ST. MARY'S COLLEGE (AUTONOMOUS)
Re-accredited with A+ Grade by NAAC

Thoothukudi – 628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

Syllabus

M.Sc. Botany

School of Biological Sciences Outcome Based Curriculum

(w.e.f. 2024)

Programme Outcome:

PO No.	After completion of the Postgraduate programme the students of St. Mary's College will be able to
PO 1	acquire expertise knowledge in their respective disciplines and become professionals.
PO 2	develop critical/logical thinking skills, managerial skills and become locally, nationally & globally competent and be a lifelong learner
PO 3	pursue research / higher learning programme & apply their experiment and research skills to analyse and solve complex problems.
PO 4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO 5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Programme Specific Outcome:

PSO No.	Students of M. Sc Botany will be able to	PO Matched
PSO-1	show proficiency in understanding cryptogams and phanerogams, as well as expertise in regulating biochemical processes, comprehending molecular mechanisms, analyzing palynological and embryological processes, exploring plant pathology and applying biostatistics.	**PO1**
PSO-2	develop advanced skills in laboratory techniques, identification of plants, microbial and molecular techniques, medicinal plants, handling of instruments, advanced software for biology, plant pathology, IPR, remote sensing and ethnobotany.	**PO2**
PSO-3	make use of critical thinking to formulate and independently carry out projects, design experiments both in the field and laboratory and execute them utilizing all requisite abilities.	**PO2, PO4**
PSO-4	employ an interdisciplinary approach by blending diverse areas of botany with other scientific disciplines for the purpose of conducting research.	**PO3, PO4, PO5**
PSO-5	apply the acquired knowledge to suggest remedies for diverseaspects of human and environmental well-being.	**PO3,PO5**

ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI
DEPARTMENT OF BOTANY
PG COURSE STRUCTURE (w. e. f. 2024)

SEMESTER I

Components	Course Code	Course Title	Hours/ Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **I**	24PBOC11	Plant Diversity I (Algae, Fungi, Lichens and Bryophytes)	6	5	40	60	100
Core **II**	24PBOC12	Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)	5	4	40	60	100
Core **III**	24PBOC13	Microbial Technology	5	4	40	60	100
Core Practical **I**	24PBOCR1	Algae, Fungi, Lichens and Bryophytes Practical	2	1	40	60	100
Core Practical **II**	24PBOCR2	Pteridophytes, Gymnosperms, Paleobotany and Microbial Technology Practical	4	2	40	60	100
Discipline Specific Elective **I**	24PBOE11 24PBOE12	**Ethnobotany, Naturopathy and Traditional healthcare** Herbal Technology	4	3	40	60	100
Skill Enhancement Course **I**	24PBOSE1	Agriculture Technology	4	3	40	60	100
		Total	**30**	**22+2**			

SEMESTER II

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **IV**	24PBOC21	Taxonomy of Angiosperms	6	5	40	60	100
Core **V**	24PBOC22	Plant Anatomy and Embryology	5	4	40	60	100
Core **VI**	24PBOC23	Ecology and Conservation Biology	5	4	40	60	100
Core Practical **III**	24PBOCR3	Taxonomy of Angiosperms Practical	2	1	40	60	100
Core Practical **IV**	24PBOCR4	Plant Anatomy, Embryology, Ecology and Conservation Biology Practical	4	2	40	60	100
Discipline Specific Elective **II**	24PBOE21/ 24PBOE22	**Plant Protection** Renewable Energy Resources	4	3	40	60	100
Skill Enhancement Course **II**	24PBOSE2	Soilless Culture	4	3	40	60	100
MOOC (Compulsory)				+2			
		Total	**30**	**22+2**			

Note: MOOC should be completed in the I Year. Internship can be completed during the II Semester vacation.

SEMESTER III

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core **VII**	24PBOC31	Biochemistry	6	5	40	60	100
Core **VIII**	24PBOC32	Genetics, Plant Breeding and Biostatistics	5	5	40	60	100
Core **IX**	24PBOC33	Plant Biotechnology	5	4	40	60	100
Core Practical **V**	24PBOCR5	Biochemistry Practical	2	1	40	60	100
Core Practical **VI**	24PBOCR6	Genetics, Plant Breeding Biostatistics and Plant Biotechnology Practical	4	2	40	60	100
Discipline Specific Elective **III**	24PBOE31/ 24PBOE32	**Research Methodology and Bioinstrumentation** Nanobiotechnology	4	3	40	60	100
Skill Enhancement Course **III**	24PBOSE3	Horticulture Techniques	4	3	40	60	100
Self-Study (Optional)/ Internship	24PBOSS1	Plant Resource Utilization		+2	--	50	50
		Total	**30**	**23+2**			

Semester IV

Components	Course Code	Course Title	Hours/ Week	Credits	Max.Marks		
					CIA	ESE	Total
Core **X**	24PBOC41	Physiology	6	5	40	60	100
Core **XI**	24PBOC42	Cell Biology, Molecular Biology and Bioinformatics	6	5	40	60	100
Core **XII**	24PBOC43	Marine Biology	6	5	40	60	100
Core Practical **VII**	24PBOCR7	Physiology Practical	2	1	40	60	100
Core Practical **VIII**	24PBOCR8	Cell Biology, Molecular Biology, Bioinformatics and Marine Biology Practical	4	2	40	60	100
Core **XIII** (Project)	24PBOP41	Project and Viva Voce	6	5	40	60	100
		Total	**30**	**23**			

SEMESTER I			
CORE I - PLANT DIVERSITY I (ALGAE, FUNGI, LICHENS AND BRYOPHYTES)			
Course Code: 24PBOC11	**Hrs / Week: 6**	**Hrs / Semester: 90**	**Credits: 5**

COURSE OBJECTIVE

To learn about the classification, distinguishing traits, geographic distribution, reproductive cycle and economic importance of algae, fungi, lichens, and bryophytes.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the structural organizations, ecological and economic importance of algae, fungi, lichens and bryophytes	K1
CO2	discuss both the theoretical and practical knowledge in understanding the diversity of basic life forms and their economic importance.	K2
CO3	relate life cycle patterns in algae, fungi, lichens and bryophytes and present the knowledge of their chemical components into develop industrial products.	K3
CO4	compare and contrast the mode of reproduction in diverse groups of basic plant forms and their economic importance.	K4
CO5	conclude and develop skills for effective utilization of lower plant forms.	K5

SEMESTER I			
CORE I - PLANT DIVERSITY I (ALGAE, FUNGI, LICHENS AND BRYOPHYTES)			
Course Code: 24PBOC11	**Hrs / Week: 6**	**Hrs / Semester: 90**	**Credits: 5**

UNIT I **Algae:** General account of algology, Contributions of Indian Phycologist: T.V. Desikachary (2019- 2005). V. Krishnamurthy (1921-2014), and M.O.P. Iyengar (1886-1963). Classification of algae by F.E. Fritsch (1935-45). Algae of diverse habitats, range of thallus organization, reproduction (vegetative, asexual and sexual) and life cycle patterns. Origin and evolution of sex in algae. Salient features of the following classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Pheophyceae and Rhodophyceae.

UNIT II **Type Study:** systematic position, structure, reproduction and life cycle of *Oscillatoria, Scytonema, Rivularia, Ulva, Cladophora, Vaucheria*, Diatom, *Padina*, *Dictyota*, *Hypnea, Acanthophora.* Economic importance of algae.

UNIT III **Fungi:** General Characteristics and mode of nutrition in fungi. Contributions of Indian Mycologists (C.V. Subramanian (1924-2016)), Classification of Fungi by Alexopoulos and Mims (1979). **Type Study:** systematic position Structure, reproduction and life cycle of *Synchytrium*. *Pythium, Rhizopus, Aspergillus, Agaricus, Colletotrichum.* Heterothallism, heterokaryosis and para sexuality in fungi. Sex hormones in fungi. Economic importance of fungi.

UNIT IV **Lichen:** History of lichenology, types of lichens on the basis of habitats, symbiotic association of lichens: mycobionts and phycobionts. Morphology and physiology of lichens, classification of Lichens by Polet (1973). Structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Ecology of lichens. Economic importance of lichens.

