B. Sc. BOTANY

SYLLABUS

FROM THE ACADEMIC YEAR

2023 – 2024

THIRUVALLUVAR UNIVERSITY
SERKKADU, VELLORE–632115

Contents

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc. BOTANY**
Programme Code:	
Duration:	**3 Years (UG)**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and

	synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Specific Outcomes:	On successful completion of Bachelor of Physics with Computer Applications programme, the student should be able to: **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory. **PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities. **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models. **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects. **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

PO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1	✓					
PO2		✓				
PO3			✓			
PO4				✓		
PO5					✓	
PO6						✓

2. Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.

- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest DBMS and Computer software for Analytics.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning abstract Statistics and simulating mathematical concepts to real world.	• Instil confidence among students • Create interest for the subject
I, II, III, IV	**Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial)	• Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		• Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		• Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		• Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment • Create small scale entrepreneurs • Training to girls leads to women empowerment
		• Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	• Strengthening the domain knowledge • Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature • Students are exposed to Latest topics on Computer Science / IT, that require strong statistical background

		• Emerging topics in higher education / industry / communication network / health sector etc. are introduced with hands-on-training, facilitates designing of statistical models in the respective sectors
IV	DBMS and Programming skill, Biostatistics, Statistical Quality Control, Official Statistics, Operations Research	• Exposure to industry moulds students into solution providers • Generates Industry ready graduates • Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	• Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
V Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
VI Semester	Introduction of Professional Competency component	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' –caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: For Advanced Learners / Honors degree		• To cater to the needs of peer learners / research aspirants

Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Credit Distribution for UG Programmes

Sem I	Credit	H	Sem II	Credit	H	Sem III	Credit	H	Sem IV	Credit	H	Sem V	Credit	H	Sem VI	Credit	H
Part 1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	5.1 Core Course – \CC IX	4	5	6.1 Core Course – CC XIII	4	6
Part.2 English	3	6	Part..2 English	3	6	Part..2 English	3	6	Part..2 English	3	6	5.2 Core Course – CC X	4	5	6.2 Core Course – CC XIV	4	6
1.3 Core Course – CC I	5	5	2..3 Core Course – CC III	5	5	3.3 Core Course – CC V	5	5	4.3 Core Course – CC VII Core Industry Module	5	5	5. 3.Core Course CC -XI	4	5	6.3 Core Course – CC XV	4	6
1.4 Core Course – CC II	5	5	2.4 Core Course – CC IV	5	5	3.4 Core Course – CC VI	5	5	4.4 Core Course – CC VIII	5	5	5. 4.Core Course –/ Project with viva-voce CC -XII	4	5	6.4 Elective -VII Generic/ Discipline Specific	3	5
1.5 Elective I Generic/ Discipline Specific	3	4	2.5 Elective II Generic/ Discipline Specific	3	4	3.5 Elective III Generic/ Discipline Specific	3	4	4.5 Elective IV Generic/ Discipline Specific	3	3	5.5 Elective V Generic/ Discipline Specific	3	4	6.5 Elective VIII Generic/ Discipline Specific	3	5
1.6 Skill Enhancement Course SEC-1	2	2	2.6 Skill Enhancement Course SEC-2	2	2	3.6 Skill Enhancement Course SEC-4, (Entrepreneurial Skill)	1	1	4.6 Skill Enhancement Course SEC-6	2	2	5.6 Elective VI Generic/ Discipline Specific	3	4	6.6 Extension Activity	1	-
1.7 Skill Enhancement -(Foundation Course)	2	2	2.7 Skill Enhancement Course –SEC-3	2	2	3.7 Skill Enhancement Course SEC-5	2	2	4.7 Skill Enhancement Course SEC-7	2	2	5.7 Value Education	2	2	6.7 Professional Competency Skill	2	2
						3.8 E.V.S.	-	1	4.8 E.V.S	2	1	5.8 Summer Internship /Industrial Training	2				
	23	**30**		**23**	**30**		**22**	**30**		**25**	**30**		**26**	**30**		**21**	**30**
Total – 140 Credits																	

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System for all UG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses [in Total]	13	14
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-2	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		23	**30**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	-	1
		22	**30**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6

Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	13
Part-4	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
	E.V.S	2	1
		25	**30**

