Master of Science in Botany

PROGRAMME STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

BOARD OF STUDIES IN BOTANY (PG)
MAHATMA GANDHI UNIVERSITY

Objectives and Programme outcome

M.Sc. Botany Programme is a two-year post-graduate programme, which deals with basic and advanced study on plants. It is one of the multi-disciplinary fields with great demand in various fields of research and development. The programme envisages developing understanding and knowledge for applying into sectors like agriculture, horticulture, floriculture, biotechnology, genomics, forest and environment. The programme is divided across 4 semesters of 90 days each.

These are exciting times in Biology. The world of Biology has been transformed in the last few decades. There was too much to select from. However, the Board of studies designed the programme envisioning the following objectives:

- To encourage a clear, comprehensive and advanced mastery in the field of Botany.
- To provide basic principles of biological sciences with special reference to Botany and itsapplied branches.
- Enabling the students to explore the intricacies of life forms at cellular, molecular and Nano level.
- To sustain students' motivation and enthusiasm and to help them not only to appreciate the beauty of different life forms but also to inspire them in the dissemination of the concept of biodiversity conservation.
- To develop problem solving skills in students and encourage them to carry out innovativeresearch projects thereby enkindling in them the spirit of knowledge creation.
- To maintain a high level of scientific excellence in botanical research with added emphasis on the role of plants in the structure and functioning of terrestrial and aquatic communities and ecosystem
- To equip students to perform functions that demand higher competence in National/International fields.

THE PROGRAM STRUCTURE

Course code	Title of the course	Teaching hours		Credits
		Theory	Practical	
SEMESTER I				
BY010101	Microbiology	27	9	4
	Phycology	45	36	
BY010102	Mycology	36	36	4
	Crop pathology	36	18	
BY010103	Bryophytes	36	18	4
	Pteridophytes	36	36	
BY010104	Gymnosperms and Paleobotany	36	27	3
	Evolution	18	--	
BY010105	Microbiology, Phycology, Mycology and Crop Pathology Practical			2
BY010106	Bryology, Pteridology, Gymnosperms, and Paleobotany Practical			2
Total		**270**	**180**	**19**
SEMESTER II				
BY010201	Anatomy	36	27	4
	Developmental Biology	18	9	
	Horticulture	18	9	
BY010202	Cell Biology	27	18	4
	Genetics	27	18	
	Plant Breeding	18	9	
BY010203	Plant Physiology	45	36	4
	Biochemistry	27	27	
BY010204	Molecular Biology	54	18	3
BY010205	Anatomy, Developmental Biology, Horticulture, Cell biology, Genetics and Plant breeding Practical			2
BY010206	Plant Physiology, Biochemistry and Molecular biology Practical			2
Total		**270**	**180**	**19**
SEMESTER III				
BY010301	Research Methodology	18	9	4
	Micro-technique	18	27	
	Biostatistics	18	9	
	Biophysical Instrumentation	18	18	
BY010302	Biotechnology, Bioinformatics and Bio-nanotechnology	72	36	4
BY010303	Angiosperm Taxonomy, Economic Botany and Ethanobotany	72	63	4
BY010304	Environmental Science	54	18	3
BY010305	Research Methodology Micro technique, Biostatistics, Biophysics and Biotechnology and Bioinformatics Practical			2
BY010306	Angiosperm Taxonomy, Economic Botany and EnvironmentalScience Practical			2
Total		**270**	**180**	**19**

SEMESTER IV				
BY820401	Elective course III Environmental Science – Basic Concepts in Environmental Studies	90	72	4
BY820402	Elective course III Environmental Science –Natural Resources and their management	90	54	4
BY820403	Elective course III Environmental Science – Environmental Monitoring and Management	90	54	4
BY820404	Elective course III Environmental Science – Practical paper I Basic Concepts in Environmental Studies			2
BY820405	Elective course III Environmental Science – Practical paper II Environmental Science –Environmental Monitoring and Management, Environmental Monitoring and Management	/		2
	Project work			4
	Viva-voce			3
Total		**270**	**180**	**23**

