS-102]: FOREST MENSURATION

Unit-1: Introduction, definition, objectives and scope of forest mensuration, scales of measurement, unit of measurement, standards of accuracy. Measurement of tree diameter and girth: objectives, standard rules governing breast height measurement, measurements using rulers, callipers and tapes, relation between girth and diameter, Bark thickness measurement.

Unit-2: Tree height measurements- methods of measurement-ocular, non-instrumental and instrumental methods, height measurement of leaning trees, instruments used, principles involved and sources of error, Tree stem form, Volume measurement- felled trees and standing trees, volume table classification, methods of preparation.

Unit-3: Measurement of weight and biomass- factors affecting weight. Yield table- kinds of yield tables, preparation of yield tables. Determination of age of the trees, tree growth measurements, increment-determination of increment, CAI &MAI, increment percent, stump analysis, stem analysis and increment boring. Forest inventory- types of enumeration, sampling methods, sampling intensity.

Unit-4: Use of remote sensing and Geographical Information System (GIS) in forest inventory. Land use land cover mapping and change detection, Unsupervised, supervised and hybrid classifications. Application of Normalized Difference Vegetation Index (NDVI) forest health mapping. Importance of various satellites, sensors and resolutions in forestry. Application of GPS in forestry

SUGGESTED READING

1. Avery, T. E. and Burkhardt, 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. Hamilton, G. D. 1975. *Forest Mensuration Hand Book*. Her Majesty's Stationary office, London.

[FS-103]: FOREST MANAGEMENT

Unit-1: Objective, scope and principle of forest management. Forestry organizations and their role in managing India's forest, Productive and protective management, tangible and intangible aspects of management, management strategies according to old and new forest policies, stand structure and dynamic. Management of private forests *vis a vis* public forestry. Joint forest management in India, developing and developed world strategies for forestry

Unit -2: Forest organization: geographical and climatic (ecological) classification, administrative (organizational) classification and management classification. Concept of sustainable forest management. Criteria indicators for sustainable forest management. Forest certification. **Unit-3:** Yield regulation: principles, objects and definitions. Sustained yields, rotation principles and practices, growing stock and increment (CAI and MAI), yield prediction and regulation in different forests (even-aged and uneven aged), Different methods of yield predictions (Von-Mental's formula and its modification; Manson's method, Brandis method) and their merits and demerits.

Unit-4: Forest working plan and working schemes, working plan organization, annual plan of operations, division of forest areas, preliminary working plan report (P.R) and W.P maps, general format of W.P. Forest valuation and appraisal in regulated forests. Management of forest plantations and commercial forests, forest cover monitoring.

SUGGESTED READING

1. Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford and IBH.
2. Dwivedi AP. 1993. A Text Book of Silviculture. International Book Distributors, Dehradun.
3. Kathiresan, 1986. Essentials of Forest Management. Natraj Publishers, Dehra Dun.
4. Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
5. Pulparambil, J. 2002. Forest Management-an HRD Approach. Uppal Publishing House, New Delhi.

[FS-104]: FOREST PRODUCTS AND THEIR UTILIZATION – CHEMISTRY AND INDUSTRY

Unit-1: Importance of forest based industries in relation to Indian economy with special reference to the state of Nagaland, chemistry of forest products, forest products and chemical engineering, impact of anthropogenic activities forest products

Unit-2: Scientific basis for selecting, handling, seasoning, surfacing, finishing, preserving, and converting wood into valuable products, Description of different forest based industries with special emphasis on paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, Use of wood of lesser known forest species for commercial purposes, non-wood forest products, future of forest based industries, concept of a forest biorefinery.

Unit-3: Constituents of eukaryotic cell wall with special reference to plant cell wall, chemical composition, structure and biological function of cellulose, hemicelluloses, pectin and lignin, methods of analysis of lignocellulosic biomass- ultimate and proximate analysis, thermal analysis of biomass, general concept of biomass conversion extraneous components of wood – soluble in water and neutral organic solvent, extraction of wood components

Unit-4: Biological and economic aspects of pine trees concerning the chemical industry, chemical composition of oleoresin (volatile and non-volatile terpenes) from major pine species, pine oleoresin products and market survey, structural difference among different gums, chemical nature and uses of volatile/essential oils, extraction of essential oils, tannins, production of katha and cutch, chemical nature and uses of important forest based dyes and pigments

