**Students with 3 years UG can take admission.**

- **Abbreviations:** T: Theory, P: Practical, C: Core; CBCP: Choice Based Credit Paper, MOOCS (Massive Open Online Course); Int: Internal; Ext: External
- A student will choose/start the research project from 3rd semester.

| Semester | Subject Code | Title of the Course | Hrs/ week | Credit (T + P) | Marks | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | Int | Ext | | |
| | | | | | | T | P | |
| I | FS-101 (C) | Plant Systematics and Conservation | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-102 (C) | Forest Mensuration | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-103 (C) | Silviculture | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-104 (C) | Forest Diseases and it Management | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-105 (CBCP) | A. Wood Science and Technology<br>B. Wild Life and Conservation Biology | 4 | 4 (4+0) | 20 | 80 | -- | 100 |
| | **Total** | | **20** | **20** | | | | **500** |
| | ***Students can exit after1 semester with Certificate Course*** | | | | | | | **(Exit)** |
| II | FS-201 (C) | Agroforestry and Climate Change | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-202 (C) | Forest Microbiology | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-203 (C) | Nursery and Plantation Technology | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-204 (C) | Utilization of Forest Products | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-205 CBCP | A. Remote Sensing & Geographic Information<br>B. Medicinal and Aromatic Plants | 4 | 4 (4+0) | 20 | 80 | -- | 100 |
| | **Total** | | **20** | **20** | | | | **500** |
| | ***Students can exit after1 year with PG Diploma*** | | | | | | | **(Exit)** |
| | ***4 years UG can have lateral entry (1 yr. PG)*** | | | | | | | |
| III | FS-301 (C) | MOOCS | 2 | 2 (2+0) | -- | 50 | -- | 50 |
| | FS-302 (C) | Internship | | 2 (2+0) | -- | 50 | -- | 50 |
| | FS-303 (C) | Research Methodology & Ethics | 4 | 4 (4+0) | 20 | 80 | | 100 |
| | FS-304 (C) | Biotechnology in Forestry | 4 | 4 (3+1) | 20 | 60 | 20 | 100 |
| | FS-305 (C) | Physiology of Woody Plants | 4 | 4 (4+1) | 20 | 60 | 20 | 100 |
| | FS-306 CBCP | A. Herbal Chemistry<br>B. Tree Seed Technology | 4 | 4 (4+0) | 20 | 80 | -- | 100 |
| | **Total** | | **20** | **20** | | | | **500** |
| IV | FS-401 | Dissertation | -- | 20 | -- | | | **500** |
| | **Total** | | | **20** | **-** | | | **500** |
| **Grand Total : 20+20+20+20=** | | | | **80** | **-** | | | **2000** |

- The student distribution for research project will be done at the end of second semester.
- Students need to opt for one of the CBCS paper from the list given above.
- Credit earned from SWAYAM not related to subject will be considered as Value Added Courses.

## FS-101(C): PLANT SYSTEMATICS AND CONSERVATION

**Unit I**

Introduction – Importance and scope of plant taxonomy, detailed study of plant classification - . Linnaues, Bentham and Hooker, Engler and Prantl and Taktajan, advantages and disadvantages. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature.

**Unit II**

Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees. Characteristics of blaze, bark colour, exudations etc.

**Unit III**

Morphology of root, stem, leaves and detailed study of reproductive morphology angiosperm.

**Unit IV**

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

**Unit V:**

Methods of collecting plants, functions of herbarium, important herbaria and botanical gardens in India and Abroad, Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. Conservation methods- ex situ and in situ. Gene banks, botanical gardens, global concerns for conservation of MAPs, Biodiversity hot spots-India.

**Practical:** Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. General study of herbarium. Dissection of flowers-making sketches-construction of floral diagrams of one species of families studied in theory.

**Suggested readings:**


- Ashok Kumar (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat. • Bor N. L. (1990). Manual of Indian Forest Botany. Periodical Expert Book Agency. New Delhi.
- Brandis. D. Revised by R. D. Jakarti (2010). Indian Trees. Dehradun.
- Charles McCann. (1966). 100 Beautiful Trees of India. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)
- Father H. Santapau. (1966). Common Trees. (Available online PDF) Gurucharan Singh. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Hardin, W., Harrar, E.S., and White, F.M. (1995) Textbook ofDendrology (8th Edition). McGraw-Hill Companies, London
- Jain S. K. and R. R. Rao. (1977). Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers. New Delhi.

- Lawrence, G.H.M.(1967). Taxonomy of Vascular Plants. Oxford&IBH, New Delhi.
- Mishra. S.R.(2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd. New Delhi.
- Naqshi. R. (1993). An Introduction to Botanical Nomenclature. Scientific Publishers. Jodhpur.
- Pandey S. N. and S. P. Mishra. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
- Parker. R. N. (1933). Forty Common Indian Trees and How to know them. (Available online PDF)
- Randhawa. M. S. (1957). Flowering Trees in India. Sree Saraswati Press Ltd. Kolkatta.
- Sahni. K. C. (2000). The Book of Indian Trees. Bombay Natural History Society. Mumbai.
- Tewari D. N. (1992). Tropical Forestry in India. International Book Distributors, Dehradun


## FS-102 (C): FOREST MENSURATION

**Unit I**

Forest Mensuration- Definition, objectives and scope of forest mensuration. Scales and Units of measurement, error and accuracy.

**Unit II**

Measurement of individual tree parameters - tree diameter and girth - objectives, standard rules governing measurement at breast height and instruments used. Upper stem diameter measurement- Objective and instruments used. Bark measurements objectives, bark thickness, bark surface area and bark volume. Crown measurement- objectives, crown diameter, crown height, crown surface area and crown volume.