EVALUATION AND GRADING

Evaluation: The evaluation scheme for each course shall contain two parts; (a) End semester evaluation (ESE) (External evaluation) (75% weightage) and (b) continous evaluation (CE) (Internal evaluation) (25% weightage). Both ESE and CE shall be carried out using direct grading system.
The model of the components and its weightages for CE and ESE are shown in below:

a) For theory (CE) (Internal)

	Components	Weightage
I.	Assignment	1
II.	Seminar	2
III.	Best two test papers	2(1 each)
Total		5

b) For theory (ESE) (External)

Evaluation is based on the pattern of question. Different types of questions shall be given different weights to quantify their range as follows:

l. No.	Type of questions	Weight	No.of questions to be answered
I.	Short answer type questions	1	8 out of 10
II.	Short essay / problem solving type questions	2	6 out of 8
III.	Long Essay type questions	5	2 out of 4

c) For Practical (CE) (Internal)

Components	Weightage
Written/Lab test	2
Lab involvement and record	1
Viva	2
Total	5

d) For Practical (ESE) (External)

Components	Weightage
Written/Lab test	7
Lab involvement and record	3
Viva	5
Total	15

e) For project (CE) (Internal)

Components	Weightage
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva	1
Total	5

f) For project (ESE) (External)

Components	Weightage
Relevance of the topic and analysis	3
Project content and presentation	7
Project viva	5
Total	15

g)Comprehensive viva - voce (CE) (Internal)

Components	Weightage
Comprehensive viva – voce (all courses from first semester to fourth semester)	5
Total	5

e) Comprehensive viva - voce (ESE) (External)

Components	Weightage
Comprehensive viva – voce (all courses from first semester to fourth semester)	15
Total	15

Performance Grading

Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a 7-point scale as detailed below.

Range	**Grade**	**Indicator**
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very Good
3.00 to 3.49	B	Good (Average)
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal (Pass)
Upto 1.99	D	Deficient (Fail)

Semester grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) calculations

SGPA (S_j) = $\Sigma(C_i \times G_i)/ \Sigma C_i$

(SGPA= Total credit points awarded in a semester/ total credits of the semester)

Where $\mathbf{S_j}$ is the J^{th} semester, '$\mathbf{G_i}$' is the grade point scored by the student in the i^{th} course '$\mathbf{C_i}$' is the credit of the i^{th} course.

CGPA= $\Sigma(C_i \times S_i)/ \Sigma C_i$

(CGPA= Total credit points awarded in all semesters / Total credits of the programme)

Where' $\mathbf{C_i}$' is the credit for the i^{th} semester '$\mathbf{S_i}$' is the SGPA for the i^{th} semester. The SGPA and CGPA shall be rounded off to 2 decimal points.

SEMESTER I

FIRST SEMESTER COURSES

BY010101	MICROBIOLOGY AND PHYCOLOGY
BY010102	MYCOLOGY AND CROP PATHOLOGY
BY010103	BRYOLOGY AND PTERIDOLOGY
BY010104	GYMNOSPERMS, PALEOBOTANY AND EVOLUTION
BY010105	MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND CROP PATHOLOGY- PRACTICAL
BY010106	BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, AND PALEOBOTANY - PRACTICAL

Total Credits: 19
Total Hours: 450

BY010101: Microbiology and Phycology
(Theory 27+45=72 Hrs; Practical 9+36=45Hrs)
Credits 4

MICROBIOLOGY (27 hrs)

Module 1: Introduction to microbiology	(2 hrs)
Module 2: Bacteria	(7 hrs)
Module 3: Bacterial systematic	(4 hrs)
Module 4: Culture of microorganisms	(4 hrs)
Module 5: Plant–Microbe interactions	(2 hrs)
Module 6: Viruses	(8 hrs)

Practical (9 hrs)

1. Preparation and sterilization of microbial culture media -Nutrient broth and nutrient agar
2. Inoculation of bacteria-stabbing and streaking
3. Differential staining of bacteria using Gram stain.
4. Endospore staining
5. Isolation of Rhizobium from root nodules.
6. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.
7. Streak out a bacterial culture on an agar plate and isolation of colonies –Quadrant streaking method
8. Antibacterial assay - disc diffusion/agar well method.