Third Year

Semester-V

Part	**List of Courses**	**Credit**	**No. of Hours**
Part-3	Core Courses including Project Viva voce / Elective Based	22	26
Part-4	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	2
		26	**30**

Semester-VI

Part	**List of Courses**	**Credit**	**No. of Hours**
Part-3	Core Courses including Project / Elective Based & LAB	18	28
Part-4	Extension Activity	1	-
	Professional Competency Skill	2	2
		21	**30**

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	3	6	4	1	22
Part V	-	-	-	-	-	2	2
Total	23	23	22	25	26	21	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

Methods of Evaluation Theory		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**
	Methods of Evaluation Practicals	
	Continuous Internal Assessment Test	40 Marks
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Record	
	Total	**100 Marks**
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

UG - BOTANY

SEMESTER I	NAME OF THE COURSE	Hours Per/ Week (Lecture/Tutorial	CREDIT	CIA	Univ Exam
Part I	Tamil Paper I	6	3	25	75
Part II	English– Paper I	6	3	25	75
Part III Core I	Core – Plant Diversity I –Algae	5	5	25	75
Core II	Plant Diversity I Algae - Practical-I	5	5	25	75
Elective Course EC 1 Discipline Specific/Generic	Allied: Zoology Paper – I	4	3	25	75
Skill Enhancement Courses SEC1 Part - IV -	1. Organic farming 2. Environmental Biotechnology 3. Nursery and Landscaping	2	2	25	75
Foundation Course FC		2	2	25	75
Total		**30**	**23**	**175**	**525**

CORE-I PLANT DIVERSITY I ALGAE

Title of the Course		**PLANT DIVERSITY I ALGAE**					
Paper Number		**CORE I**					
Category	Core	**Year**	I			**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	2		--	5	
Pre-requisite		Students should be familiar with the basics of different classes of algae.					

Learning Objectives		
C1	To provide a comprehensive knowledge on the biology of algae.	
C2	To provide a basis for better understanding of the evolution higher of plants.	
C3	To understand reproductive biology, ecology of plants by studying the simpler systems in algae.	
C4	To understand the role of algae in ecosystems as primary producers of nutrition.	
C5	To understand importance of algae to animals and humans.	
Course outcomes	On completion of this course, students will;	
CO1	Relate to the structural organization, reproduction and significance of algae.	K1
CO2	Demonstrate knowledge in understanding the various life cycle patterns and the fundamental concepts in algal growth	K2
CO3	Explain the benefits of various algal technologies on the ecosystem.	K3
CO4	Compare and contrast the thallus organization and modes of reproduction in algae.	K4
CO5	Determine the emerging areas of Algal Biotechnology for identifying commercial potentials of algal products and their uses.	K5
UNIT	**CONTENTS**	
I	Classification (Fritsch-1935-1945), criteria for classification, algal distribution.	
II	Thallus organization (unicellular-*Chlorella,* Diatoms, colonial-*Volvox*, filamentous-*Anabaena*, *Oedogonium*, siphonous-*Caulerpa*, parenchymatous- *Sargassum, Gracilaria*).	
III	Reproduction-Vegetative, asexual, sexual reproduction and life histories (haplontic-*, Oedogonium* and *Chara*, diplontic-Diatoms and *Sargassum*, diplohaplontic-*Ulva* and diplobiontic-*Gracilaria*) (Examples may be changed according to the availability of the specimens).	
IV	Algal cultivation methods, Algal production systems; indoor cultivation methods and large-scale cultivation of algae, harvesting of algae.	
	Algae as food and feed: Agar-agar, Alginic acid and Carrageenan;	