**Unit III**

Height measurement direct and indirect methods. Height measurement principles- geometric and trigonometric principles, height measuring instruments, error in height measurement and height measurement of learning tree.

**Unit IV**

Trees stem form- theories, classification of form factors and form quotient. Volume tables- definition, classification and preparation. Tree biomass- objective and biomass estimation methods. Age determination of tree- objective and methods. Tree growth measurement – objectives, increment, determination of increment, stump analysis, stem analysis and increment boring. Measurement of tree crops – objectives, crop diameter, crop height, crop age and crop volume.

**Practical:** Units of measurement and uses in forestry. Measurements of diameter, girth and upper stem diameter of trees using Calipers, Tape, Ruler, Penta Prism, Criterion Dendrometer etc. Measurement of bark thickness, bark volume, bark area. Measurement of crown diameter, crown area and crown volume. Measurement of tree height using instrumental methods- Abney's level, Ravi Altimeter, Spiegel Relaskop, Clinometer etc. Estimation of form factor. Volume estimation of logs, felled trees and standing trees. Preparation of local volume table. Determination of age of standing trees by increment boring method. Study on stump analysis. Calculation of CAI and MAI.

**Suggested readings:**


- Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition).

- Khanna Bandhu. Dehra Dun.364 pp.
- Forest mensuration: A Handbook for Practitioners.(2006). Forestry Commission Publications. 330 pp.
- Husch, B., Beers, T.W. and Kershaw,Jr. J.A. (2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.
- Laar, V. A. and Akca, A. (2007). Forest Mensuration. Managing Forest Ecosystems (Vol.13).Springer.384pp.
- West, P.W. (2009). Tree and Forest Measurement (2nd edition). Springer. 192pp.
- Agarwal, P. (2008). Forest Mensuration- Tree measurement. Bishen Singh Mahendra Pal Singh Publishers & Distributors of Scientific Books, 220pp.
- Panwar, P. and Bhardwaj, S.D. (2005). Handbook of Practical Forestry. Agrobios (India), 191pp.


## FS-103 (C): SILVICULTURE

**Unit I:**

Forest ecosystems- Introduction to tropical/ temperate silviculture. Role of silviculture in forest and wild land management, major forest formations classification, distribution, composition and structure. Vegetation dynamics- species richness-diversity indices. Vegetation forms of India and their productivity. Forest ecosystemstructure and functioning, community development, competitive interactions in forest communities, forest succession, concepts and models of succession-Connell-Slatyer models, climax theories, tolerance.

**Unit II:**

Ecophysiology of tree growth- effect of radiation and water relationship, mineral nutrients and temperature. Forest stand development – stand development, even aged and uneven-aged stands, age and site quality. Tree architecture and its role in stand management.

**Unit III:**

Stand density determination-stand density indices-stand density management density management diagram, silvicultural treatments involved- thinning as a stand management tool, objectives of thinning, effects on growth and yield, thinning effect on economic yield of stands. Forest site quality evaluation-direct and indirect methods.

**Unit IV:**

Treatment analysis-silvicultural regimes- factors influencing choice of regimes, use of system analysis to determine regimes, models for evaluating silvicultural alternatives, development of silvicultural regimes to suit management objectives, optimum management strategies, silvicultural prescriptions for maximum production regime.

**Practical:** Visit to forest areas to study forest composition, classification, factors of locality, site quality, form and growth of forest trees- study plant succession- study stand density, changes on productivity- thinning effects.

**Suggested readings:**


- Daniel TW, Helms JA and Baker FS. 1979. Principles of Silviculture. McGraw-Hill Book Company.
- Julius E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
- Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
- Khanna LS. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
- Lamprecht. 1986. Silviculture in the Tropics.Verlag Paul Parey, Hamburg und Berlin.

- Nyland RD, Laura S, Kenefic, Kimberly K, Bohn and Susan LS.2016 Silviculture: Concepts and Applications (III edition), Kindle Edition, USA.
- Pascal. 1988. Wet Evergreen Forests of the Western Ghats.
- Shepherd KR. 1986. Plantation Silviculture. Springer.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.


## FS-104 (C): FOREST DISEASES AND IT MANAGEMENT

**Unit I**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases; Survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development, Co-evolution of plant pathogens. Host parasite interaction, recognition of host by pathogens, concept of infection, entry of pathogen into host, mode of host penetration.

**Unit II**

Growth and reproduction of plant pathogens, infection and factors influencing disease development. Dissemination and survival of plant pathogens. Distribution, economic importance, symptoms, etiology and management of the following. Diseases of important tree species like Teak, Dalbergia sp., Acacia spp., Neem, Cassia, Sal, Albizia, Terminalia, Mango, Jack, Pines, Deodar, Eucalyptus, Bamboo, Casuarina, Rubber, Sandal wood, medicinal and aromatic plants grown in different agroforestry systems.

**Unit III**

Biodegradation of wood in use. Types of wood decay, gross characters of decay, sapstain, different types of rots in hardwoods, softwoods and their prevention. Graveyard test and decay resistant woods. Principles of forest disease management. Definition and scope of disease management in forestry.

**Unit IV**

Principles of plant disease management, various methods of plant disease management- cultural, physical, biological, chemical, organic amendments of soil ,use of botanicals, traditional /indigenous techniques for plant disease control, integrated control measures of plant diseases.

**Unit V**

Meristem and tissue culture techniques in disease management, Trangenic Plants for insect, fungal, viral and bacterial diseases. Nursery diseases of important forest species.