Phycology (45 hrs)

Module 1: Introduction	(4 hrs)
Module 2: General features of Algae	(27 hrs)
Module 3: Ecological and Economic importance of Algae	(9 hrs)
Module 4: Algal biotechnology	(5 hrs)

Practical (36 hrs)

1. Critical study of diagnostic features and identification of the following genera based onmorphological, anatomical and reproductive parts;

(a) Cyanophyceae - *Gleotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema*.

(b) Chlorophyceae - *Chlamydomonas, Volvox, Ecballocystopsis, Ulothrix, Microspora, Ulva,Cladophora, Pithophora. Coleochaeta, Chaetophora, Drapernaldia, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium, Desmedium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella*.

(c) Xanthophyceae – *Vaucheria*.

(d) Bacillariophyceae –O*dontella, Navicula*.

(e) Phaeophyceae - *Ectocarpus, Colpomenia, Hydroclathrus, Dictyota, Padina, Sargassum, Turbinaria*.

(f) Rhodophyceac - *Brtrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*.

2. Students are to collect and identify algae from different habitat. Prepare and submit a report of the field work with sufficient photographs of algal collection.

BY010102 MYCOLOGY AND CROP PATHOLOGY

(Theory 36 + 36 = 72 Hrs; Practical 36 + 18 = 56 Hrs) Credits 4

MYCOLOGY (36 hrs)

Module 1: General introduction	(2 hrs)
Module 2: Thallus structure and reproduction in Fungi	(27 hrs)
Module 3: Fungal associations and Fungal Physiology	(5 hrs)
Module4 : Physiology of Fungi	(2hrs)

Practical (36 hrs)

1. Critical study of the following types by preparing suitable micropreparations; *Stemonitis, Physarum, Saprolegnia, Phytophthora, Albugo, Rhizopus, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Phyllochora, Puccinia, Termitomyces, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Pestalotia, Parmelia,Graphis , Usnea, Cladonia.*

2. Isolation of fungi from soil and water by culture plate technique.

3. Staining and microscopicstudy of mycorrhizal colonization in root

4. Collection and identification of common field macro fungi/lichen (10 types).Submit report with photographs

CROP PATHOLOGY (36 hrs)

Module 1: Introduction to crop pathology	(2 hrs)
Module 2: Process of infection and pathogenesis	(4 hrs)
Module 3: Defense mechanism in plants	(4 hrs)
Module 4: Transmission of plant disease	(3 hrs)
Module 5: Plant disease management	(8 hrs)

Module 6: Major diseases in plants (15 hrs)

Practical (18 hrs)

1. Identify the diseases mentioned in the syllabus with due emphasis on symptoms and causative organisms by Herbarium/ live specimen.

2. Isolation of pathogens from diseased tissues (leaf, stem, fruit and seed) by blotter / culture methods.

3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.

4. Culture media preparation and sterilization PDA/ Czapek dox's medium

BY010103: BRYOLOGY AND PTERIDOLOGY

(Theory 36 + 36 = 72 Hrs; Practical 18 + 36= 54 Hrs) Credits: 4

Module 1: Introduction (4hrs)
Module 2: Ecological significance of bryophytes (3hrs)
Module 3: Economic importance of bryophytes (3hrs)
Module 4: General characters and thallus organization (26 hrs)

Practical (18 hrs)

1. Detailed study of the structure of gametophytes and sporophytes of the following genera of Bryophytes by suitable micropreparation: *Riccia, Targionia, Cyathodium, Marchantia, Lunularia,Dumortiera, Reboulia, Pallavicinia, Porella, Anthoceros, Notothylas, Sphagnum, Pogonatum*.

2. Students are expected to submit a report of field trip to bryophytes natural habitats to familiarize with the diversity of bryophytes.

PTERIDOLOGY (36hrs)

Module 1: General introduction	(2 hrs)
Module 2: Classification and evolution of Pteridophytes	(9 hrs)
Module 3: Structure of the plant body	(20 hrs)
Module 4: Developmental studies in Pteridophytes	(3 hrs)
Module 5: Ecological and economic importance	(2 hrs)

Practical (36 hrs)

1. Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera:

Lycopodium, Isoetes, Selaginella, Equisetum, Psilotum, Angiopteris, Ophioglossum, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia (Dicranopteris), Pteris and *Adiantum.*

2. Study of fossil pteridophytes with the help of specimens and permanent slides.
3. Field trips to familiarize with the diversity of pteridophytes in natural habitats and submit a report.