UNIT V **Bryophytes:** General characters and Classification of Bryophytes by Rothmaler (1951). **Type Study:** systematic position, structure,

reproduction and life cycle of *Targionia*, *Porella*, *Polytrichum*, *Sphagnum*. Economic importance of bryophytes.

Books for Reference

1. Alexopoulos, C. J., & Mims, M. (2007). *Introductory Mycology. 4th Edition*. Wiley Publishers.
2. Barsanti, L., & Guadtieri, P. (2014). *Algae: Anatomy, Biochemistry and Biotechnology, 2nd Edition*, CRC Press.
3. Edwardlee, R. (2018). *Phycology, 5th Ed., Cambridge University Press, London*.
4. Johri, R. M., Lata, S., & Tyagi, K. (2012). *A Textbook of Bryophyta*. Dominant Publishers & Distributors Pvt., Ltd., New Delhi.
5. Kevin, K. (2018). *Fungi biology and Application, 3rd Edition*. Wiley Blackwell.
6. Kumar, H. D. (1999). *Introductory Phycology*. Affiliated East-West Press, Delhi.
7. Nash, T. H. (2008). *Lichen Biology*, Cambridge University press.
8. Pandey, P. B. (2014). *College Botany-1: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta*. Chand Publishing, New Delhi.
9. Sharma, O. P. (2014). Bryophyta, Mcgraw Hill..
10. Sharma, O. P. (2011). *Fungi and Allied Microorganisms*, Mc Graw Hill.
11. Singh., Pandey., & Jain. (2020). *A text book of Botany, 5th Edition, Rastogi Publication*. Meerut.
12. Sundaralingam, V. (1991). *Marine algae*. Bishen Singh and Mahendra Pal Singh Publishers, Dehradun.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	3	2
CO2	3	3	2	2	3	3	3	3	2	3
CO3	3	2	3	3	2	3	2	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

S-Strong (3) M-Medium (2) L-Low (1)

SEMESTER I			
CORE II - PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)			
Course Code: 24PBOC12	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 4**

COURSE OBJECTIVE

The course is structured to explore the evolutionary diversification, morphology, anatomy, reproduction, life cycles and fossil evidence of vascular plants, offering a holistic perspective on their evolutionary journey and ecological roles.

COURSE OUTCOMES

CO. No.	On completion of this course, the students will be able to:	PO
CO1	recall the classification, general characters of the classes and economic importance of vascular plants.	**K1**
CO2	relate the morphological and anatomical features of different genera of pteridophytes, gymnosperms and fossils.	**K2**
CO3	demonstrate or present the life cycle patterns and abnormalities in life cycle of vascular plants.	**K3**
CO4	compare the evolutionary relationship of pteridophytes, gymnosperms and fossils.	**K4**
CO5	evaluate the impact of environmental changes the affect vascular plants.	**K5**

SEMESTER I			
CORE II - PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)			
Course Code: 24PBOC12	**Hrs / Week: 5**	**Semester: 75**	**Credits: 4**

UNIT I **Pteridophytes**: General characteristics, Classification (Reimer, 1954) (up to Order level), Reproduction, Alternation of generation in life cycle, Abnormalities in life cycle (apogamy and apospory), Stelar evolution. Heterospory and seed habit, Sorus and its types, Telome theory, Affinities with bryophytes, gymnosperms and angiosperms, Economic importance.

UNIT II **Type Study:** Morphology, anatomy, reproduction and life history of *Psilotum, Isoetes, Equisetum, Angiopteris, Osmunda, Salvinia.*

UNIT III **Gymnosperms:** General account of Gymnosperms: morphology, anatomy, reproduction, phylogeny. Classification by K. R. Sporne (1965), Economic importance of Gymnosperms.

UNIT IV **Type Study:** Morphology, anatomy, reproduction and life history of *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum* and *Ephedra.*

UNIT V **Paleobotany:** Introduction, Geological time scale, Contribution of Birbal Sahni to paleobotany, Gondwana flora of India, Fossilization and fossil types, Economic importance of fossils. Detailed study fossil pteridophytes (*Rhynia, Lepidocarpon, Calamites*), fossil gymnosperms (*Cordaites* and *Lyginopteris*).

Books for Reference

1. Arnold, A.C. (2005). *An Introduction to Paleobotany.* Jodhpur: Agrobios.
2. Bhatnagar, S.P., & Alok Moitra. (2020) *Gymnosperms*. Bengaluru: New Age International (P) Ltd., Publishers.
3. Johri, R.M., Lata, S., & Tyagi, K. (2005). *A text book of Gymnosperms*. New Delhi: Dominate pub and Distributer.
4. Pandey, S.N., & Trivedi, P.S. (2015) *A Text Book of Botany Vol. II*. New Delhi: Vikas Publishing.
5. Rashid, A. (2013). *An introduction to Pteridophyta – Diversity, Development and differentiation.* New Delhi: Vikas Publications.

6. Sharma, O.P. (2017). *Pteridophyta*. New York: McGraw Hill Education. Singh, V., Pandey, P.C., & Jain, D.K. (2021). *A Text Book of Botany*. Meerut: Rastogi Publications.
7. Sporne, K.R. (1967). *The Morphology of Gymnosperms*. London: Hutchinson & Co.
8. Sporne, K.R. (2017). *The morphology of Pteridophytes* (The structure of Ferns and Allied Plants). Warsaw: Andesite Press.
9. Taylor, E., Taylor, T., & Krings, M. (2008). *Paleobotany: The Biology and Evolution of Fossil Plants.* USA: Academic Press.
10. Vashishta, P.C., Sinha, A.K., & Anil Kumar. (2018). *Botany for Degree students. Gymnosperms*. New Delhi: S. Chand and Company Ltd.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	2	2	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	3	3	2.8	2.8	3	2.8	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER I			
CORE III - MICROBIAL TECHNOLOGY			
Course Code: 24PBOC13	**Hrs / Week: 5**	**Hrs / Semester:75**	**Credits: 4**

COURSE OBJECTIVE

To provide insight into microbial diversity, growth mechanisms, contamination issues and their practical applications.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	understand the various types of microorganism, structural organization of bacteria, virus, mycoplasma and rickettsiales	K1
CO2	demonstrate the different techniques to culture bacteria, measure the growth of bacteria, purify virus, preserve milk and production of microbial products	K2
CO3	assess the role of microorganism in food processing, spoilage, dairy products and industrial processing.	K3
CO4	acquire skills to prepare nutrient media, preserve microbes, milk and dairy products.	K4
CO5	evaluate the antibiotics efficacy on microorganism and microorganisms in hydrocarbon degradation.	K5

SEMESTER I			
CORE III - MICROBIAL TECHNOLOGY			
Course Code: 24PBOC13	**Hrs / Week: 5**	**Hrs / Semester:75**	**Credits: 4**

UNIT I History and Scope of Microbiology, Microbial Diversity, Three domain system, Contributions of Antonie Van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming. Bacteria: Morphology (size, shape, motility), ultra structure of a bacterial cell. Transfer of genetic material through conjugation, transformation and transduction.

UNIT II **Bacterial culture:** Methods of culturing anaerobes, methods of isolation of pure culture, culture characteristics. Growth: bacterial growth pattern, factor influencing microbial growth, measuring microbial growth, preservation of microbes.

UNIT III **Viruses:** Types, structure, reproduction and life cycle of bacteriophages and TMV virus. Brief account on virioids, virusoids and prions. General account of mycoplasma and rickettsiales. Purification and quantitative assay of plant viruses. Mode of action of penicillin, streptomycin and sulfonamides.

UNIT IV **Food and dairy microbiology**: Sources of microbial contamination of food, food poisoning, food-borne infections. Methods of food preservation. Microbial contamination of milk, milk-borne diseases, processing of milk products.

UNIT V **Industrial microbiology:** Structure and use of fermentor. Large scale production and importance: Alcohol (ethanol), Beverages (wine), Antibiotics (penicillin), Vitamin (B12), Enzyme (amylase). Role of microorganisms in hydrocarbon degradation.