**Practical:** Collection, observation and preservation of diseased specimens and pathogenic structures; Morphological characters of fungi and bacteria; Morphological characters of viruses and phytoplasma; Preparation of culture media, isolation and subculturing of pathogens; Methods of inoculation and proving pathogenicity (Koch Postulates); Symptoms, signs and diagnosis of tree diseases; Symptoms, etiology and control of diseases/disorders of important tree species (sandal wood, teak and Dalbergia); Symptoms, etiology and control of disease/disorders of (eucalyptus, bamboo, cassia, semul and Terminalia); Symptoms, etiology and control of disease/disorders of important tree species (rubber, casuarina, neem and mango); Symptoms, etiology and control of disease/disorders of important tree species (Albizia, sal, sababul and Acacia); Symptoms, etiology and control of disease/disorders of important tree species (jack, Lagerstroemia, Anogeissus and Emblica).

**Suggested readings**:

- Bakshi, B.K. Forest Pathology. 1976. Principles and Practices in Forestry. Controller of Publications, New Delhi.
- Khanna, L.S. 1984. Forest Protection, Khanna Bandhu, Dehra Dun.
- Beeson, C.F.C. 1941. Forest Insects of India, The Ecology and Control of the Bishen Singh and Mahendrapal Singh, Dehra Dun.
- Ferraz, L.C. and D. Brown. 2002. An Introduction to nematodes - Plant Nematology. Pensoft Publishers. 221 pp.
- Gupta, V.K. and N.K. Sharma. 1988. Tree Protection. Indian Society of Tree Scientists, Solan.
- Herrick, G.W. 1988. Insect Enemies of Trees. Pioneer Publishers, Jaipur.
- Kumar,V. 1995. Nursery and Plantation Practices in Forestry. Scientific Publishers, Jodhpur.
- Speight, M.S. and D. Wainhous 1989. Ecology and Management of Forest Insects. Clarendon Press, Oxford.


## FS-105 (CBCP) A: WOOD SCIENCE AND TECHNOLOGY

**Unit-I**

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-II**

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- III**

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-IV**

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 readings:**


- Mehta T. 1981. A Handbook of Forest Utilization. Periodical Expert Book Agency.
- Rao, KR & Junaja KBS. 1992. Field Identification of 50 Important Timbers of India. ICFRE, Dehradun.
- Sharma LC. 1977. Development of Forests and Forest-based Industries. Bishen Singh

Mahender Pal Singh, Dehradun.

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

## FS-105 B (CBCP): WILDLIFE AND CONSERVATION BIOLOGY

**Unit-I:**

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-II:**

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-III:**

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: Manelephant conflict), remedial strategies to deal with man animal conflict.

**Unit-IV:**

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 readings:**

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

## FS-201(C): AGROFORESTRY AND CLIMATE CHANGE

**Unit I**

Agroforestry: objectives, importance, potentials and limitations for implementations. Land capability classification and land evaluation. Basis of classification of agroforestry systems and principles, indigenous vs. exotic, intraspecific variations, crown architecture of tropical/ temperate trees. Ideotype concept for selection of multipurpose trees. Nitrogen fixing trees. Overview and case studies of different agroforestry systems.

**Unit II**

Structural and functional attributes of agroforestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, silvopastoral systems, shelter-belts and windbreaks, energy plantations and home gardens.

**Unit III**

Role of trees in soil productivity and conservation– micro-site enrichment- litter and fine root dynamics, Nitrogen fixation and nutrient pumping. Soil productivity and management in agroforestry.

**Unit IV**

Community forestry and social forestry, linear strip plantations. Trends in agroforestry systems research and development, Diagnosis and Design –PRA-RRA tools in agroforestry problem diagnosis. Climate Change mitigation and adaptation through agroforestry- climate negotiations- LULUCF- agroforestry options.

**Unit V**

Global climate change-factors involved, green house gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change: Forest responses and vulnerabilities to climate change mitigation.Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP: LULUCF, REDD++ and CDM.

**Practical:**

- Survey and analysis of land use systems in the adjoining areas
- Study of tree crown architecture
- Design and plan of suitable models for improvement
- PRA-RRA tools in agroforestry problem diagnosis.

**Suggested readings:**


- Buck LE, Lassoie, Fernandes ECM 1999. Agroforestry in Sustainable Agri. Systems. CRC Press.
- Kumar BM and Nair PKR. 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Springer publication.
- Kumar BM and Nair PKR. 2013. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges (Advances in Agroforestry). Springer publication.
- Nair PKR and Latt 1998. Directions in Tropical Agroforestry Research. Kluwer.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
- Peter Huxley. 1999. Multiple Cropping with Woody and Non-Woody Plants. John Wiley and Sons Ltd, Oxford, United Kingdom.
- Tejwani KG. 1994. Agroforestry in India. Oxford & IBH Publishing Co. Pvt Ltd.
- Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
- Young A. 1997. Agroforestry for Soil Management. CABI.
- Anderson P and Palik B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.


## FS 202 (C): FOREST MICROBIOLOGY

**Unit I**

Definition and scope of microbiology, Branches of microbiology, History of Forest Microbiology - scope and signification of Forest Microbiology.

**Unit II**

Types of nutritional media - sterilisation - staining of microorganisms. Preservation of microbial cultures. Nutritional types: autotroph, heterotroph, phototroph and chemolithotrophs. Requirements for growth- Temperature, pH and other factors. Bacterial growth kinetcs - continuous culture and syschrous culture. Bacterial genetics: Genetic recombination of bacteria. Natural genetic engineer (Agrobacterium), microbial production of organic acids.

**Unit III**

Industrially important microorganisms & their products microorganisms in various forest ecosystems - Isolation and enrichment methods, Factors affecting microbial population in soil. Soil-microorganism in relation to plant root diseases and brief account of soil borne plant pathogens. Classification of root diseases – systems, chronic and acute, organism involved. Pathogenic root infecting fungi – types and their ecology; factors and measurements of tropism in fungi and other pathogens in host recognition

**Unit IV**

Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere.

Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste.