BY010104: GYMNOSPERMS, PALAEOBOTANY AND EVOLUTION

(Theory: 27 + 09 + 18= 54 hrs; Practical: 27 hrs) Credits: 4

GYMNOSPERMS (27 hrs)

Module 1: Introduction	(3 hrs)
Module 2: Vegetative and reproductive structures of Gymnosperms	(20 hrs)
Module 3: Gametophyte development of Gymnosperms	(2 hrs)
Module4: Economic importance of Gymnosperms	(2 hrs)

Practical (27 hrs)

1. Study the morphology and anatomy of vegetative and reproductive parts of *Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria, Podocarpus* and *Gnetum.*

2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarize various gymnosperms in nature and field, identification of Indian gymnosperms and submit a report.

PALEOBOTANY (Theory: 9 hrs; Practical: 9 hrs)

Module 1: Introduction	(1 hr)
Module 2: Fossils	(3 hrs)
Module 3: Techniques and Preservation	(3 hrs)
Module 4: Nomenclature and applied aspects	(2 hrs)

EVOLUTION: (Theory: 18 hrs)

Module 1: Introduction	(3 hrs)
Module 2: Evidences for evolution	(2 hrs)
Module3: Natural Selection	(3 hrs)
Module 4: Mutation as an Evolutionary Force	(3 hrs)
Module 5: Speciation	(3 hrs)
Module 6: Co-evolution	(2 hrs)

SEMESTER II

SECOND SEMESTER COURSES

BY010201	PLANT ANATOMY, DEVELOPMENTAL BIOLOGYAND HORTICULTURE
BY010202	CELL BIOLOGY, GENETICS AND PLANT BREEDING
BY010203	PLANT PHYSIOLOGY AND BIOCHEMISTRY
BY010204	MOLECULAR BIOLOGY
BY010205	PLANT ANATOMY, DEVLOPMENTAL BIOLOGY, HORTICULTURE, CELL BIOLOGY, GENETICS AND PLANT BREEDING - PRACTICAL
BY010206	PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY - PRACTICAL

Total Credits: 19
Total Hours: 450

BY010201: PLANT ANATOMY, DEVELOPMENTAL BIOLOGY AND HORTICULTURE

(Theory: 36 + 18+ 18= 72 Hrs; Practical: 27 + 09 + 09= 45 Hrs) Credits: 4

PLANT ANATOMY (Theory: 36 Hrs; Practical: 27 Hrs)

Module 1: Introduction	(1 hr)
Module 2: Meristem	(4 hrs)
Module 3: Secondary Structure	(16 hrs)
Module 4: Leaf and Node	(4 hrs)
Module 5: Reproductive Anatomy	(8 hrs)
Module 6: Applied Anatomy	(3 hrs)

Practical (27 Hrs)

1. Study the Anomalous- Primary and Secondary features in:*Bignonia, Amaranthus, Nyctanthes, Piper, Bougainvillea* and *Strychnos.*
2. Study of stomatal types (Anomocytic, anisocytic, paracytic and piacytic) and determination of stomatal index.
3. Study of nodal patterns (Unilacunar. Trilacunar and Multilacunar).

DEVELOPMENTAL BIOLOGY (Theory: 18 Hrs+ Practical: 9 Hrs)

Module 1: History and Basic Concepts of Development (5hrs)
Module 2: Overview of Plant Development (9 hrs)
Module 3: Morphogenesis and Organogenesis in Plants (4 hrs)

Practical (9hrs)

1. Embryo excision from young seeds.

2. Identification of different types of ovules, embryos, polyembryony, endosperm, pollen grains, anther growth stages.

HORTICULTURE **(Theory: 18 Hrs Practical: 9 Hrs)**

Module 1: Introduction (2 hrs)
Module 2: Principles of Horticulture (4 hrs)
Module 3: Horticulture Applications (6 hrs)
Module 4: Floriculture (3 hrs)
Module 5: Modern trends in horticulture (3 hrs)

Practical: (9 Hrs)

1. List out the Garden components in the Photograph.
2. Demonstration of Preparation of a Terrarium.
3. Propagation methods-layering and grafting.