SUGGESTED READING

1. Dwivedi A. P. 1993. Forestry in India, Surya Publications
2. Krishnamurthy T. Minor Forest Products of India. Oxford & IBH
3. Mehta T. 1981. A Handbook of Forest Utilization, Periodical Expert Book
4. Agency

[FS-105]: PRACTICAL - I AND FIELD STUDY

- 1) Application of sampling procedures
- 2) Handling of Global Positioning System
- 3) Measurement of height and diameter of individual tree
- 4) Visual and digital image interpretation
- 5) Estimation of cell wall components
- 6) Extraction of essential oils, resins, tannins etc
- 7) Identification of some important tree species and their utility Index
- 8) Field visit to a wildlife sanctuary

[FS-201]: FOREST ECOLOGY

Unit-1: Concept of forest ecosystem, Significance of forest, forest ecosystem structural and functioning, forest diversity indices (alpha diversity, beta diversity, gamma), Genetic Diversity; Gene pools, Genetic drift, Basics of diversity; phenotypic and genotypic variations, ecological niche, Forest community composition and methods used for measuring forest composition.

Unit-2: Forest productivity: Energy capture and trophic structure, Food chain and Food web, Ecological pyramid Forest biogeochemistry with emphasis on carbon and nitrogen cycling in tropical forest, Water movement in forest (hydrological cycle). Forest biomes: Desert -cold and hot deserts, grass lands, tidal forests, wetland secondary forests, terrestrial and aquatic ecosystem. **Unit-3:** Forest types in India, Principles and establishment of herbaria and arboreta. Nutrient cycling in forest: nutrient uptake, retention and return, source of nutrients. Nutrient input (wet, dry and weathering), accumulation and return through litter fall, organic matter decomposition, nutrient release and output through runoff and leaching, nutrient conservation strategies in forest. **Unit-4:** Primary and secondary succession, succession and autogenic changes in environment, Classical models of succession, seral and climax concept, Forest disturbances; Forest fragmentation, role of disturbance on forest structure and function, Forest degradation and restoration; Causal factors for degradation, factors affecting forest recovery patterns, acceleration of recovery, case studies of forest recovery patterns in India

SUGGESTED READING

1. Kimmins, J.P. 2004. *Forest Ecology: A foundation for sustainable management*. 3rd Edition. Prentice Hall. Upper Saddle River, NJ. ISBN: 0-02-364071-5.
2. Thomas, P.A. and Packham, J.R. 2007. *Ecology of woodlands and forests*. Cambridge University Press. Cambridge, UK. ISBN: 978-0-521-54231-9.
3. Warning, R.H. and Running, S.W. 2007. *Forests Ecosystems*. 3rd Edition. Elsevier Academic Press. San Diego, CA. ISBN: 978-0-12-370605-8
4. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, environment and resource conservation. Anamaya Publishers, New Delhi

[FS – 202]: BIODIVERSITY CONSERVATION

Unit-1: Concept of biodiversity; biodiversity at genetic, species and ecosystem levels. Ecosystem diversity in India with special focus on forest ecosystems, Importance of biodiversity at Global and National level, Conservation of natural resources (Biodiversity Hotspots, Wildlife Sanctuaries, National Parks and Biosphere Reserves).

Unit-2: Climate and its impact on biodiversity: Global warming and forests, greenhouse effect and its consequences, ozone layer depletion. Threatened, vulnerable, endangered and endemic species. Categories of IUCN, Red Data Book. Important threatened/endemic plant and animal taxa of Nagaland. International efforts for conservation of biodiversity.

Unit-3: Factors causing loss of biodiversity (India, North-East with special relevance to the state of Nagaland), Future strategies for conservation of biodiversity in India. The Biological Diversity Act 2002 and its salient features, Role of NGO's in biodiversity conservation. Indigenous Traditional Knowledge (ITK). Biotechnological approaches to biodiversity conservation: Germplasm conservation, *invitro* fertilization and cryopreservation.

Unit- 4: Forest genetic resources of India: Timber and non-timber species, handling and storage of FGR. Indian forest and vegetation: Types and distribution. Ecosystem services. Forest and its ecological importance/significance. General introduction to Intellectual Property Rights (IPR), Quarantine laws and genetic resource exchange.