Books for Reference

1. Baveja, C.P. (2009). A Textbook of *Microbiology*. New Delhi: Arya Publications.
2. Dubey, R.C., & Maheshwari, D.K. (2003). *A Textbook of Microbiology*. New Delhi: S. Chand and Company.
3. Kumar, H.D., & Swati Kumar. (2008). Modern Concepts of *Microbiology*. New Delhi: Vikas Publications.
4. Pelzar, M. J., Chan, E.C.S., & Noel R Krig. (2010). *Microbiology*. New Delhi: Tata McGraw-Hill Publishing Company Pvt. Ltd.
5. Prescot, L.M., Harley, J.P., & Klein, D.A. (2002). Microbiology. New York: McGraw-Hill.
6. Adams, M.R., & Moss, M.O. (2008). *Food Microbiology*. Cambridge: Royal Society of Chemistry.
7. Sullia, S.B., & Shantharam, S. (1998). *General Microbiology*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
8. Tauro, P., Kapoor, K.K., & Yadav, K.S. (1997). *An Introduction to Microbiology*. New Delhi: Wiley Eastern Company Ltd.
9. Tortora, G.J., Funke, B.R., & Case, C.L. (2004). *Microbiology: An Introduction* (8th ed.). New Delhi: Pearson Education Pvt. Ltd.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	2	3	2	2	2
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	3	3
Avg	3	3	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8

S-Strong (3) M-Medium (2) L-Low (1)

SEMESTER I			
CORE PRACTICAL I- ALGAE, FUNGI. LICHENS AND BRYOPHYTES PRACTICAL			
Course Code: 24PBOCR1	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

COURSE OBJECTIVE

To improve knowledge of the taxonomy of each group by mastering the ability of accurately identifying the morphology and microstructure of algae, and fungi, lichens, bryophytes etc., and develop the technical abilities in staining, sectioning, sterilizing, and characterizing the thallophytes, and other varieties of non-flowering plants.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO1	recall and applying the basic keys to distinguish at species level identification of important algae, fungi, lichens, bryophytes, pteridophytes and gymnosperms through its structural organizations.	**K1**
CO2	explain the structure of algae, fungi, lichens, Bryophytes	**K2**
CO3	demonstrate practical skills in identification of thallophytes	**K3**
CO4	analyse the importance of structural diversity in the evolution of plant forms.	**K4**
CO5	evaluate the techniques to isolate and culture of alga and fungi as well as to understand the diversity of plant forms.	**K5**

SEMESTER I			
CORE PRACTICAL I- ALGAE, FUNGI. LICHENS AND BRYOPHYTES PRACTICAL			
Course Code: 24PBOCR1	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit: 1**

1. Study of the following type with their reference to their systematic position, thallus and reproductive structures
   i. **Algae:** *Oscillatoria, Scytonema, Rivularia, Ulva, Codium, Cladophora, Vaucheria, Diatoms, Hypnea, Acanthophora, Padina, Dictyota* and *Stoechospermum*
   ii. **Fungi:** *Synchytrium Pythium, Rhizopus, Mucor, Aspergillus, Xylaria, Polyporus,* and *Agaricus*
   iii. **Lichens:** *Parmelia*
   iv. **Bryophytes:** *Targionia, Lunularia, Porella, Polytrichum* and *Sphagnum* (depending on availability of the specimen).
2. Separate the algal pigments by paper chromatography
3. Culturing of *Aspergillus* by streak plate method
4. Isolation and identification of fungi from soil by dilution plate and baiting method.
5. Isolation and identification of fungi from air by open plates method

Reference

1. Chmielewski, J. G., & Krayesky, D. (2013). *General Botany laboratory Manual*. Author House, Bloomington, USA.
2. Gangulee, H. C., & Kar, A. K. (2013). College Botany. Vth Edition. S. Chand.
3. Kumar, H. D. (1999). *Introductory Phycology*. Affiliated East-West Press, Delhi.
4. Sharma, O. P. (2017). *Bryophyta*, MacMillan India Ltd, New Delhi.
5. Webster, J., & Weber, R. (2007). *Introduction to Fungi*, 3rd Ed. Cambridge University Press, Cambridge.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	2	3	2
CO2	3	2	2	2	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	2.8	2.8	2.8	2.8	3	2.8	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER I			
CORE PRACTICAL II – PTERIDOPHYTES, GYMNOSPERMS, PALEOBOTANY AND MICROBIAL TECHNOLOGY PRACTICAL			
Course Code: 24PBOCR2	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

COURSE OBJECTIVE

To impart hands-on expertise in sterilization techniques, microbial identification, isolation, sectioning, characterization for both microbes and vascular plants, enhancing practical skills in biological sciences.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	identify the species of the plant and categorize the type of bacteria observed during the practical session.	K1
CO2	illustrate the microbiology experiments and categorize the genera of both pteridophytes and gymnosperms.	K2
CO3	compile the principle underlying the microbiology experiments and the distinguishing characteristics of the identified plant species.	K3
CO4	analyze the findings from the experiments and contrast the characteristics of pteridophytes and gymnosperms.	K4
CO5	conclude the experimental outcomes through discussion, providing evidence to support the distinguishing characteristics of vascular plants, supplemented by illustrative diagrams.	K5

SEMESTER I			
CORE PRACTICAL II – PTERIDOPHYTES, GYMNOSPERMS, PALEOBOTANY AND MICROBIAL TECHNOLOGY PRACTICAL			
Course Code: 24PBOCR2	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

PLANT DIVERSITY II

1. Study the following types with reference to their systematic position, thallus and reproductive structures of **Pteridophytes**: *Psilotum, Isoetes, Selaginella, Equisetum, Gleichenia, Pteris, Adiantum,* and *Salvinia*. **Gymnosperms**: *Thuja, Cupressus, Araucaria, Podocarpus, Gnetum and Ephedra*. (depending on availability of the specimen).
2. Study the fossil forms of *Rhynia, Lepidocarpon, Calamites. Cordaites* and *Lyginopteris.*

MICROBIAL TECHNOLOGY

1. Methods of sterilization, media preparation (Nutrient agar, potato dextrose agar and rose bengal agar), inoculation technique (streak plate method and pour plate method)
2. Identification of bacteria by Gram's staining
3. Effect of temperature, pH, salinity, disinfectants, radiation on the growth of bacteria.
4. Enumeration of bacteria found in milk - SPC method.
5. Testing the quality of milk - Dye-reduction test (Resazurin and Methylene blue).
6. Bacterial analysis of water for coli forms - MPN
7. Enumeration of soil bacteria by serial dilution technique (any three soil types).
8. Effect of antibiotics on the growth of bacteria. - Determination of MIC

Reference

1. Ashok, M. Bendre, & Kumar. (2010). *A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Paleobotany*. Rastogi publication.
2. Chmielewski, J.G & Krayesky, D. (2013). *General Botany Laboratory Manual*. Bloomington, USA: Author House.
3. Gangulee, H.C., & Kar, A.K. (2013). *College Botany*. New Delhi: S. Chand Publication.
4. Lakshmanan, M., Kunthala Jeyaraman, Jeyaraman, and Gnanam. (1971). *Laboratory experiments in microbiology and molecular biology*. Chennai: Higginbothams Pvt. Ltd.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	3	3	3	3	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	2	3	3	2	2	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTH CARE			
Course Code: 24PBOE11	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To explore the essence of ethnobotany, we delve into the intricate interplay between plant life, cultural lifestyles and traditional practices of indigenous tribes.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall the concept and their importance of ethnobotany and naturopathy.	K1
CO2	distinguish the life style and traditional practices of plants by Indian tribals.	K2
CO3	implement the role plants and their products for their livelihood of tribal people of India.	K3
CO4	analyse the methods to transform ethnobotanical knowledge into value added products.	K4
CO5	conclude the concept of digitizing ethnobotanical knowledge.	K5

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - ETHNOBOTANY, NATUROPATHY AND TRADITIONAL HEALTH CARE			
Course Code: 24PBOE11	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Ethnobotany**: Concept, important landmarks in the development, scope, sub disciplines of ethnobotany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of ethnobotany: A brief history of ethnobotanical studies in the world and in India.