BY010202: CELL BIOLOGY, GENETICS AND PLANT BREEDING
(Theory: 27+27+18=72Hrs; Practical: 18+18+9=45 Hrs; Credits: 4)

CELL BIOLOGY (Theory: 27 Hrs; Practical: 18 Hrs)

Module 1: Introduction to plant cells (7 hrs)
Module 2: Cell signaling (6 hrs)
Module 3: Cell interaction (4 hrs)
Module 4: Cytoskeleton (3 hrs)
Module 5: Cell cycle and its regulation (7 Hrs)

Practical (18 hrs)

1. Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems (Recorded by photomicrographs).
2. Identification of different stages of meiosis from suitable plant material (Recorded by photomicrographs).
3. Microscopic observation (Chloroplast).
4. Study of mitotic index from suitable plant material.

GENETICS (Theory: 27Hrs; Practical: 18 Hrs)

Module 1: Genetics - From "Factors" to "Genes" and gene interactions (6 hrs)
Module 2: Human Genetics and Cancer (9 hrs)
Module 3: Mutations (4 hrs)
Module 4: Population Genetics (8 hrs)

Practical (18 Hrs)

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis, Cytoplasmic Inheritance, Multiple alleles and quantitative inheritance.
2. Work out problems in population genetics-gene and genotype frequency, Hardy-Weinberg equilibrium.

PLANT BREEDING (Theory: 18 Hrs; Practical 9 hrs)

Module 1: Introduction (2 hrs)
Module 2: Hybridization (3 hrs)
Module 3: Idiotype breeding (2 hrs)
Module 4: Breeding for resistance (3 hrs)
Module 5: Mutation breeding (6 hrs)
Module 6: Modern breeding methods (2 hrs)

Practical: (9 Hrs)

1. Hybridization techniques in self and cross pollinated plants.
2. Estimation of pollen sterility through in-vitro germination/staining-technique.
3. Visit a Plant Breeding station to familiarize with breeding programmes. Submit a report of the visit.

BY010203: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(Theory 45+27 =72 Hrs; Practical 36+27=63 Hrs; Credits: 4)

PLANT PHYSIOLOGY (Theory: 45 Hrs; Practical: 63 Hrs)

Module 1: Transport and Translocation of water and solutes	(8 hrs)
Module 2: Photosynthesis	(12 hrs)
Module 3: Respiration	(10 hrs)
Module 4: Nitrogen metabolism:	(4 hrs)
Module 5: Stress physiology	(4 hrs)
Module 6: Sensory photobiology	(4 hrs)
Module 7: Plant growth regulators	(3 hrs)

Practical (36 hrs)

1. Measurement of Photosynthesis - Hill Reaction.
2. Estimation of proline in plant tissues under various abiotic stresses.
3. Estimation of phenol in plant tissues affected by biotic stress.
4. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
5. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.
6. Determination of osmotic potential by tissue weight method.
7. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the Rf value
8. Demonstration of amylase activity and GA effect in germinating cereal seeds.
9. Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution.
10. Separation and collection of leaf pigments by silica gel column chromatography.
11. Determination of nitrate reductase activity.
12. Extraction and estimation of leghaemoglobin from root nodules.

BIOCHEMISTRY (Theory: 27 Hrs; Practical 27 Hrs)

Module 1: Introduction	(2 hrs)
Module 2: Carbohydrates	(4 hrs)
Module 3: Lipids	(5 hrs)
Module 4: Amino acids and proteins	(5 hrs)
Module 5: Enzymes	(7 hrs)
Module 6: Secondary metabolites	(4 hrs)

Practical (27 Hrs)

1. Preparation of buffers-Citrate and Phosphate-various strengths.
2. Quantitative estimation of reducing sugar.
3. Separation of amino acids by TLC.
4. Quantitative estimation of protein (Lowry's method).
5. Preparation of Molar, Normal, Percentage and PPM solutions and their dilutions
6. Estimation of total phenolics in plant tissue
7. Isolation and estimation of amylase from germinating seeds.