**Practical:**

- Gram staining techniques
- Preparation media for soil microbes and tree species
- Study of various sterilization techniques
- Microbial isolation from root hair of legume plants
- Isolation of soil microbes from forest soil
- Staining of various forest microbe
- Isolation of mycorrhizal species from roots of tree species
- Culture of soil microbe and maintenance of beneficial microbe
- In vitro culture and maintenance of mycorrhizal colonies.

**Suggested Readings:**


- Hattori, T. 1973. Microbial life in the soil. Marcel Dekker Inc. New York.
- Lynch, J.M. 1983. Soil Biotechnology. Blackwell Scientific publications, London.
- Mehta, S.L., M.L. Lodha and P.V. Sane. 1993. Recent advances in plant biochemistry. Publications and Information Division, ICAR, New Delhi.
- Motsara, I.M.R., P. Battacharya and Beena Srivastava. 1995. Biofertilizer technology, marketing and usage - A source book cum glossary. FDCO, New Delhi.
- Subba Rao, N.S. 1977. Soil Microorganisms and Plant growth. Oxford and IBH Publications, New Delhi. 6. Subba Rao, N.S. 1993. Biofertilizers in agriculture and forestry. Oxford and IBH Publ. Co., New Delhi. p. 242.
- Subba Rao, N.S. and C. Rodriguez-Barrueo. 1995. Casuarinas. Oxford & IBH Publ. Co., New Delhi.
- Subba Rao, N.S. and Y.R. Dommergues. 2000. Microbial interactions in agriculture and forestry. Vol. I & II. Oxford and IBH Publishing Co., New Delhi.
- Walker, N. 1975. Soil Microbiology. Butterworths, London.

- 10.Bergersen, F.J. and J.R. Postgate. 1987. A century of nitrogen fixation research. Present status and future prospects. The Royal Soc., London.
- 11.Burris, R.G. 1978. Soil Enzymes. Academic Press, New York.


## FS-203 (C): NURSERY & PLANTATION TECHNOLOGY

**Unit I**

Introduction and importance of nursery. Types of nurseries-temporary and permanent, bare root, containerized and clonal nursery. Bare root nursery- nursery soil and water management, bed preparation, pre-sowing seed treatments, seed sowing and intermediate operations, viz., pricking, watering, fertilization, weeding and hoeing.

**Unit II**

Root culturing techniques. Types of green house and mist chamber for propagation. Vegetative propagation – importance, selection of superior genotypes. Advanced methods of propagation, growing media, fertilizers, sanitation and management in vegetative propagation. Special requirement for clonal propagation. Propagation structure and management.

**Unit III**

Clonal propagation: miniclonal and micro cuttings technology. Vegetative propagation of bamboos and canes. Factors affecting rooting of cuttings. Lifting windows. Important forest nursery pests and diseases and their management. Seedling quality assessment, grading, packaging, storing and transportation.

**Unit IV**

Role of plantation foresty in meeting the wood demand. Purpose of plantation. Factors determining scale and rate of plantation. Land suitability and choice of species. Preliminary site preparation for establishing plantation. Plantation planning. Project formulation and appraisal. Planting programme. Time of planting. Spacing, pattern and planting methods.

**Unit V**

Nutritional dynamics and irrigation of plantation. Mechanization in plantation. Protection and after care of plantation. Pruning and thinning in plantations. Rotation in plantation. Failures of plantations. Unit VII Sustainable yield from plantations. Case studies in plantations of Eucalyptus. Poplars, Acacias, Pine, Gmelina, Bamboo, etc. Production technology of energy plantations. Industrial plantations.

**Practicals:**

- Introduction and identification of modern equipments and tools used in nursery;
- Pre-sowing seed treatments;
- Preparation of nursery beds and growing media for containerized nursery;
- Sowing of seed and other intermediate operations;
- Preparation and planting of cuttings;
- Assessment of seedling quality;
- Visit to forest nurseries;
- Nursery practices of commercially important tree species;
- Preparation of plantation calendar;

- Preliminary arrangement for a plantations programme;
- Planting geometry and calculation of planting stock;
- Studies on wood based industries – problems and prospects;
- Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and Bamboo plantations;
- Production technology for energy plantations. INM in plantations.

**Suggested readings:**


- Bhardwaj RL and Sarolia DK. 2011. Modern Nursery Management. Published by Agrobios Publishing. New Delhi (India).
- Kumar GA and Gopikumar. 2003. Forest Nursery and Tree Husbandry.
- Kumar V. 2012. Nursery and Plantation Practices in Forestry. Scientific Publishers (India).
- Saini RS, Kaushik N, Kaushik RA and Godara NR. 2012. Practical Nursery Production. Agrobios, New Delhi (India).
- Dwivedi AP 1993. Forestry in India. Surya Publ.
- Julius E. 1982. Planation Forestry in the Topics. Clarendon Press Oxford.
- Kumar, V. 1999. Nursery and Plantation Practices in Forestry. Scientific Publ.
- Luna R.K. 1989. Plantation Forestry in India. International Book Distributors.
- Prakash R. Chaudhary DC and Negi SS. 1998. Plantation and Nursery Techniques of Forest Trees. International Book Distributors


## FS-204 (C): UTILIZATION OF FOREST PRODUCTS

**Unit I:**

Lichen: Definition, phycobiont and mycobiont**,** General features of Lichens, distribution, Classification (Miller), Distribution, types – crustose, foliose and fruticose, thallus organization, vegetative & sexual reproduction, lichens as indicators of pollution & economic importance. Mycorrhiza: Definition, distribution, types of mycorrhiza, isolation of spores from soil, culture methods, role of mycorrhiza in agriculture and forestry.

**Unit II**

Biofertilizers: Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production. Nitrogen cycle in Nature. Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component, Biochemistry of nitrogen fixation.