UNIT II **Plants used by tribals of India:** Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars Badagas, Kurumbres, Thodas and Malayalis. Plants used by tribals of Tamil Nadu.

UNIT III **Sources of ethnobotanical data:** Primary: archeological sources and inventories, Secondary: travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research. Prior Informed Consent, Participatory Rural Appraisal (PRA) techniques, interviews and questionnaire methods, choice of resource persons. Folk taxonomy: plants associated with culture and socio-religious activities. Non–timber forest products (NTFP) and livelihood, Sustainable harvest and value addition.

UNIT IV **Naturopathic medicine:** Role of plants in naturopathy, Importance and relevance of medicinal drugs in India. Indian Systems of Medicine (Ayurveda, Siddha, Allopathy, Homeopathy, Unani, Tibetan, Yoga and Naturopathy). Disease diagnosis, treatment and cure using natural therapies: dietetics, botanical medicine, homeopathy, fasting, exercise, lifestyle counseling, detoxification, and chelation, clinical nutrition, hydrotherapy, naturopathic manipulation, spiritual healing, environmental assessment,

Traditional health care: Health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being.

UNIT V **Bioprospecting and value addition:** Bioprospecting of drug molecules derived from Indian traditional plants; Methods for bioprospecting of natural resources, From folk Taxonomy to species confirmation - evidences based on phylogenetic and metabolomic analyses; Ethnobotanical databases and Traditional knowledge Digital Library (TKDL).

Books for Reference

1. Gokhale, S. B., Kokate, C. K., & Gokhale, A. (2016). *Pharmacognosy of Taditional Drugs* (1st ed.). Pune: Nirali Prakashan.
2. Gringauz. (2012). *Introduction to Medicinal Chemistry: How Drugs Act & Why?*. Noida: Wiley India Pvt Ltd.
3. Jain, A., & Jain, S. K. (2016). *Indian Ethnobotany – Bibliography of the 21st Century*. India: Scientific Publishers.
4. Joshi, S. G. (2018). *Medicinal Plants*. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
5. Kumar, N. (2018). *A Textbook of Pharmacognosy*. India: Aitbs Publisher**.**
6. Laird, S. A. (2002). *Biodiversity and Traditional Knowledge*: *Ewuitable Partnerships in Practice*. London: Earthscan Publications Ltd.
7. Ministry of Environment and Forests. (1994). *Ethnobiology in India: A Status Report*. All India Coordinated Research Project on Ethnobiology. New Delhi: Ministry of Environment and Forests.
8. Singh, P. (2013). *Medicinal Plants*: *Conservation, Cultivation and Utilization*. New Delhi: Daya Publishing House.
9. Subramaniam, S. V., & Madhavan, V. R. (Eds.). (1983). *Heritage of the Tamil Siddha Medicine*. Madras: International Institute of Tamil Studies.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	3	2
CO2	3	3	3	2	3	3	3	3	3	3
CO3	2	2	3	3	2	2	2	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	2	3	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - HERBAL TECHNOLOGY			
Course Code: 24PBOE12	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To know the pharmacological importance of medicinal plants and to enlist phytochemicals and secondary metabolites of market and commercial value.

COURSE OUTCOMES

CO. No.	Upon completion of this course the student will be able to	PO
CO-1	recall the importance of herbal technology	K1
CO-2	understand the classification of crude drugs from various botanical sources.	K2
CO-3	apply new drug formulations using therapeutically valuable phytochemical compounds for the healthy life of society	K3
CO-4	analyze on the application of secondary metabolites in modern medicine	K4
CO-5	critique the current trade status and role of medicinal plants in socio economic growth.	K5

SEMESTER I			
DISCIPLINE SPECIFIC ELECTIVE I - HERBAL TECHNOLOGY			
Course Code: 24PBOE12	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I: Pharmacognosy- scope and importance - source - Crude Drugs – Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of crude drugs. Cultivation and utilization of medicinal and aromatic plants in India.

UNIT II: Plant tissue culture as source of medicines, Role of plant tissue culture in enhancing secondary metabolite production (*Withania somnifera, Rauwolfia serpentina, Catheranthus roseus, Andrographis paniculata* and *Dioscorea sp*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of phytopharmaceuticals.

UNIT III: Plant propagation analysis of phytochemicals - Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs - Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.

UNIT IV: General methods of phytochemical and biological screening - Carbohydrates and derived products: Glycosides - extraction methods (*Digitalis, Dioscorea*); Tannins (Hydrolysable and Condensed types); Volatile oils - extraction methods (Clove, Mentha). Study of some herbal formulation techniques as drug cosmetics.

UNIT V: Types of phytochemicals - Alkaloids - extraction methods (*Taxus, Cinchona*); Flavonoids- extraction methods, Resins- extraction method: Application of phytochemicals in phytopharmacueticals; Biocides, Biofungicides, Biopesticides. Women entrepreneurship development –

marketing cultivated medicinal plants – National Medicinal Plants Board of India.

Books for Reference

1. Rao, A. V. (2000). *Herbal cure for common diseases*. Diamond books, Pvt. Ltd.
2. Anonymous. (2004). *Cultivation of Selected Medicinal Plants*. National MedicinalPlants Board, Govt. of India, New Delhi.
3. Biswas, P. K. (2006). *Encyclopedia of Medicinal plants (Vol. I-VII)*. Dominant Publishers, New Delhi.
4. Chichister, U. K. J. (1999). *Cultivation and Processing of Medicinal Plants*. Wiley & Sons. Treaseand Evans.
5. Dey, A. C. (1998). *Indian medicinal plants used in Ayurvedic preparations*, Bishen Singh Mahendra Pal Singh Publication.
6. Kirthikar., & Basu. (2012). *Indian Medicinal Plants*. University Bookstore, Delhi. India.
7. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (1996). *Pharmacognosy*. Nirali Prakashan, 4th Ed.
8. Kumaresan, V., & Regland, A. (2004). *Taxonomy of Angiosperms systematic Botany, Economic Botany, Botany & Ethnobotany*. Saras publication.
9. Lewis, W. H., & Lewis, M. P. F. E. (1976). *Medical Botany. Plants affecting Man's Health*. A Wiley Inter Science Publication. John Wiley and Sons, New York.
10. Mukherjee, P. K. (2008). *Quality control of herbal drugs. 3rd edition. Business Horizons Pharmaceutical Publishers.* New Delhi, India.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3
Avg	3	3	3	3	3	3	3	2.8	2.8	3

S-Strong (3) M-Medium (2) L-Low(1)

SEMESTER I			
SKILL ENHANCEMENT COURSE I - AGRICULTURE TECHNOLOGY			
Course Code: 24PBOSE1	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To provide comprehensive knowledge about agriculture in Indian economy, microorganisms used in agriculture, limitations and constraints of biopesticides and their role in control of pests.

COURSE OUTCOMES

CO No.	Upon completion of this course, students will be able to	PO
CO1	recall the scope and importance of agriculture, biofertilizers and biopesticdes	**K1**
CO2	relate the general characteristics of agricultural zones, biofertlilzers and biopesticides used in agriculture and their production	**K2**
CO3	present the various factors affecting crop production, mass cultivation of biofertilizers	**K3**
CO4	analyze the climatic conditions in agriculture, biofertilizer in cultivation of crops, biopesticides and their beneficial role in controlling insect pests	**K4**
CO5	evaluate the various types of biofertilizer in plant growth and biopesticide in control of pests	**K5**

SEMESTER I			
SKILL ENHANCEMENT COURSE I- AGRICULTURE TECHNOLOGY			
Course Code: 24PBOSE1	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Introduction to Agriculture**: Definition, Scope of agriculture in India, Importance of agriculture in Indian economy, Branches of agriculture. Agro-climatic zones and of India and Tamil Nadu, Agro ecological zones of India. Classification of crops and soils. Factors affecting crop production: climatic, edaphic, bioticphysiographic and socio economic factors.

UNIT II **Biofertilizers:** Introduction, Benefits of using biofertilizer. Mass cultivation of biofertilizers: *Azospirllium*, *Azotobacter*, *Azolla*, production of mycorrhiza – *Rhizobium*, Phosphate Solubilizing Bacteria (PSB).