V	Diatomite. Resource potential of algae: Application of algae as fuel, agriculture and pharmaceutical. Phycoremediation. Role of algae in CO_2 sequestration, Algae as indicator of water pollution, algal bioinoculants, Bioluminescence.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:	
1	Dehradun. Edwardlee, R. 2018. Phycology, 5th Ed., Cambridge University Press, London.
2	Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi
3	Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
4	Vashishta, P.C. 2014. S.Chand & Company Ltd, New Delhi.
5	Ian Morris. 1977. An introduction to the algae. Hutchinson & Co (Publishers) Ltd. London.
References Books:	
1	Aziz, F and Rasheed, R. 2019. A Course Book of Algae. Publisher: University of Sulaimani.ISBN: 978-9922-20-391-1.
2	Mihir Kumar, D. 2010. Algal Biotechnology. Daya Publishing House, New Delhi.
3	Chapman V.J. and Chapman D.J, 2013. The Algae. Alpha Numera.
4	Fritsch, F.E. 1945. Structure and reproduction of Algae. Cambridge University press.
5	Round, FE. 1984.The Ecology of Algae. Cambridge University Press.
6	Lee, R.D. 2008.Phycology 4th Edition, Cambridge University Press, New York.
7	Bold, H.C and Wynne, M.J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of India New Delhi.
Web Resources:	
1	https://www.crcpress.com/Therapeutic-and-Nutritional-Uses-of-Algae/Pereira/p/book/9781498755382
2	https://www.crcpress.com/Therapeutic-and-Nutritional-Uses-of-Algae/Pereira/p/book/9781498755382
3	https://www.crcpress.com/Algae-Anatomy-Biochemistry-and-Biotechnology-Second-Edition/Barsanti-Gualtieri/p/book/9781439867327

4	https://www.crcpress.com/Marine-Algae-Biodiversity-Taxonomy-Environmental-Assessment-and-Biotechnology/Pereira-Neto/p/book/9781466581678
5	https://www.kopykitab.com/Botany-For-Degree-Students-ALGAE-by-B-R-Vashishta-Dr-A-K-Sinha-Dr-V-P-Singh
6	https://www.wileyindia.com/a-textbook-of-algae.html
7	https://www.kobo.com/in/en/ebook/algae-biotechnology
8	https://www.ikbooks.com/books/book/life-sciences/botany/a-textbook-algae/9788188237449/

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	3	2	1	2	2	2	1
CO 2	3	3	2	2	3	3	2	`1	3	3
CO 3	2	2	1	1	2	2	1	3	2	2
CO 4	3	3	3	3	3	2	3	3	3	2
CO 5	3	3	2	3	2	3	3	3	2	3

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

CORE-II PLANT DIVERSITY I ALGAE - PRACTICAL-I

Title of the Course	**PLANT DIVERSITY – I: ALGAE Practical I**						
Paper Number	CORE II						
Category	Core	**Year**	I			**CourseCode**	
		Semester	I				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**		**Total**
	2		-		3		5
Pre-requisite	Students should be familiar with the basics of algae.						

Learning Objectives	
C1	To develop skills to identify algae based on habitat, thallus structure and the internal organization.
C2	To identify microalgae in a mixture.
C3	To develop skills to prepare the microslides of algae.
C4	To study the economic importance of few species.
C5	To understand importance of algae to animals and humans

Course outcomes: On completion of this course, the students will be able to CO	**Programme outcomes**
CO1 Recall and identify algae using key identification characters.	K1
CO2 Demonstrate practical skills in preparation of fresh mount and identification of algal forms from algal mixture.	K2
CO3 Describe the internal structure of algae prescribed in the syllabus	K3
CO4 Decipher the algal diversity in fresh/marine water and their economic significance.	K4
CO5 Evaluate the various techniques used to culture algae for commercial purposes	K5

EXPERIMENTS

1. Micro-preparation of the types prescribed in the syllabus. 2. Identifying the micro slides relevant to the syllabus. 3. Identifying types of algal mixture. 4. Economic importance of Algae as: (i) Food (ii) Feed (iii) Biofertilizers (iv) Seaweed liquid fertilizer (v) Hydrogen production by algae (vi) SCP (vii) Agar Agar (viii) Alginate (ix) Diatomaceous earth. 5. Field visit to study fresh water/marine water algal habitats. 6. Visit to nearby industry actively engaged in algal technology.	
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi. 2. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany-1 (10th ed).Rastogi Publications, Meerut. 3. Round, FE. 1984.The Ecology of Algae. Cambridge University Press. 4. Aziz, F and Rasheed, R. 2019. A Course Book of Algae. Publisher: University of Sulaimani.ISBN: 978-9922-20-391-1. 5. Singh, Pandey and Jain. 2020. A text book of Botany, 5th Edition, Rastogi Publication, Meerut.
Reference Books:	1. Nancy Serediak and M. Huynh. 2011. Algae identification lab Guide. Accompanying 2. manual to algae identification field guide, Ottawa Agriculture and Agri food Canada publisher. 3. Chapman, V.J and Chapaman, D.J. 1960.The Algae, ELBS & MacMillan, London. 4. Lee, R.D. 2008.Phycology 4th Edition, Cambridge University Press, New York. 5. Dehradun. Edwardlee, R. 2018. Phycology, 5th Ed., Cambridge University Press, London.
Web resources:	1. https://www.amazon.in/Practical-Manual-Algae-Sundara-Rajan/dp/8126106492 2. https://books.google.co.in/books/about/Practical_Manual_of_Algae.html?id=8d5DAAAACAAJ&redir_esc= 3. https://freebookcentre.net/biology-books-download/Concepts-of-Botany-Algae-(PDF-21P).html 4. https://www.ebooks.com/en-in/book/210152662/algae/sachin-kumar-mandotra/ 5. https://books.google.co.in/books/about/Algae.html?id=s1P855ZWc0kC&redir_esc=y