**Unit III**

Historical developments of mushroom cultivation and present status, Food, medicinal value, uses of mushroom, edible and poisonous mushrooms. Life cycle of cultivated mushroom, preparation and strain improvement, maintenance of pure culture preparation of spawn and facilitated required for establishing commercial spawn lab.

**Unit IV**

Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO2, ventilation in cropping rooms. Insect pests, diseases and abnormalities of cultivated mushroom and their management, post-harvest processing and value addition.

**Unit V**

Biodiesel: Definition, Methods for biodiesel production - Direct combustion, incineration,

pyrolysis, Transesterification. Purification process, Physical and Chemical properties of biodiesel, fuel quality and air quality of biodiesel.
Biogas and Bioethanol from forest resources. Fermentation products from forest resources of Northern states (Nagaland), Vermicomposting.

**Practicals:**

- Collection and identification of lichens from forest
- Isolation of mycorrhiza and it cultivation
- Survey of locally available mushrooms and their identification. Preparation of spawn, compost, spawning, casing, harvesting and postharvest handling of edible mushroom. Identification of various pathogens, competitors of various mushrooms.
- Production of biodiesel from tress species.
- Determination of biophysical properties of biodiesel
- Production of bioethanol and other products from forest sources (fruits)

**Suggested readings:**


- Hale, M.E.Jr. (1983). Biology of Lichens. Edward Arnold, Maryland.
- Schwintzer, C.R. and Tjepkema, J.D. (1990). The Biology of Frankia and Actinorhizal Plants. Academic Press Inc., San Diego, USA.
- Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin
- Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.
- Marimuthu, T. et al. (1991). Oyster Mushroom, Development of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
- Pathak, V.N. and Yadav, N. (1988). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
- Tewari Pankaj Kapoor, S.C. (1988). Mushroom Cultivation. Mittal Publications, New Delhi.
- Tripathi, D.P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Dahiya, A, 2014. Biomass to biofuels, 1st edition
- Kellomaki, S, Kilpelainen, A and Alam, A, 2013. Forest Bioenergy production: Management, carbon sequestration and Adaptation
- Thiffault, Smith, Junginger and Berndes, 2016. Mobilisation of Forest Bioenergy in the boreal and temperate biomes.
- M. Mathiyazhagan, 2011, Assessment of fuel efficiency of biodiesel from non-edible oils and waste oil, Ph.D. thesis, Bharathidasan University, Tiruchirappalli, Tamilnadu. Satyanarayana, V. (2005). Biotechnology. Books and Allied (P) Ltd., Kolkata.
- Manickam Mathiyazhagan, 2021, Biodiesel Technology, LAP Lambert Academic Publishing, available on Amazon.
- M.Mathiyazhagan G.Bupesh and Meenakshi Sundaram, 2022, Biodiesel and its Environmental impact and sustainability, EnvironmentalDegradation; Challenges and strategies for Mitigation, Springer.


## FS-205 (CBCP) A: REMOTE SENSING & GEOGRAPHIC INFORMATION

**Unit-I:**

Handling the system tools: Disk clean up, Disk defragmenter, Driver converter (FAT 32), Maintenance wizard, Scan disk, System file checker. Microsoft office: Word, Excel and Power Point. Access: Introduction, Blank access database, Primary key, Table, Datasheet view, Design view, Table wizard, Import table, Relationships, Query, Design view, Simple query wizard, Design view, Report, Report wizard

**Unit-II:**

Remote Sensing: Basic principles, type and scope of remote sensing. Introduction to aerial photography and photo grammetry. Measurements from aerial photographs, photo-interpretation, area determination and thematic mapping. Introduction to various types of satellites and sensors, resolution and form of data available. Acquisition and interpretation of satellite data for forestry purpose, vegetation mapping.

**Unit-III**:

Geographic Information System: GIS and its use in Forest management. Forest inventory planning, design, alternatives, execution, compilation and reporting. ERDAS Imagine

**Suggested readings:**


- James B. Campbell and Randolph Wynne, 2011. Introduction to Remote Sensing, 5th edition.
- Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 2015. Remote Sensing and Image Interpretation, 7th edition.
- Prasad S. Thenkabail, 2016. Remote Sensing Handbook, Three Volumes.
- Basudeb Bhatta, 2021. Remote Sensing and GIS, 3rd edition


## FS-205 (CBCP) B: MEDICINAL AND AROMATIC PLANTS

**Unit - I**

Medicinal Plants – past and present status in world and India. MAPs as industrial crops - constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Non-timber forest products (NTFP), Good Agriculture Practices (GAP). Indian Himalayan region (IHR).

**Unit - II**

Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Herbal industries.

**Unit-III**

Important medicinal plants of India with their systematics, geographical distribution and uses. Acorus calamus, Adhatoda vasica, Abrus precatorius Aloe vera, Phyllanthus amarus, Stevia rebaudiana, Belladona and Cinchona.

**Unit –IV**

Important aromatic plants of India. Introduction and historical background of aromatic plants. Aromatic and cosmetic products. Raw material for perfumes etc. Cosmetic Industries. Major, minor and less known aromatic plants of India. Taxonomic descriptions and uses of important aromatic plants – citronella, davana, damask rose, geranium, khus grass, large cardamom, lavender, lemon grass, mentha, holy basil, patchouli, rosemary Palmarosa, vetiver, artemisia,

eucalyptus, thyme, marjoram and oreganum. Aromatic spices - clove, cinnamon, nutmeg, ajwain, dill, celery, tamarind, garcinia, curryleaf and saffron.