SUGGESTED READING

1. Aggarwal, K.C. 2002. Global biodiversity. Nidhi Publishers.
2. Dhyani SN. 1994. Wildlife Management. Rawat Publisher
3. Khan TI & Al-Azmi DN. 1999. Global Biodiversity Conservation Measures. Pointer Publisher.
4. Nautiyal S & Koul AK. 1999. Forest Biodiversity and its Conservation Practices in India. Oriental Enterprise.
5. R. Umashaanker *et.al.* 2001. Forest Genetic Resources. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

[FS-203]: FOREST RESOURCE MANAGEMENT AND ECONOMICS

Unit-1: Nature and scope of forest economics, importance of forestry in economic development. Production economics, production function, factor-product relationship, fundamental principles, Application of microeconomics in solving forest resource problems-concept of demand and supply with special reference to forestry outputs.

Unit-2: Concept of market and marketing, approaches, classification, role of markets, different forms and types of market competition, forest products marketing, marketing practices of forest products in India, problems in forest products marketing, Capital in forestry, Valuation of forest goods and services, Natural and environmental resource accounting –methods and implications.

Unit-3: Inter-regional and international trade in forest products, forest certification, impact of economics and physical variables upon forest appraisal and management decisions, externalities and property rights, Project formulation, implementation, monitoring and evaluation.

Unit-4: Financial considerations – cost principles, types of costs, determination of minimum costs, breakeven cost analyses. Economic considerations – economic viability of sustainable forest management, compounding and discounting of costs and benefits, discounted cash flow, net present value (NPV), Internal rate of return (IRR), benefit cost ratio (B/C ratio), uncertainty and use of sensitivity analysis.

SUGGESTED READING

1. FAO 1986. Guidelines to Practical Project Appraisal. Natraj Publ.
2. Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997.
3. Natural Resource Economics : Theory and Applications in India. Oxford & IBH.
4. Nautiyal JC. 1988. *Forest Economics – Principles and Applications*. Natraj Publications, Dehradun.
5. Sharma LC. 1980. Forest Economics, Planning and Management. International Book Distributors, Dehradun

[FS- 204]: FOREST PROTECTION

Unit-1: Principles of forest protection, factors affecting forest health, history and importance of forest pathology in India and in the world, susceptibility of forest to damages, destructive agencies, nature of damage, cause, preventive and remedial measures, important diseases and insect pests of nurseries, natural and plantation forests, standing and felled trees and their management, insect pests and mycoflora of seeds of forest trees and their management.

Unit-2: Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration, heart rot – factors affecting heart rot, damage caused, compartmentalization of decay in trees and management of heart rots, role of mycorrhiza in tree health, Forest fires, causes, prevention and management, control measures against fire.

Unit-3: Theories of natural regulation of insect populations, wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health

Unit-4: Forest pest management-integrated pest management program with special reference to biological control of insect pests and diseases of forest trees, plant breeding for disease resistance, molecular tools for developing disease resistance trees- developing genetically modified or transgenic plants for disease resistance

SUGGESTED READING

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

[FS-205]: PRACTICAL - II AND FIELD STUDY

- 1) Measurement of biomass and productivity
- 2) Collection and preservation of specimen
- 3) Estimation of productivity of forest ecosystem
- 4) Study of forest community structure and its succession status
- 5) Methods of vegetation analysis
- 6) Exercises on financial and economic appraisal of forestry projects
- 7) Comparison of different Biodiversity indices
- 8) Survey and characterisation of important forest pest in nursery and plantations
- 9) Collection of different wood rotting fungi from Nagaland
- 10) Field trip to study forest vegetation

[FS-301]: FOREST POLICY, LAWS AND INTERNATIONAL CONVENTIONS

Unit-1: Forest policy by the Ministry of Environment and Forests, Government of India, relevance and scope; forest policy division: mandate/subject matter of the forest policy division, National Forest Policy – 1894, 1952 and 1988, Forest policy – Food and Agriculture Organization of the United Nations Organization.

Unit-2: General principles of criminal law; objectives of criminal law, Indian Penal Code-history, objectives, structure, controversies. Criminal procedure code-cognizable and non cognizable offences, Indian evidence act applied to forestry matters, Forest conservation laws in India

Unit-3: Indian Forest Act –1927, general provision and detailed study, Forest Conservation Act 1980, Wildlife Protection Act 1972, The Environment (Protection) Act, 1986, Important Forest Rules and Guidelines, forest governance and climate change mitigation

Unit-4: International conventions - Kyoto protocol, Montreal protocol, Earth summit, Nairobi declaration, United Nations Convention on Environment and Development (UNCED), United Nations Convention on Sustainable Development, (UNCSD), Wetland-Ramsar convention, United Nations Framework for Climate Change (UNFCCC), CBD.