BY010204: MOLECULAR BIOLOGY
(Theory 54 hrs; Practical 18 hrs; Credits: 3)

Module 1: Nucleic acids	(6 hrs)
Module 2: Organization of the Genome	(4 hrs)
Module 3: Replication of the Genome	(6 hrs)
Module 4: Gene Expression	(15 hrs)
Module 5: Control of Gene Expression	(10 hrs)
Module 6: Recombination	(5 hrs)
Module 7: Epigenetic inheritance	(4 hrs)
Module 8: Mutation repair	(5 hrs)

Practical (18 hrs)

1. Work out problems based on DNA structure, replication, gene expression and genetic code (Genetic code chart may be brought for reference during examination).

SEMESTER III

THIRD SEMESTER COURSES

BY010301	RESEARCH METHODOLOGY, MICRO-TECHNIQUE, BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION
BY010302	BIOTECHNOLOGY, BIOINFORMATICS AND BIO-NANOTECHNOLOGY
BY010303	ANGIOSPERM TAXONOMY,ECONOMIC BOTANY AND ETHANOBOTANY
BY010304	ENVIRONMENTAL SCIENCE
BY010305	RESEARCH METHODOLOGY MICROTECHNIQUE, BIOSTATISTICS, BIOPHYSICS AND BIOTECHNOLOGY NAD BIOINFORMATICS PRACTICAL
BY010306	ANGIOSPERM TAXONMY, ECONOMIC BOTANY AND ENVIRONMENTAL SCIENCE PRACTICAL

Total Credits: 19
Total Hours: 450

BY010301: RESEARCH METHODOLOGY, MICROTECHNIQUE,BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION

(Theory: 18+18+18+18= 72 Hrs; Practicals: 09+27+09+18 = 63Hrs) Credits:4

RESEARCH METHODOLOGY (Theory: 18 Hrs)

Module 1: Introduction (3 hrs)
Module 2: Review of literature (6 hrs)
Module 3: Preparation of project report and Dissertation/Thesis (3 hrs)
Module 4: Preparation of Project Proposals,Presentation and Publication of Research Outcomes (6 hrs)

Practical (9 Hrs)

1. Visit a scientific library or documentation center and submit a report.
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper.
4. Prepare a list of references.

MICROTECHNIQUE (Theory: 18 Hrs)

Module 1: Killing and Fixing (3 hrs)
Module 2: Dehydration, Clearing, Embedding and Sectioning (5 hrs)
Module 3: Staining (5 hrs)
Module 4: Whole mounts (5 hrs)

Practical (27 Hrs)

1. Students are expected to be thorough with the following techniques.
   (a) Preparation of semi-permanent slides.
   (b) Preparation of permanent slides.
   (c) Preparation of whole mounts.
   (d) Maceration.
   (e) Preparation of fixatives (FAA, Carnoys'fluid).
   (f) Preparation of dehydration series (Alcohol, Acetone, TBA).
   (g) Preparation of paraffin blocks.
   (h) Preparation of serial sections.
2. Candidates should prepare and submit 10 permanent slides in which the followingcategories should be included:
   (a) Free hand sections (single/double stained).
   (b) Serial sections (single/double stained).
   (c) Wood sections and whole mounts.

BIOSTATISTICS (Theory18 Hrs)

Module 1: Introduction to Statistics (4 hrs)
Module 2: Probability, Correlation and Regression (5 hrs)
Module 3: Design of experiments (4 hrs)

Module 4: Tests of Significance (5 hrs)

Practical (9 Hrs)

1. Test the significance of a given data using t-Test, Chi square -test.
2. Analysis of a set of data for Correlation / Regression (Scatter diagram).
3. Determine the probability for different types of events.

BIOPHYSICAL INSTRUMENTATION (Theory 18 Hrs)

Module 1: Introduction to Microscopy (3 hrs)
Module 2: Principles and Applications of Instruments (6 hrs)
Module 3: Basic Principles and Applications of Chromatography (4 hrs)
Module 4: Basic principles and applications of Electrophoresis and Spectroscopy (5 hrs)

Practical: (18 Hrs)

1. Micrometry; calibrate the ocular and stage micrometre on a light microscope and measure an object.
2. Calibrate the pH meter and measure the pH of different samples.
3. Estimate the concentration of the given sample using colorimeter or spectrophotometer.
4. Separate plant pigments by TLC or Column chromatography.