UNIT III **Biopesticides:** Introduction, History, Current status and global scenario of bio-pesticides, Advantages, Limitations and constraints of using bio-pesticides, Remedies for bio-pesticide production, Usage and marketing, Regulatory framework, Main statues and legal requirements for bio-pesticides.

UNIT IV **Pest control using biopesticides:** Pests of rice and their biocontrol (thrips, brown plant hopper, yellow stem borer and leaf folder). Pests of maize and their biocontrol (stem fly and stem borer). Pests of sugarcane and their biocontrol (white flies, sugarcane holy aphid and grass hopper). Pests of peanut and their biocontrol (red hairy caterpillar, gram pod borer and pod bug).

UNIT V **Lecture cum lab:** Hybrid seed production, Tissue culture: micropropagation, Biocontrol agents: *Trichoderma* and *Pseudomonas*, Soil testing (Submission of report).

Books for reference

1. Bailey, A., Chandler, D., Grant, W.P., Greaves, J., Prince, G., & Tatchell, M. (2010). *Biopesticides: pest management and regulation*. CABI Publishers.
2. Glare, T.R., & Moran-Diez, M.E. (2016). *Microbial-Based Biopesticides: Methods andProtocols.* New Jersey, USA: Humana Press.
3. Gnanamanickam, S.S. (2019). *Biological Control of Crop Diseases.* Florida, USA: CRC Press.
4. Kaushik, N. (2004). *Biopesticides for sustainable agriculture: prospects and constraints.* New Delhi: TERI Press.
5. Manoharachary, C., Singh, H.B., & Varma, A. (2020). *Trichoderma*: *Agricultural Applications and Beyond*. New York, USA: Springer International Publishing.
6. Nollet, L.M.L., & Rathore, H.S. (2019). *Biopesticides Handbook.* Florida,USA: CRC Press.
7. Sahayaraj, K. (2014). *Basic and Applied Aspects of Biopesticides.* New Delhi: Springer India.
8. Suri, S. (2019). *Biofertilizers and biopesticides*. New Delhi: A.P.H. Publishing Corporation.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	2	2	3	3	3
Avg	3	2.8	2.8	2.8	3	2.8	2,8	2.8	3	3

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER II			
CORE IV - TAXONOMY OF ANGIOSPERMS			
Course Code: 24PBOC21	**Hrs / Week : 6**	**Hrs / Semester: 90**	**Credits: 5**

COURSE OBJECTIVE

To recognize the key areas of modern taxonomy to ensure students with deep understanding of plant character identification, classification and nomenclature

Course Outcomes:

Co. No.	On completion of this course the students will be able to:	PO
CO1	recall the taxonomic hierarchy, botanical nomenclature, major system and tools of classification, characteristics and economic significance of families	**K1**
CO2	discuss the various taxonomic evidences, classification and current trends in biosystematics. compare the vegetative, floral characters of the different families	**K2**
CO3	compile the relative merits and demerits of major systems of classifications, rules of ICBN, tools of taxonomy and economic importance of the different families.	**K3**
CO4	analyze and illustrate the floral characters of different families and outline the principles of botanical nomenclature, major systems of classifications and the taxonomic evidences	**K4**
CO5	conclude the characteristics of the locally available plants prescribed in the syllabus and construct taxonomic key (group activity)	**K5, K6**

SEMESTER II			
CORE IV - TAXONOMY OF ANGIOSPERMS			
Course Code: 24PBOC21	**Hrs / Week : 6**	**Hrs / Semester: 90**	**Credits: 5**

UNIT I **Introduction**: Definition, objectives and brief history of plant taxonomy. **Botanical Nomenclature**: need for scientific name, type method, author citation, and typification and effective publication, rejection of names and principle of priority. Principles, rules and recommendations of ICBN. **Phylocode**: principles and salient features. **Taxonomical Hierarchy:** Taxonomic groups, categories and ranks, species concept, infraspecific ranks, genus and family.

UNIT II **Classifications:** Relative merits and demerits of major systems of classifications: Linnaeus (1753), Bentham and Hooker's (1862-1883) and Angiosperm Phylogeny Group (IV) (2016). **Current Trends in Biosystematics**: **Phenetics**: principles of taximetrics, Operational Taxonomic Units (OTUs). **Cladistics**: phylogenetic terms, concepts and phylogenetic diagrams. **Numerical taxonomy**: construction of taxonomic groups, applications, merits and demerits.

UNIT III **Tools of Taxonomy**: Floras, manuals, monographs, websites. Roles of herbarium and important botanical gardens (New York Botanical Garden, USA & Royal Botanical Garden, Kew) of the World. **Dichotomous keys**: guidelines for constructing dichotomous keys (indented and bracketed key). **Digital herbaria:** e- flora. **Taxonomic evidences:** anatomy, cytology, embryology and chemosystematics based on the phytochemicals (phenols, alkaloids, flavonoids and terpenoids). Molecular systematics (DNA bar coding).

UNIT IV **Vegetative, floral characters and economic importance of the following families:**

Polypetalae: Capparidaceae, Brassicaeae, Malvaceae, Tiliaceae, Meliaceae, Rhamnaceae, Sapindaceae, Papilionaceae Mimosaceae, Combretaceae, Passifloraceae

Gamopetalae: Sapotaceae, Solanaceae, Boraginaceae.

UNIT V **Vegetative, floral characters and economic importance of the following families:**

Gamopetalae: Scrophulariaceae, Bignoniaceae, Verbenaceae. **Monochlamydeae**: Nyctaginaceae, Casuarinaceae. **Monocots**: Musaceae, Zingiberaceae, Cannaceae, Commelinaceae, Cyperaceae.

Books for Reference

1. Jain, S. K., & Rao, R. R. (1993). *A handbook of field and herbarium methods*. Today and Tomorrow Publcation, Delhi.
2. Kumaresan, V., & Regland, A. (2004). *Taxonomy of Angiosperms systematic Botany, Economic Botany & Ethnobotany*. Saras Publication, Nagercoil, Tamil Nadu.
3. Pandey, B. P. (1999). Economic *Botany*. New Delhi: S.Chand & Company Ltd.,New Delhi.
4. Pandey, B. P. (2013). *Taxonomy of Angiosperms.* S. Chand Publishing, New Delhi.
5. Pandurangan, A. G., Vrinda, K. B., & Dan, M. (2013). *Frontiers in plant taxonomy*. JNTBGRI, Thiruvananthapuram, Kerala.
6. Rendle. (1979). *The classification of flowering plants vol. II & I.* Vikas Publishing House Pvt. Ltd., Shaibabad, UP.
7. Sharma, O. P. (2017). *Plant Taxonomy*. *(II Edition).*The McGraw Hill Companies. New Yark.
8. Singh, V., & Jain. (1997). *Taxonomy of Angiosperms*, Rastogi publications, New York.
9. Singh, G. (2007). *Plant systematics theory and practices*. Oxford and IBH Publishing Co. Shahpur, Delhi.
10. Subramaniam, N. S. (1997). *Modern plant taxonomy*. Vikas Publishing House, New Delhi.
11. Vardhana, R. (2009). *Economic Botany. 1st ed.* Sarup Book Publishers Pvt Ltd. New Delhi.
12. Vashista, P. C. (1985). *Taxonomy of Angiosperms*. New Delhi: Vikas Publications.
13. Wallis, T. E. (1999). *Text book of Pharmacognosy*. CBS Publishers and Distributors, New Delhi.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	2	3	2	3	2	3	2	2	2
Avg	3	2.8	3	2.8	2.8	2.8	3	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER II			
CORE V- PLANT ANATOMY AND EMBRYOLOGY			
Course Code: 24PBOC22	**Hrs / Week: 5**	**Hrs / Semester:75**	**Credits: 4**

COURSE OBJECTIVE

The course is designed to provide a comprehensive understanding of angiosperms, examining their origin, structure, growth, development and reproduction by delving into the intricacies of anatomy and embryology

COURSE OUTCOMES

CO. No	On completion of this course, the students will be able to:	PO
CO1	describe the diverse functions performed by plant tissues and reproductive organs in the life cycle of angiosperms.	**K1**
CO2	illustrate the internal structure of various plant organs, as well as the distinctive characteristics of male and female gametophytes in angiosperms.	**K2**
CO3	demonstrate the developmental processes involved in the formation of tissues, organs, as well as male and female gametophytes within angiosperms.	**K3**
CO4	analyze the contrasting anatomical features between monocotyledonous and dicotyledonous plants, while also delving into the variations in ovule types and embryo sac structures.	**K4**
CO5	suggest approaches for facilitating both vegetative and reproductive growth processes in angiosperms.	**K5**

SEMESTER II			
CORE V-PLANT ANATOMY AND EMBRYOLOGY			
Course Code: 24PBOC22	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 4**

UNIT I **Meristematic tissues**: Definition, characteristics, classification of meristems, theories of root and shoot apices. **Permanent tissues:** simple tissues (parenchyma, collenchyma and sclerenchyma), complex tissues (xylem and phloem). **Secretary tissues:** external and internal.