SUGGESTED READING

1. Gaston, K.J and Spicer, J.I. 2004. *Biodiversity: An Introduction*. Blackwell Publishing Company.
2. Richard. B. Primack. 1998. *Essentials of conservation biology*. Sinauer Associates, Inc. USA.
3. Agarwal, S.K. 2002. *Biodiversity conservation*. Rohini Publishers, Jaipur.

[FS-302]: FOREST BIOTECHNOLOGY AND TREE IMPROVEMENT

Unit-1: Concept of forest tree breeding, tree improvement and forest genetics. Variation: causes and kinds of variation, importance and its consequences, natural variation as a basis for tree improvement, variations in natural stands- ecotypes, clines, races, and land races

Unit-2: Selective breeding methods- mass, family, within family, family plus within family, plus tree selection, genetic testing-mating designs, breeding for wood quality, disease resistance and resistance to adverse environment, Production of quality seeds and seed certification, Seed production areas and seed orchards – type, functions, establishment and management.

Unit-3: Progeny and clone testing, estimating genetic parameters and genetic gain, heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Polyploidy, aneuploidy and haploidy in soft and hard wood species, induction of polyploidy, Hardy-Weinberg law, null hypothesis, Wohlund's principle, economics of tree breeding

Unit-4: Biotechnology in tree improvement and mutation breeding, Tree genetic engineering of useful traits, *Agrobacterium tumefaciens* mediated genetic transformation, prospects of genetic transformation with appropriate traits, use of molecular markers, germplasm conservation, cryopreservation methods as a means of maintaining juvenility in advanced breeding programmes with industrially important species

SUGGESTED READING

1. Brown. TA, 2006. *Gene cloning and DNA analysis-An introduction*
2. Satyanarayana. U, 2008. *Biotechnology*
3. Glick, BR and Pasternak, JJ, 1998. *Molecular Biotechnology: Principles and applications of recombinant DNA*
4. Surendran C, Sehgal RN and Paramathma, M. 2003. *Text Book of Forest Tree Breeding*, ICAR Publications
5. Zobel, BJ and Talber ,J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons
6. White JW. 1976. *Introduction to Forest Genetics*, Academic Press

[FS-303]: WOOD SCIENCE AND TECHNOLOGY

Unit-1: Ultrastructure and composition of softwoods and hardwoods, chemical composition of wood – cell wall constituents – cellulose, hemicelluloses, lignin, pectic substances, physical properties and shrinkage of wood, elastic, strength, and vibration properties of wood, natural characteristics affecting mechanical properties of wood, reaction wood, fire performance characteristics of wood.

Unit-2: Importance of wood seasoning and preservation; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. Methods of wood preservation, important wood based industries and present status of supply of raw materials to wood industries.

Unit-3: Biopulping, enzyme pulp bleaching, biotechnological production of wood composites, bioremediation of wood treated with preservatives, bioactive wood polymer composites, wood degradation by chemicals, treatment of pulp effluents, wood substitution, energy forestry Vs plantation forestry, utilization of plantation wood – SWOT analysis

Unit-4: Production of chemicals and fuels from forest biomass with special reference to wood as chemical and bioenergy feedstock, wood as a feedstock for upcoming biorefineries, fermentation of lignocellulosic woody biomass for bio-alcohol production, pyrolysis of wood, types of pyrolysis, gasification of woody biomass, important wood extractives, wood plastics, wood refinery techniques, chemicals produced as by-product in pulp industry, destructive distillation of wood, future of the wood chemical industry

SUGGESTED READING

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

[FS-304]: PRACTICAL - III AND FIELD STUDY

- 1) Collection, identification and preservation of important insect borers and wood decaying pathogens
- 2) Determination of wood density
- 3) Study of wood properties
- 4) Determining wood chemistry
- 5) Determination of calorific value of wood
- 6) Proximate analysis (moisture, volatile matter, ash and fixed carbon) content of wood
- 7) Use of statistical software for data analysis in forestry studies
- 8) Selection of plus trees
- 9) Calculation based on genetics and breeding on forestry
- 10) Field trip to a National Park

[FS-401]: FOREST AND PEOPLE

Unit-1: Forests and their importance, economic and social benefits of forests, forest societies, interactions and relationships between indigenous people and forests, population growth and deforestation, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation

Unit-2: Afforestation programmes and forest conflicts, wildlife and human conflicts-special emphasis on men elephant conflict, concept of social fencing, important forest movements such as Chipko and Appiko Movement, gender dimension of forest management, tribal economy and forests, pastoralists and their dependence on forests, forests and economic security of tribals

Unit-3: Management of Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and sustainable development practices, planning and management of natural, cultural resources and peoples way of life for sustainable use in tourism with special focus on rural areas

Unit-4: Forest rights, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management

SUGGESTED READING

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

[FS-402]: WILDLIFE AND CONSERVATION BIOLOGY

Unit-1: Concept and significance of wildlife, history of wildlife management and conservation in India, control and management of overabundant wildlife populations: Use of barriers, demographic and genetic management of small populations; Ecological monitoring of animal species and restoration programmes; Wildlife trade: Assessment and documentation; Preventive measures and trans-boundary problems.