BY010302: BIOTECHNOLOGY, BIOINFORMATICS AND BIONANOTECHNOLOGY (Theory 72 Hrs; Practical 36 Hrs; Credits: 4)

BIOTECHNOLOGY (54 hrs)

Module 1: Bioprocess Technology (5 hrs)
Module 2: Plant tissue culture (12 hrs)
Module 3: Genetic engineering (15 hrs)
Module 4: Genome editing (3 hrs)
Module 5: Advanced tools and techniques in Biotechnology (10 hrs)
Module 6: Genomics (5 hrs)
Module 7: Societal concerns with biotechnology (4 hrs)

BIOINFORMATICS (13 hrs)

Module 1: Methods, tools and applications of bioinformatics (3 hrs)
Module 2: Advanced tools and techniques in Biotechnology (10 hrs)

BIONANOTECHNOLOGY (5 Hrs)

Module 1: Introduction to nanoparticles and nanotechnology (3 hrs)
Module 2: Applications of bionanotechnology (2 hrs)

Practical (36 Hrs)

1. Production of amylase by solid state and submerged fermentation.
2. Preparation of the stock solutions of MS medium.
2. Preparation of MS medium from stock solutions.
3. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium.
4. DNA isolation from coconut/onion/cauliflower and separation using agarose gel.
5.Blast search with Protein Sequence (*Magnolia latahensis*sequence)
6. Blast search with Nucleic Acid Sequence (Neanderthal man's Paleo DNA)
7. Phylogenetic tree creation with the help of CLUSTAL X, W or MUSCLE and tree drawing tools.
8. Creation of phylogentic trees for selected families ofEudicots
9. Molecular docking (using either free or commercialSoftware)

BY010303:ANGIOSPERM TAXONOMY, ECONOMIC BOTANYAND ETHNOBOTANY

(Theory - 72 Hrs;Practical - 63 Hrs; Credits: 4)

Module 1:Introduction (6 hrs)
Module 2:Units of classification and Phylogeny of Angiosperms (9hrs)
Module 3:Data sources of taxonomy (brief account): (5hrs)
Module 4:Methodology of Identification of plants (9 hrs)
Module 5:Tools of Taxonomy (3 hrs)
Module 6:Botanical Nomenclature (4 hrs)
Module 7:Study of angiosperm diversity (27 hrs)
Module 8:Economic Botany (6 hrs)
Module 9: Ethnobotany (3 hours)

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Practical (63 Hrs)

1. Workout a minimum of 2 members from each family with suitable sketches and description in technical terms of locally available plants. Record reasons assigned for Class, subclass, series/order, family and draw at least one species from each family in the record.
2. Identification of local flora using Flora of Presidency of Madras- J. S. Gamble.
3. Conduct study tour for not less than 5 days to study angiosperm diversity and collect plants from diverse habitats belonging to plant families specified above and also visit important botanical gardens and institutions of taxonomic research and submit a report.
4. Preperation of 25 herbarium specimens from the plant families of study and submit.
5. Study of preperation of dendrogram using a suitable software (of a family or Genus of study).

6. Workout nomenclatural problems regarding priority and author citations.
7. Familiarization of morphological terms form live specimens; specimens of economic botany from families of study.

BY010304: ENVIRONMENTAL SCIENCE

(Theory 54 Hrs; Practical 27 Hrs; Credits 3)

Module 1: Introduction to Ecological Science	(2 hrs)
Module 2: Autecological concepts - Population Ecology	(5 hrs)
Module 3: Synecological concepts - Community ecology	(5 hrs)
Module 4: Dynamic Ecology - Ecological succession	(3 hrs)
Module 5: Biosphere and Ecosystem	(7 hrs)
Module 6: Phytogeography	(5 hrs)
Module 7: Environmental pollution	(10 hrs)
Module 8: Environmental biotechnology and solid waste management	(4 hrs)
Module 9: Global environmental problems and climate change	(4 hrs)
Module 10: Biodiversity and its conservation	(9 hours)

Practical (27 hrs)

1. Analysis of water quality for; (a) Dissolved CO_2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate (f) Total alkalinity.