**Suggested readings:**

- Medicinal Plants of Uttarakhand by C.P. Kala (2010).
- Indian Medicinal Plants by P.C. Trivedi (2009).
- Medicinal Plants of Indian Himalaya by S.S. Samant and U. Dhar.
- Hand Book of Aromatic Plants by S.K. Bhattacharjee (2004).
- Handbook of MAPs by S.K. Bhattacharjee (2009).

## FS-301 (C): MOOCS

## FS-302 (C): INTERNSHIP

## FS-303 (C): RESEARCH METHODOLOGY AND ETHICS

**Unit I**

Cellular Analysis and Separation Process: Principle and Applications of Optical microscope, phase contrast, Electron Microscope, confocal microscope, Atomic Force Microscope. Principles of Sedimentation and types of centrifugation.

**Unit II**

Chromatography and Spectroscopy: Principles and applications of Chromatography- Paper chromatography- Thin layer chromatography, Ion exchange chromatography- Affinity chromatography- Adsorption chromatography, GC-MS and HPLC. Principles and applications of colorimeter and spectrophotometer-UV- Vis spectrometer.

**Unit III**

Electrophoresis and Blotting Techniques, Principles of Electrophoresis- Agarose and polyacrylamide gel electrophoresis, Southern Blotting, Northern Blotting-Western blotting. Labelling of DNA probes for blotting analysis. Principles of Polymerase Chain Reaction.

**Unit IV:**

Interpretation of data and paper writing, general layout of a research paper, research paper, review paper and short communications, Writing project proposal, preparation of thesis/ dissertations/research project report and development of scientific articles for publication, ethical issues related to publishing, conflict of interest, plagiarism and self-plagiarism, use of encyclopedias, research guides, handbook etc.,

**Suggested readings:**


- Wilson, K., and Walker, J., (1999). Practical Biochemistry: Principles and Techniques, Cambridge University Press.
- Geddes L.A., and Balsar L.E (2003). Principles of Applied Biomedical Instrumentation-John Wiley and Sons.
- Srivastava, M.L., (2011). Bioanalytical Techniques (2011), Narosha Publishers, New Delhi.Skoog, D. A., Holler, F.J., and Nieman, S.R., (1998). Principles of Instrumentation,Cengage Learning Press.
- Freifelder, D., (1983).Applications to Biochemistry and Molecular Biology,W.H.Freeman Publisher.
- Chatwal, G.R and Anand, S.K. (2009). Instrumental methods of Chemical Analysis, Himalaya Publishing House, New Delhi.

- Plummer, D.T. (2008). An Introduction to Practical Biochemistry, Tata McGraw- Hill Publication, New Delhi.
- Boyer, R.F. (2011). Biochemistry Laboratory: Modern theory and techniques,Prentice Hall Publishers. 8. Wilson, K. and Walker, J. (2000). Principles and Techniques of Practical Biochemistry, Cambridge University Press Publishers.
- Okotore, R.O. (2008). Basic Separation Techniques in Biochemistry. New Age International Pvt Ltd Publishers.
- Palanivel, P. (2000). Laboratory Manual for Analytical Biochemistry & Separation Techniques, School of Biotechnology, Madurai Kamaraj University, Madurai.
- Sawhney,S.K. and Singh, R.(2005) Introductory practical Biochemistry, Narosa Publishing House, New Delhi.


## FS-304 (C): BIOTECHNOLOGY IN FORESTRY

**Unit I**

Introduction. Cloning, need for cloning, problems with cloning. Traditional cloning techniques versus micro-propagation, prospects of micro-propagation in forestry. Techniques procedures and problems in micro propagation, Protocols for micro-propagation. Preconditioning of explants, surface sterilization, nutritional media, other environmental factors controlling micro-propagation, choice of explants for micro-propagation. Micro propagation of juvenile material. Micro propagation of mature trees. In-vitro propagation of plants with low sexual reproduction rates, miscellaneous application.

**Unit II**

Initiation and maintenance of callus. Organogenesis and somatic embryogenesis – factors influencing somatic embryogenesis-applications in forestry, Somatic seeds, encapsulation techniques. Terminator seed, Cell suspension cultures. Anther and pollen cultures. Triploids through endosperm culture, embryo culture. Applications of In-vitro fertilization, isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization. Cryopreservation, storage of plant genetic resources. Production of secondary metabolites by cell cultures. Meristem culture, virus free plants.

**Unit III**

Genetic engineering – application in forestry Isozymes, restriction fragment length polymorphisms (RFLPs), randomly amplified polymorphic DNAs (RAPDs) and microsatellites. Genetic fingerprinting, Marker assisted selection. Different PCR techniques: their characteristics, with advantages and disadvantages.

**Unit IV**

Quantification of genetic diversity, genotype verification and delineation. Introduction of genes. Promoters and marker genes. disease resistance, herbicide tolerance and tolerance to salt and other stresses.

**Practicals:**

Introduction to tissue culture lab; Micropropagation: Aseptic techniques; Preparation of culture media, formulation of different culture media; Induction and maintenance of callus, regeneration of plants from callus, regeneration of plants from embryoids; Cell suspension culture; Anther and pollen culture. Quantification of tissue culture; Isolation and culture of protoplasts; Marker assisted RFLP in test trees; Study of PCR techniques used in tree improvement; Application of GENALEX ‘bolt on’ for excel, arlequin, PopGene and FSTAT for Wright’s F-statistics and analysis of molecular variance (AMOVA).