Unit-2: Special projects for wildlife conservation: Project Tiger, Operation Rhino, Project Elephant. Protected area network of India, Conservation methods: *In-situ* and *Ex-situ* conservation (wildlife sanctuaries, national parks, biosphere reserves, botanical garden etc). Wetland ecosystems and Ramsar sites. Case studies of captive – Red panda and Snow leopard. Conservation breeding programs (e.g. Vulture, Amur falcon, Tragopan blythii, Mithun, etc).

Unit-3: Eco development in support of conservation & protected area management, animal habitat studies, issues of eco development activities; Community participation in wildlife management: Conservation and development linkage; Man animal conflict (Case studies: Man-elephant conflict), remedial strategies to deal with man animal conflict.

Unit-4: Population estimation (census technique), Importance of wildlife health management; Wildlife health investigations: needs, challenges and recommendations; Major wildlife diseases in India; Wildlife health monitoring and surveillance;

SUGGESTED READING

1. GokulaVaradharajan. Elementary Wildlife Biology. Lambert Academic Publishing
2. Hosetti, B.B. Concepts of Wildlife Management. Daya Publishing House
3. James A Bailey. Principles of Wildlife Management. John Wiley & Sons Ltd.
4. Michael L. Morrison and Heather A. Mathewson. Wildlife Habitat Conservation: Concepts, Challenges and solutions. John Hopkins University Press.
5. Paul R. Krausman and Bruce D. Leopold. Essential Readings in Wildlife Management and Conservation. John Hopkins University Press
6. Raymond Fredrick Dasmann. Wildlife Biology. 2nd edition, Wiley

[FS-403-A]: MEDICINAL AND AROMATIC PLANTS

Unit-: History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants (MAPs) in India. Introduction to the Ethnobotany concept, MAP: importance, origin, distribution, area, production, climatic, soil requirements, nutritional and water requirements. Good agricultural practices (GAP) for MAPs. Conservation status of MAPs in the Indian context with particular focus on the state of Nagaland

Unit-2: Primary and secondary plant metabolites, types of secondary metabolites in plants- flavonoids, terpenoids, alkaloids- chemical structure, extraction, production and applications, *in vitro* production of secondary metabolites by tissue culture approach, applications of secondary metabolites, therapeutic uses of phytoconstituents such as gums, anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids etc.

Unit-3: Organic compounds and their classification- aliphatic, aromatic, alkaloids, steroids, terpenoids, glycosides, phenolic compounds, heterocyclic compounds and carbohydrates. Procedures involved in the extraction of phytoconstituents/phytochemicals from medicinal plants. Chromatographic separation procedures in phytochemistry, therapeutic and pharmaceutical uses of important medicinal plants of the state of Nagaland with special emphasis on their cultivation regimes.

Unit-4: Plant protection, harvesting and processing of important medicinal and aromatic plants. Post harvest processing- drying, grading and storage. Essential oils: Extraction and production methods of natural essential oils. Chemical composition of essential oils, bioactivity (antibacterial, antifungal, anti-tumor, anti-oxidant etc.) of various essential oils and their storage. General applications of essential oils with special reference to aromatherapy

SUGGESTED READING

1. Alikhan. I and Khanum .A, 2008. Role of Biotechnology in Medicinal and Aromatic Plants. UKAZ Publications
2. Gupta AK, Tandon N & Sharma M. 2008. Quality Standards of Indian Medicinal Plants, ICMR
3. Johnson CB and Franz C, 2005. Breeding Research on Aromatic and Medicinal Plants. International Book Distributors
4. Sharma R, 2004. Agrotechniques of Medicinal Plants. Daya Publications