UNIT II **Primary structure:** General account of dicot root, stem, leaf and monocot root, stem, leaf. Development of lateral roots and adventitious roots, Root – stem transition. Ontogeny of leaves.

UNIT III **Secondary growth:** activity of cambium (formation of cambial ring and secondary vascular tissues, structure of wood), activity of cork cambium (formation of periderm, bark, lenticels) in dicot stem. Secondary growth in dicot root. Anomalous secondary growth in dicot stem (*Bignonia*, *Mirabilis)* root (*Raphanus*) and monocot stem (*Dracaena)*. Nodal anatomy, Seed anatomy.

UNIT IV **Embryology:** Structure of microsporangium, Microsporogenesis. Structure of pollen grain. Development of male gametophyte. Structure of megasporangium, Types of ovules, Megasporogenesis, Development of female gametophyte. Types of embryo sac (monosporic, bisporic, tetrasporic).

UNIT V Fertilization, Sexual incompatibility (pollen-stigma incompatibility), methods to overcome incompatibility, Types of endosperm (nuclear, cellular, helobial), Types of haustoria, Functions of endosperm. Structure and development of dicot and monocot embryo. Causes and classification of polyembryony, Practical application of polyembryony.

Books for Reference

1. Bhojwani, S. S., Bhatnagar, S.P., & Dantu, P.K. (2015). *The Embryology of Angiosperms*. New Delhi: Vikas Publishing House.
2. Bierhorst, D.W. (1971). *Morphology of Vascular Plants.* Newyork: Macmillan publishers.
3. Crang, R., Lyons-Sobaski, S., & Wise, R. (2018). *Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants.* USA*:* Springer International Publishing.
4. Cutler, D.F., Botha, T., & Stevenson, D.W. (2008). *Plant Anatomy: An Applied Approach*. Malden, USA: Black well Publishing.
5. *Eames, A.*J., & Mac Daniels, L.H. (2013). *Introduction to Plant Anatomy.* US: McGraw-HillInc.
6. Krishnamurthy, K.V. (1988). *Methods in Plant Histochemistry.* Madras: S. Viswanathan & Co.
7. Maheshwari, P. (1963). *Recent Advances in Embryology of Angiosperms.* New Delhi: Intl. Soc. Plant Morphologists.
8. Pandey. S.N. & Ajanta Chandha. (2006). *Plant Anatomy and Embryology*. New Delhi: Vikas Publishing House Pvt. Ltd.
9. Pullaiah, T., Lakshiminarayana, K., & Hanumantha Rao, B. (2006). *Textbook of Embryology of Angiosperms*. New Delhi: Regency Publications.
10. Sharma, P.C. (2017). *Text Book of Plant Anatomy.* New Delhi: Arjun Publishing House.
11. Swamy, B.G.L., & Krishnamurthy. K.V. (1990). *From flower to fruits.* New Delhi: Tata–McGraw Hill publishing Co Ltd.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	2	2	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	3	3	3	2.8	2.8	3	3	2.8	2.8	3

S-Strong (3) M-Medium (2) L-Low (1)

SEMESTER II			
CORE VI - ECOLOGY AND CONSERVATION BIOLOGY			
Course Code: 24PBOC23	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 4**

COURSE OBJECTIVE

To ensure a better understanding of communities, ecosystems, and biodiversity, as well as conservation strategies

COURSE OUTCOMES

CO. No	On completion of this course the students will be able to:	PO
CO1	describe the scope and importance of population ecology, plant communities and ecosystemecology	**K1**
CO2	understand the ecological, edaphic and biotic factor of the community	**K2**
CO3	identify the different ecosystem, threatened and endangered plant species and their conservation methods.	**K3**
CO4	evaluate the causes of endangered and endemic species	**K4**
CO5	recommend some methods to conserve and protect the biodiversity.	**K5**

SEMESTER II			
CORE VI - ECOLOGY AND CONSERVATION BIOLOGY			
Course Code: 24PBOC23	**Hrs / Week: 5**	**Hrs / Semester: 75**	**Credits: 4**

UNIT I **Ecosystem Ecology:** Introduction: types of ecology, importance of ecology. The earth environment: Biosphere, hydrosphere, lithosphere. Population structure and dynamics: Basic concepts - characteristics of population, size and density, dispersion, age structure, natality, mortality, biotic potential and life table. Population dynamics – theory of population growth, Plant population dynamics, Regulation of population growth, Evolution among population and population interaction

UNIT II Ecological Factors: Introduction: Abiotic factors, biotic factors, and anthropogenic factors. Ecosystem structure and Functions: structure of ecosystem, homeostasis, trophic level, food chain, pyramids, energy flow and biogeochemical cycle.

UNIT III **Ecosystem Development and Ecosystem of the world:** Types of succession, process of succession, hydrosere, xerosere, coevolution, tropical ecosystem, temperate ecosystem, boreal ecosystem, and Indian ecosystem.

UNIT IV **Biodiversity and wild life Conservation:** Conservation of biodiversity In situ conservation – National park, wild life sanctuaries and Biosphere reserve, afforestation, social forestry, agro forestry. Ex situ conservation - field gene bank, seed bank, pollen bank, tissue culture, DNA bank and cryopreservation methods. Species based approaches, Social approaches-sacred groves and sthalaviriksha. Green movements – Chipko movement and Silent valley movement.

UNIT V **Management Ecosystem for Sustainable uses.** Introduction, concept of ecosystem management, principles of sustainable develpoment, limitations, ecological urbanization. Global Environmental problems and conservation strategies: population explosion, climate change, loss of biodiversity, depletion of ozone layer, acid rain, conservation strategies.

Books for Reference

1. Dahiya, P., & Ahlawat, M. (2013). *Environmental Science: A New Approach.* New Delhi: Narosa Publishing House.
2. Gillson, L. (2015). *Biodiversity Conservation and Environmental Change*. Oxford: Oxford University Press.
3. Keddy, P. A. (2017). *Plant Ecology: Origins, Processes, Consequences* (2nd ed.). Cambridge: Cambridge University Press.
4. Kormondy, E. J. (2017). *Concepts of Ecology* (4th ed.). U.S.A.: Prentice Hall.
5. Krishnamurthy, K. V. (2006). *An Advanced Textbook on Biodiversity: Principles and Practice.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
6. Nachiketa, N. (2018). *Environmental & Ecology: A Dynamic Approach* (2nd ed.). New Delhi: GKP Access Publishing.
7. Odum, E. (2017). *Fundamentals of Ecology* (5th ed.). Bengaluru: Cengage.
8. Prabu, P. C., Udayasoorian, C., & Balasubramanian, G. (2009). *An Introduction to Ecology and Environmental Science*. Delhi: Avinash Paperbacks.
9. Rana, S. V. S. (2009). *Essentials of Ecology and Environmental Science*. New Delhi: PHI Learning Private Limited.
10. Sharma, P. D. (2017). *Ecology and Environment.* Meerut: Rastogi Publication.
11. Sharma, P. D. (2019). *Plant Ecology and Phytogeography*. Meerut: Rastogi Publications.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	2	3	3
CO2	3	3	2	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	2	3	3	3	3	3	3	3	3	3
Avg	2.8	3	2.8	2.8	2.8	3	3	2.8	3	3