**Suggested readings:**


- Bajaj YPS. 1986. Biotechnology in Agriculture and Forestry. Springer Verleg, New York.
- Bonga JM and Durjan J. 1987. Cell and Tissue Culture in Forestry Vol. I & II. MartinusNijost Publishers, Dordrecht.
- Hainer R. 1996. Biotechnology in Forest Tree Improvement. (FAO Bulletin 1994) International Book Distributors. Dehra Dun.
- Muchugi A, Kadu C, Kindt R, Kipruto H, Lemurt S, Olale K, Nyadoi P, Dawson I and Jamnadass R. 2008. Molecular Markers for Tropical Trees, A Practical Guide to Principles and Procedures. ICRAF Technical Manual no. 9. Dawson I and Jamnadass R. eds. Nairobi: World Agroforestry Centre.
- Murphy TM and Thompson WF. 1988. Molecular Plant Development. Prentice Hall, Engleward, cliffe, New Jersey.
- Russel GE. 1988. Biotechnology of Higher Plants. Intercept publishers, Nimborne, Dorset.
- Russell Haines. 1994. Biotechnology in Forest Tree Improvement with Special Reference to Developing Countries. Food and Agriculture Organization of the United Nations, Rome.


## FS-305 (C): PHYSIOLOGY OF WOODY PLANTS

**Unit I**

Introduction, Tree physiology. Growth, phases of growth, growth curve, factors affecting growth.- Wood formation. Plant cell as a structural and functional unit. Organization of cells and tissues, morphogenesis.

**Unit II**

Structure of leaves, stem wood, bark and roots in trees. Functions and process in plant growth and development.

**Unit III**

Photosynthesis, structure of photosynthetic tissues and organs, enzyme, energetics and factors influencing photosynthesis. Photorespiration, its mechanisms and significance, factors affecting photorespiration. Respiration, mechanisms, enzymes, energetics and factors influencing respiration. Respiratory quotient.

**Unit IV**

Water relations of trees, absorption, ascent of sap. Translocation of solutes, phloem loading and phloem transport. Transpiration, mechanisms and factors influencing the transpiration.

Mineral nutrition-Mineral salt absorption and translocation, deficiency and toxicity of mineral nutrients. Diagnosis of mineral deficiency.

**Unit V**

The enzymes, nomenclature and classification, structure and composition. Mode of action. Phytohormones, auxins, GA, cytokinins, ABA, ethlynene. Biosynthesis and biochemical activity of plant hormones. Synthetic plant growth regulators. Growth retardants.

Nitrogen fixing trees, Nitrogen metabolism.N2 fixation, physical and biological. Nitrogen assimilation, Amino acid and protein synthesis.

**Practicals:** Preparation of growth curves of different tree seedlings; Study of structure of leaves; Measurement of photosynthesis; Observing structure of plant cells and leaves in C3 and C4 species; Studying stomata in different tree species and working out stomatal frequency; Measurement of stomatal size in different tree species; Estimation of transpiration rates in different trees; Isolation and estimation of chlorophyll; Observing xylem vessel size variation in tree species;• Estimation of plant water status by different methods; Nutrient deficiency symptoms in tree seedlings.

**Suggested readings:**


- Dreyer E. 2011. Forest Tree Physiology. University of Minnesota, Elsevier
- Kramer PJ and Kozlowsky TT. 1979. Physiology of Woody Plants. Academic Press.
- Kramer PJ. 1972. Plant and Soil Water Relationships. TMH Edition, Tata McGraw Hill Publ. Co., New Delhi.
- Ksenzhek OS. andVolkov AG. 1998. Plant Energetics. Academic Press, New York.
- Lack AJ and Evans DE. 2001. Plant Biology- Instant Notes. Vina Books Pvt. Ltd., New Delhi.
- Larcher W. 2003. Physiological Plant Ecology. 4th edn, Springer-Verlag, Germany
- Luttge U. 2008. Physiological Ecology of Tropical Plants. Springer-Verlag, Germany
- Malik CP and Srivastava. 2015. Textbook of Plant Physiology. Kalyani Publishers, Mumbai
- Moore TC. 1989. Biochemistry and Physiology of Plant Hormones. 2nd ed. SpringerVerlan, Berlin.
- Noggle RG. and Fritz GJ. 2010. Introductory plant physiology. Sinauer Associates Inc. Publishers, Sunderland
- Pallardy HG. 2008. Physiology of Woody Plants. Elsevier, Amsterdam
- Taiz L and Zeiger E. 2007. Plant Physiology 4th ed. Sinauer Associates Inc. Publishers, Sunderland.
- Zimmerman MH and Brown CL. 1971. Tree structure and Function, Springer Verlag.


## FS-306 (CBCP) A: HERBAL CHEMISTRY

**Unit I**

Biosynthesis of carbohydrates, lipids, volatile oils and resins. Types and classification of carbohydrates and lipids and their uses as phytopharmaceuticals.

**Unit II**

Basic pathways of synthesis of secondary metabolites and production of phyto-pharmaceuticals such as glycosides, alkaloids and isoprenoid compounds. Biogenesis of medicinally important glycosides and alkaloids - Anthraquinone glycosidal drugs, saponin glycosidal drugs, cyanogenetic glycosidal drugs,coumarins and furanocoumarin glycosidal drugs. Isoquinoline alkaloidal, tropane steroidal and terpenoid alkaloidal drugs etc.

**Unit III**

The physiological roles of secondary metabolites in relation to Plant-vertebrate interaction; Plant-insect interaction; Plant – plant interaction; plant-microorganisms interaction. Turnover and degradation of secondary metabolites - The concept of turnover of secondary metabolites.

**Unit IV**

Accumulation of secondary products and the differentiation of storage spaces. Secondary metabolites and plant systematic- The relationship of chemical and botanical data. Introduction to amino acids, enzymes, terpenoids (volatile oils and resins) and plant hormones.

**Suggested readings:**

- The Biochemistry of Plants by EE Conn.
- Plant Biochemistry by Hans-Walterheldt.
- Medicinal Chemistry by GR Chatwal. (1998).
- Medicinal Chemistry: A Molecular & Biochemical Approach by Mogardey and Donald (2006).
- Medicinal Chemistry Laboratory Manual by Dickson, (1998).
- Introduction to Medicinal Chemistry; How Drugs Act & Why by Gringauz, (1997).
- Biochemistry Vol 6 by Freeman

## FS-306 (CBCP) B: TREE SEED TECHNOLOGY

**Unit I**

Trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation.