2. Quantitative estimation of dissolved silicate, dissolved sulphate, nitrite and total alkalinity.

2. Physico-chemical analysis of soil: (a) Total water soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).

3. Quantitative and qualitative community analysis. Carry out a project on species structure and the frequency, abundance, density of different species and similarity index of different communities in a natural system. Students must be able to explain the structure of vegetation from the given data on the above mentioned characteristics.

4. Phytoplankton counting using Sedgwick Rafter counter.

5. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community) and submit a report.

6. Students should be aware of the common environmental problems, their consequences and possible solutions.

SEMESTER IV

FOURTH SEMESTER COURSES

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE				
BY820401	Basic concepts in environmental studies	90	72	4
BY820402	Natural resources and their management	90	72	4
BY820403	Environmental monitoring and management	90	72	4
BY820404	Basic concepts in environmental studies - Practical			2
BY820405	Natural resources and their management & Environmental monitoring and management - Practial			2
	Project work			4
	Viva-voce			3

Total Credits: 23

Total Hours: 450

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820401: BASIC CONCEPTS IN ENVIRONMENTAL STUDIES

(Theory 90 Hrs; Practical 72 Hrs; Credits 4)

Module 1: History	(5 hrs)
Module 2: Natural environment	(7 hrs)
Module 3: Earth and its atmosphere	(18 hrs)
Module 4: Weather and Climate	(20 hrs)
Module 5: Ecosystems	(20 hrs)
Module 6: Community Ecology	(10 hrs)
Module 7: Population ecology	(10 hrs)

Practical (72 hrs)

1. Qualitative and quantitative study of freshwater/marine planktons
2. Soil texture using micrometry from two different sites. Principle and explanation
3. Determination of moisture content.
4. Determination of soil pH from at least three different locations and correlate it with the soil type
5. Determination of chloride, calcium, magnesium, potassium and phosphorous.
6. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results. Compare the results of Dark and Light bottle method and Chlorophyll method.
7. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices.
8. Identification of plants growing in different habitats and studying their adaptations

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820402: NATURAL RESOURCES AND THEIR MANAGEMENT
(Theory 90 hrs; Practical 54 hrs; Credits 4)

Module 1: Natural resources and their management	(4 hrs)
Module 2: Principles of resource management – Water resources	(8 hrs)
Module 3: Principles of resource management – Energy resources	(10 hrs)
Module 4: Principles of resource management – Land resources	(4 hrs)
Module 5: Principles of resource management – Food resources	(5 hrs)
Module 6: Principles of resource management – Mineral resources	(5 hrs)
Module 7: Principles of resource management – Biological resources	(34 hrs)
Module 8: Environmental economics	(10 hrs)
Module 9: Society and Environment	(10 hrs)
Module 10: Environmental ethics	(4 hrs)

Practical (54 hrs)

1. Water Quality Analysis:

a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica.

b. Determination of total dissolved salts (TDS).

2. Toxicity Analysis of Water: For Chlorine, H2S, Ammonia, Copper and Chromium.

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY030403: ENVIRONMENTAL MONITORING AND MANAGEMENT
(Theory 90 Hrs; Practical 54 Hrs; Credits 4)

Module 1: Environmental Management	(12 hrs)
Module 2: Ecosystem Management	(10 hrs)
Module 3: Solid Waste Management	(8 hrs)
Module 4: Toxicology	(15 hrs)
Module 5: Environmental Impact Assessment	(6 hrs)
Module 6: Remote Sensing and GIS	(17 hrs)
Module 7: Environment versus Development	(5 hrs)
Module 8: Sustainable Development	(10 hrs)
Module 9: Environmental laws and policies	(7 hrs)

Practical (54 hrs)

1. Estimation of BOD and COD of polluted water.
2. Isolation and Enumeration of microorganisms in soil (TBC or TMC) - Types of Bacteria and fungi.
3. Bacteriological quality testing of water and waste water.

a. Presumptive Coliform test b. Confirmatory Coliform test.

Field Study: (Three/four days) Visit at least one Institution engaged in environment/conservation research and a sanctuary/national park and an industrial/polluted area or any natural ecosystems. Submit a report of the study with photgraphs of the activity.