S-Strong (3) M-Medium (2) L-Low (1)

SEMESTER II			
CORE PRACTICAL III - TAXONOMY OF ANGIOSPERMS PRACTICAL			
Course Code: 24PBOCR3	**Hrs / Week: 2**	**Hrs / Semester: 30**	**Credit:1**

COURSE OBJECTIVE

To understand and develop skill sets in plant identification and taxonomic key preparation

COURSE OUTCOMES

CO. No	On completion of this course the students will be able to:	PO
CO1	recall the botanical names, families, and morphological features of plants mentioned in the syllabus	**K1**
CO2	understand the principles and criteria for creating effective artificial keys for plant identification	**K2**
CO3	apply knowledge to correlate plant products with their morphological features, botanical names, and families	**K3**
CO4	analyze the characteristics of species using virtual herbarium and live specimens for accurate identification	**K4**
CO5	construct taxonomic keys for a variety of plant species, considering differentiating characteristics and evaluate accurate species descriptions based on virtual herbarium and live specimens	**K5 & K6**

SEMESTER II			
CORE PRACTICAL III - TAXONOMY OF ANGIOSPERMS PRACTICAL			
Course Code: 24PBOCR3	**Hrs/Week: 2**	**Hrs/Semester: 30**	**Credit:1**

1. Construction of taxonomic keys (dichotomous).
2. Study of wild taxa representing different families prescribed in the syllabus and identification to species level.
3. Study the economic important plants mentioned in the syllabus with special reference to the morphology, botanical name and family.
4. Solving nomenclature problems.
5. Identify the locally available plants using floras.

- A field trip at least 3-4 days to a floristically rich area to study plants in nature and field report submission of not less than 10 herbarium sheets representing the families studied.

Reference

1. Gample, J. S. (1956). *Flora of the Presidency of Madras–VolI & II*, Reprint. Authority of Secretary of state for Indian Council.
2. Mathew, K. M. (1981-1984). *The flora of Tamil Nadu, Carnatic. Volume I to III*. Tiruchirapalli: Rapinet herbarium, St. Joseph's College.
3. Subramaniam, N. S. (1996). *Laboratory Manual of Plant Taxonomy*. Vikas Publishing House Pvt. Ltd., New Delhi.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	2	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3	3
Avg	3	2.8	3	2.8	2.8	2.8	3	3	2.8	3

S-Strong(3) M-Medium(2) L-Low(1)

SEMESTER II			
CORE PRACTICAL IV - PLANT ANATOMY, EMBRYOLOGY, ECOLOGY AND CONSERVATION BIOLOGY PRACTICAL			
Course Code: 24PBOCR4	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

COURSE OBJECTIVE

The curriculum aims to explore how angiosperms adapt structurally and functionally to their surroundings, while also emphasizing the importance of conserving natural resources.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	describe the anatomy and reproductive structures of angiosperms, as well as delving into the quantitative traits of plant communities that provides a comprehensive understanding of botanical ecosystems.	K1
CO2	Explain the principles of the ecology experiments and the anatomy of root, stem and leaf of angiosperms.	K2
CO3	demonstrate maceration techniques, embryology and ecology experiments.	K3
CO4	analyze the findings from the experiments and contrast the characteristics of monocot and dicot plants.	K4
CO5	conclude the experimental outcomes through discussion, providing evidence to support the distinguishing characteristics of vascular plants, supplemented by illustrative diagrams.	K5

SEMESTER II			
CORE PRACTICAL IV - PLANT ANATOMY, EMBRYOLOGY, ECOLOGY AND CONSERVATION BIOLOGY PRACTICAL			
Course Code: 24PBOCR4	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 2**

PLANT ANATOMY AND EMBRYOLOGY

1. Study of shoot apex of Hydrilla
2. Study of trichomes.
3. Sectioning and observation of nodal types.
4. Study of anatomy of dicot and monocot leaves.
5. Study of secondary growth of dicot and monocot root and stem
6. Study of anomalous secondary growth of root and stem.
7. Study the leaves with respect to stomatal types by epidermal peeling.
8. Study and measure the wood element using the maceration technique and ocular meter.
9. Submission of permanent slide using double staining technique.
10. Sectioning of T.S. of anther
11. Observation if *in vitro g*ermination of pollen grains using hanging drop technique.
12. Dissection and observation of different stages of embryos.
13. Study the types of ovules and embryosac with the help of permanent slides/ photomicrographs.

ECOLOGY AND CONSERVATION BIOLOGY

1. Adaptation of plants – Hydrophytes, Xerophytes and Halophytes.
2. Determination of the quantitative characters of a plant community by quadrat method (abundance, density, dominance, species diversity, frequency).

3. Determination of the quantitative characters of a plant community by line transect method.
4. Determination of soil moisture, porosity, bulk density and pH.
5. Analysis of two soil samples for carbonate, nitrates and organic matter.
6. India map showing grassland, forest and desert.
7. Endangered / endemic plants list and photos (any 2)
8. India map showing biosphere reserves.

Reference

1. Bendre, A., & Kumar, A. (2008). *Text Book of Practical Botany II*. Meerut, India: Rastogi Publications.
2. Cutler, D. F., Botha, C. E. J., Stevenson, D. W., & William, D. (2008). *Plant Anatomy: An Applied Approach* (No. QK641C87). Oxford, UK: Blackwell.
3. Esau, K. (2006). *Anatomy of Seed Plants* (2nd ed.). John Wiley & Sons.
4. Nachiketa, N. (2018). *Environmental & Ecology: A Dynamic Approach* (2nd ed.). Noida, India: GKP Access Publishing.
5. Sharma, P. D. (2019). *Plant Ecology and Phytogeography*. Meerut, India: Rastogi Publications.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	2	3	3	3	3	3
CO3	2	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	3	3	3	2.8	2.8

S – Strong (3) M – Medium (2) L – Low (1)

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE II - PLANT PROTECTION			
Course Code: 24PBOE21	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To develop innovative strategies for controlling specific plant diseases based on understanding of pathogen biology and host-pathogen interactions.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	understand components of plant disease, the stages of development of plant diseases and recognize the general symptoms exhibited by plants caused by various pathogens.	K1
CO2	explain the interrelationship between hosts and parasites and the various defense mechanisms employed by plants against pathogens	K2
CO3	apply knowledge of different methods of plant disease control, integrated disease or pest management approaches to mitigate plant diseases	K3
CO4	analyze the characteristic features, symptoms, and control measures of common plant diseases, applying learned concepts to real-world scenarios.	K4
CO5	evaluate the epidemiology of plant diseases and forecast disease outbreaks and compare and contrast different methods used to study plant diseases,	K5

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE II - PLANT PROTECTION			
Course Code: 24PBOE21	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Introduction to plant disease**: Definition, Components (disease pyramid), Causes, classification, significance. Stages in the development of disease (disease cycle). **Symptoms of plant diseases:** Symptoms caused by fungi, bacteria, viruses, mycoplasma, nematodes.

UNIT II **Dissemination of plant pathogens:** Dissemination by air, water, animal, birds, insects, man and viruses. **Host parasite interaction**: mechanism of infection, path of infection, weapons of attack (enzymes, growth regulators and toxins in plant disease).

UNIT III **Defense mechanism:** General account, structural defense and biochemical defense. **Genetic basis of host-pathogen interaction:** Genes and disease, plant resistance (non-host resistance, true resistance, apparent resistance), genetics of virulence in pathogen and resistance in host plant, gene for gene concept, nature of resistance to disease, genetics of resistance through hypersensitive response.

UNIT IV **Methods of plant disease control:** regulatory methods, cultural methods, physical methods, chemical methods, biological methods (tactics of biological control, biological control of insects, nematodes, weeds, and mechanism of biological control). Integrated disease or pest management

UNIT V **Symptoms and control measures of common Plant diseases:** bacterial leaf blight of rice, citrus canker, leaf spot of brinjal, tikka disease of ground nut, wilt of cotton, downy mildew of grapes, bunchy top of banana, red rot of sugarcane, blister blight of Tea.