**Unit II**

Ecological fruit and seed types – seasonality and periodicity of flowering and fruiting. Seed structure and chemical composition development and maturation germination breakdown of storage products endogenous hormonal regulation effect of stimulators and inhibitors. Dormancy its causes and breakage specific problems of seeds of woody plants.

**Unit III**

Determining optimal harvest maturity indices. Methods of seed collection and processing. Storage methods – loss of viability during storage. Dormancy and pretreatment and seed testing techniques.

**Unit IV**

Quality seed production technologies – Seed stand/ seed production area, pollen management in seed orchards. Seed transfer guidelines. Seed certification and legislation.

**Unit V**

Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment. Seed fortification. Seed pelleting.

**Practicals:** Identification of forest seed; Seed sampling, Seed quality testing- purity, viability and germination; Collection and processing of seeds/ fruit. Different storage methods; Pretreatment of seed;• Seed fortification; Seed pelleting.

**Suggested readings:**

- Dutta M and Saini GC. 2009. Advances in Forestry Research in India, Vol. XXX. Forest Tree Improvement and Seed Technology. International Book Distributors.
- KhullarP, Thapliyal RC, Beniwal BS, Vakshasya and Sharma A. 1991. Forest Seeds. ICFRE.

- Lars H Schmidt. 2000. Guide to Handling of Tropical and Subtropical Forest Seeds. Danida Forest Seed Centre.
- Mema NP. 1989. Principles of Seed Certification and Testing. Allied Publ.
- Negi SS. 2008. Forest Tree Seeds. International Book Distributers
- Ram Prasad and Kandya RK. 1992. Handling of Forestry Seeds in India.Associated Publ.
- Vanangamudi K. 2007. Advances in Seed Science and Technology, Volume IV. Agrobios (India). Vanangamudi K. 2013. Advances in Seed Science and Technology, Volume III. Agrobios (India).
- William RL. 1985. A Guide to Forest Seed Handling with Reference to the Tropics. FAO.
- Zobel B and Talbert J. 1984. Applied Forest Tree Improvement. John Wiley & Sons.


## Details of Multiple Entry and Multiple Exit (MEME) Programmes

**As per the NEP 2020, students may**

### Name of the Programme: Certificate in M.Sc. Forestry

**Eligibility:** 3 Years (Hons) B.Sc. in Life Science and 4 Year B.Sc. in Forestry.

The student admit either in semester 1 or 3 earning 20 credits and exit after the completion of 1 semester will be awarded for Certificate in M.Sc. Forestry.

### Name of the Programme: Diploma in M.Sc. Forestry

**Eligibility:** 3 Years (Hons) B.Sc. in Life Science and 4 Year B.Sc. in Forestry.

The student admit either 1st or 2nd year on completion of 2 semesters of M.Sc. Forestry Programme earning 40 credits and exit with the completion of 2 semesters will be awarded for Diploma in M.Sc. Forestry.

### Name of the Programme: M.Sc. in Forestry

**Eligibility:** 3 Years (Hons) B.Sc. in Life Science and 4 Year B.Sc. in Forestry.

Candidate on completion of all the 4 semesters of M.Sc. Forestry Programme earning 80 credits will be awarded for Degree in M.Sc. Forestry.

**Note:** Students re-entering after an exit must complete the remaining semesters to obtain higher qualifications for example, a student with a certificate from semester 1 can re-enter semester 2 to get Diploma or continue to semester 3 and 4 for Master Degree in Forestry.

### Question pattern for END TERM examination

**Theory Papers:**

**Questions should be taken from all the units**

| | |
|---|---|
| Part A- all the questions should be answered | - 05X03=15 |
| Part B- all the questions should be answered | - 03X05=15 |
| Part-C Answer any Three questions | - 03X10=30 |
| **Total** | **= 60 Marks** |
| **In case of 80 Marks Papers (CBCP) the questions are** | |
| Part A- all the questions should be answered | - 05X04=20 |
| Part B- all the questions should be answered | - 05X04=20 |
| Part-C Answer any Three questions | - 04X10=40 |
| **Total** | **= 80 Marks** |

**Practical Papers:**

**Questions should be asked from the completed experiments of core courses**

| | |
|---|---|
| Part-A: Minor Experiment should be given | - 1X05=05 |
| Part-B: Major Experiment should be given | - 1X10=10 |
| Record & Viva Voce | - 05 Marks |
| **Total** | **=20 Marks** |

## Evaluation pattern for Theory Papers

- Question papers for term end examination should be obtained from course teacher or university directives.
- Answer script of Term End Examination should be evaluated by course teacher or other faculty appointed by Head of the Department or university directives.
- Internal marks should be given by the concerned course teacher.

**Pattern for Internal Mark Distribution (20 Marks)**

| | | |
|---|---|---|
| 1. | Assignment | 05 Marks |
| 2. | Seminar | 05 Marks |
| 3. | Attendance | 10 Marks |
| | **Total** | **20 Marks** |

**Project Work/Dissertation:**

- Allotment of the dissertation will be done by the Head of Department along with other faculty members of the department.
- The dissertation may be undertaken in parental or sister departments of the university (science department) or any of the National Laboratories/ Institute/ Universities/ Government approved Companies/ Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.
- The dissertation will be evaluated by the Departmental Committee under the chairmanship/Head of the Department or University directives.
- **Note:** Duly certified record notebooks should be submitted for all the practical examinations and those who do not submit need not be permitted to the concerned practical examination.