[FS-403-B]: FOREST BIOTECHNOLOGY

Unit-1: General introduction to biotechnology, major milestones in biotechnology, emergence of molecular biotechnology, green and white biotechnology, genomics, proteomics, bioinformatics and computational biology, biotech genetic information, applications of biotechnology, introduction to r-DNA technology, concerns and consequences of wide spread applications of modern biotechnology, scope of biotechnology in forest sciences, current trends in biotechnology research, future of biotechnology research

Unit-2: Concept of totipotency, introduction to plant tissue culture, applications of tissue culture, basics of plant tissue culture-sterilization techniques, choice of explants, culture media, different types of culture, protoplast isolation, fusion and culture, cybrids, embryo culture, meristem culture, biotransformation and secondary metabolite production, conservation strategies, application of plant tissue culture in agriculture, horticulture and forestry

Unit-3: Principles and techniques in plant molecular biology & genetic engineering-DNA extraction, agarose gel electrophoresis, restriction digestion, SDS-PAGE, southern, western and northern blotting, PCR, molecular markers, FISH, cloning and expression vectors, DNA library current trends in DNA sequencing, nucleotide sequence analysis-multiple sequence analysis, BLAST and phylogenetic analysis

Unit-4: Intellectual property rights - patents, geographical indications, copyrights, industrial design, trademark, trade secrets etc., territoriality of IPR , benchmarks for patentability of inventions; understanding the Patent system in India; Filing patents outside of India. Searching patents databases for designing research objectives, patent search strategy, debates surrounding patent protection in fields like biotechnology, computer sciences, etc

SUGGESTED READING

1. Bhojwani, S.S and Razdan, MK, 1996. Plant tissue culture: Theory and Practice
2. Brown. TA, 2006. Gene cloning and DNA analysis-An introduction Satyanarayana. U, 2008. Biotechnology
3. Glick, BR and Pasternak, JJ, 1998. Molecular Biotechnology: Principles and applications of recombinant DNA

[FS-403-C]: FOREST BIOENERGY

Unit-1: New and renewable energy sources, concept of biomass and bioenergy, biomass formation, global bioenergy scenario, classification of biomass, characterization of biomass - ultimate and proximate analysis, biochemical constituents-cellulose, hemicelluloses, lignin, biomass estimation and techniques for biomass resource assessment, use of remote sensing and Geographical Information System in forest assessment , bio-based economy

Unit-2: Thermo-chemical conversion: Direct combustion, incineration, pyrolysis-types and significance, gasification and thermochemical liquefaction. Biochemical conversion: Use of micro-organisms, enzymes and catalysts to make fuels and chemicals, transesterification and biodiesel production, bioconversion of substrates into bio-alcohol, organic acids, solvents, amino acids and antibiotics

Unit-3: General Introduction to the biorefinery concept, platform biorefineries, outline of an integrated biorefinery and the various (upstream and downstream) unit operations involved, microbial biorefineries Vs plant based biorefineries, Algae as a feedstock for upcoming biorefineries, scope of bioenergy for India with special relevance to the state of Nagaland.

Unit-4: Criteria for evaluation of fuelwood species for energy, consumption trends of fuelwood, general introduction to energy forestry, energy plantations with special emphasis on short rotation forestry and short rotation coppice, energy plantations and waste land reclamation, energy plantations and power generation, problems and benefits of energy forestry, exemplary trials in energy forestry, scope of energy forestry with special reference to the state of Nagaland

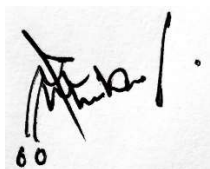
SUGGESTED READING

1. Dahiya, A, 2014. Biomass to biofuels, 1st edition
2. Kellomaki, S, Kilpelainen, A and Alam, A, 2013. Forest Bioenergy production: Management, carbon sequestration and Adaptation
3. Thiffault, Smith, Junginger and Berndes, 2016. Mobilisation of Forest Bioenergy in the boreal and temperate biomes

[FS-404]: PROJECT WORK AND SUBSEQUENT DISSERTATION SEMINAR

Major objective: To expose the students to practical training, designing of experiments, preparing for data collection from field/laboratory and develop skill on writings of dissertation. Students are expected to develop skill to design, execute and report independent research on Forestry.

Each student shall submit a dissertation based on the assigned field/laboratory work, approved in the Departmental Research Council, allotted during the 3rd Semester. Right from the initiation of the project work, each candidate will have to periodically present progress report in form of a seminar in addition to regular discussion with the supervisor, which will be considered for evaluation.

A handwritten signature in black ink, appearing to be 'S. K. S.', with a small '60' written below it.