Books for Reference

1. Bilgrami, K. S., & Dube, H. S. (1985). *A Textbook of Modern Plant Pathology*. Sahibabad, Uttar Pradesh, India: Vikas Publishing House.
2. Pandey, B. P. (1999). *Plant Pathology*. New Delhi, India: S. Chand & Company Ltd.

3. Sharma, N., Sharma, A., & Tripathi, A. (2018). *Basic Plant Pathology*. New Delhi, India: CBS Publishers & Distributors Pvt. Ltd.
4. Sharma, P. D. (2013). *Plant Pathology*. New Delhi, India: Rastogi Publication.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	2	3	3	3	3	3
Avg	3	3	3	2.8	2.8	3	2.8	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE II - RENEWABLE ENERGY RESOURCES			
Course Code: 24PBOE22	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

The course is designed to enrich students' understanding of the diverse renewable energy resources present in the country, delving into their potential, the spectrum of energy technologies in promoting sustainable development.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	Discuss the need of energy conversion and various methods of energy storage.	K2
CO2	Demonstrate the fundamental concepts and working principles of renewable energy systems and devices	K3
CO3	Examine the field applications of renewable energy sources	K4
CO4	Evaluate renewable energy sources as an alternate form of energy and to know how it can be tapped.	K5
CO5	Create awareness among the students about the array of energy resources and highlight their significance for promoting sustainable energy practices.	K6

SEMESTER II			
DISCIPLINE SPECIFIC ELECTIVE II - RENEWABLE ENERGY RESOURCES			
Course Code: 24PBOE22	**Hrs / Week: 4**	**Hrs / Semester: 60**	**Credits: 3**

UNIT I **Fundamentals of Energy:** Introduction to energy, Classification of energy sources, Energy chain, Common forms of energy, Advantages and disadvantages of conventional and non-conventional energy sources, Environmental aspects of energy, Energy for sustainable development, Energy scenario in India.

UNIT II **Solar Energy:** Introduction, Types, advantages, disadvantages and applications of solar radiation, Solar water heating, Solar cooking, Solar greenhouse, Solar distillation, Solar pond.

UNIT III **Wind Energy:** Introduction, Basic principles of wind energy conservation, Wind energy conversion, Advantages and disadvantages of wind power, Wind energy storage, Application of wind energy, Environmental aspects of wind energy.

UNIT IV **Bio Energy:** Biomass resources, Biomass resource conversion technologies, Urban waste to energy conversion, Biomass gasification, Biomass liquification, Biogas production from waste biomass, Biodiesel production, Biomass energy scenario in India.

UNIT V **Ocean and Geothermal Energy:** Introduction to ocean energy, Principle of ocean thermal energy conversion (OTEC), Methods of electricity conversion system, Ocean tidal energy, Advantages, disadvantages and applications of OTEC, Geothermal energy source, Advantages, disadvantages and applications of geothermal energy, Environmental problems related to geothermal energy.

Books for Reference

1. Illayaraja, K., & Siddharth, S. (2000). *Renewable Energy Resources*. Mahesh Karthick Publications. Palani.
2. Twidell, J., & Weir, J. (2006). *Renewable Energy Resources* (2nd ed.). Taylor and Francis Group. London and New York.

3. Khan, B. H. (2009). *Non-conventional Energy Resources* (2nd ed.). Tata McGraw Hill Publication. Noida.
4. Kothari, D. P., Singal, K. C., & Ranjan, R. (2008). *Renewable Energy Sources and Emerging Technologies*. Prentice-Hall of India Private Limited. New Delhi.
5. Rai, G. D. (1999). *Non-conventional Energy Resources*. Khanna Publishers. New Delhi.
6. Rajput, R. K. (2012). *Non-conventional Energy sources and Utilization*. S. Chand and Company Ltd. New Delhi.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	2	3	3	3	3
CO3	3	2	3	3	3	3	3	3	2	3
CO4	3	3	2	3	3	3	2	3	3	3
CO5	2	3	3	3	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	3	2.8	2.8	3	2.8	3

S - Strong (3); M - Medium (2); L - Low (1)

SEMESTER II			
SKILL ENHANCEMENT COURSE II– SOILLESS CULTURE			
Course Code: 24PBOSE2	**Hrs. / Week: 4**	**Hrs. / Semester: 60**	**Credits: 3**

COURSE OBJECTIVE

To acquire proficiency in employing soilless cultivation techniques for growing plants in water – deficient conditions particularly focusing on commercial applications.

COURSE OUTCOMES

CO. No.	Upon completion of this course, students will be able to	PO
CO1	recall and consider the importance of nutrient solution disinfection, substrate kinds' and development impacts	K1
CO2	discuss the Soilless Plant Cultivation, Crop Layout Equipment, Container Media, Controlling Nutrient Solution Systems, and Features of Irrigation Systems	K2
CO3	construction of designing, calculating, and formulating hydroponic nutrient solutions	K3
CO4	examination on water, nutrients, and environmental factors management to influence plant growth and yield.	K4
CO5	justify different soilless culture systems, and their pros and cons	K5

SEMESTER II			
SKILL ENHANCEMENT COURSE II – SOILLESS CULTURE			
Course Code: 24PBOSE2	**Hrs. / Week: 4**	**Hrs. / Semester: 60**	**Credits: 3**

UNIT I **Hydroponic Systems:** Scope, importance and introduction to soilless cultivation of plants. History of solution culture, Present status of soilless culture. Soilless systems: deep water culture, floating hydroponics, NFT, plant plane hydroponics, aeroponics. Substrates for soilless system: bag culture, container culture, trough culture, thin layer systems, various alternative systems.

UNIT II **Equipments in Hydroponics:** Installations used to prepare and deliver nutrient solution, sensors. Equipment for the lay-out of the crop, equipment for irrigation and nutrient solution recycling. Physical properties of substrates: pH, EC, bulk density, particle size distribution, porosity, water release curves, hydraulic conductivity. Chemical properties of substrates: determination of water soluble and exchangeable nutrients, CEC, AEC, organic matter content.

UNIT III **Soilless Culture Media:** sand, gravel, rock wool, expanded minerals, pumice, zeolite, pyroclastic materials, peat, coir, tree bark, sawdust and wood fibres, Container media analyses: Total and available nutrients, Microbiology and phytosanitation.

UNIT IV **Nutrient Management in Hydroponics:** nutrient ratios on plant growth, yield and quality. Management of nutrient solution in open systems. Monitoring and adjusting the nutrient supply and nutrient recycling methods. Monitoring and controlling the climatic conditions: temperature, light, humidity, and carbon dioxide for plant culture.

UNIT V **Maintenance of Hydroponic Systems:** Nutrient solution disinfection: heating, UV-irradiation, chemical treatments by means of ozone, hydrogen peroxide, chlorine, iodine, etc., membrane filtration, slow sand filtration. Irrigation control in hydroponics: Characteristics of irrigation systems (capacity, uniformity). Delivery Systems (overhead systems, drip irrigation, sub irrigation). Irrigation scheduling (preset schedule, sensor based schedule, transpiration-based schedule).

Books for Reference:

1. Marschner, H. (1995). *Mineral Nutrition of Higher Plants* (2nd ed.) London: Academic Press.
2. Mengel, K. and Kirkby, E.A. (2001). *Principles of Plant Nutrition* (5th ed). Dordrecht: Kluwer Academic Publishers.
3. Raviv, M and Lieth, J.H. (2008). *Soilless Culture, Theory and Practice*. London: Elsevier.
4. Resh, Howard M. (2012). *Hydroponic food production: a definitive guide book for the advanced home gardener and the commercial hydroponic grower* 7th edition. ISBN: 978-1-4398-7867-5.
5. Schwartz, M. (1995). *Soilless Culture Management.* Springer Verlag, Berlin. Proceedings of the World Congress on Soilless.

MAPPING WITH PROGRAMME OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	3	2	3	2
CO2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	3	3	2	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

S-Strong (3) **M-Medium (2)** **L-Low (1)**