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	3	2	1
CO 2	3	3	2	2	3	3	2	3	3	3
CO 3	2	2	3	3	1	2	1	3	1	2
CO 4	3	3	3	3	3	2	3	3	3	2
CO 5	3	3	2	2	2	3	3	3	2	3

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

ORGANIC FARMING

Title of the Course		ORGANIC FARMING				
Paper Number		Non-Major Elective-I				
Category	Elective	Year	I			CourseCode
		Semester	I			
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total	
		2	-	-	2	
Pre-requisite		Students to gain knowledge on the scope of organic farming and its significance.				

Learning Objectives	
C1	To enable students to gain knowledge on the scope of organic farming and its significance.
C2	To impart practical insights sustainable agriculture, green manuring, recycling and composting.
C3	To understand the physical and chemical properties of soil.
C4	To study sustainable agriculture.
C5	To know about the importance of biofertilizers.

Course outcomes: On completion of this course, the students will be able to: CO	Programme Outcomes
1. Recognize the different forms of biofertilizers and their uses.	K1
2. Explain and interpret the components, patterns, and processes of bacteria for growth in crop production.	K2
3. Apply techniques for synthesizing green manure and develop strategies to increase crop yield.	K3
4. Analyze and decipher the significance of biofertilizers in soil fertility.	K4
5. Develop new strategies to enhance growth and quality check of medicinal herbs considering the practical issues pertinent to India.	K5

UNIT	CONTENTS
I	Soil – physical, chemical properties. Soil pollution – oil, chemicals –fertilizers, pesticide and herbicide, non-degradable solids, biomagnification, consequences of land pollution – damage to soil and crops.
II	Organic farming – definition, basic concept of organic farming, integrated plant nutrient supply management, integrated insect pest and disease management, integrated soil and water management. Sustainable agriculture practices-crop rotation, mixed cropping.

III	Management of organic wastes and green manures: Farm manures, Composts, Mulches and pest control, importance of organic manure, importance of green manure, crops of green manure, oil cake. Animal based organic manure–cow dung, vermicompost-methods, production and utilization.
IV	Biofertilizers–classification, nitrogen fixers–*Rhizobium*, Cyanobacteria, *Azolla* and Vesicular Arbuscular Mycorrhiza.
V	Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods.

Extended ProfessionalComponent (is a part of internal component only,Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. NIIR Board. 2012. The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services. 2. Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers. 3. Subba Rao N.S. 2017. Biofertilizers in Agriculture and Forestry. Fourth Edition.Medtech. 4. Vayas,S.C, Vayas, S. and Modi, H.A. 1998. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad. 5. Dongarjal, R.P and Zade, S.B. 2019. Insect Ecology and Integrated Pest Management Akinik Publications, New Delhi.
Reference Books	1. Vayas,S.C, Vayas, S and Modi, H.A. 1998. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad. 2. Sathe, T.V.2004. Vermiculture and Organic Farming. Daya publishers. 3 Subha Rao, N.S.2000. Soil Microbiology, Oxford & IBH Publishers, New Delhi. 4. Reddy, S.R. 2019. Fundamentals of Agronomy Kalyani Publications, Uttar Pradesh 5. Tolanur, S. 2018. Fundamentals of Soil Science IIndEdition , CBS Publishers , New Delhi
Web Resources	1. https://www.amazon.com/Beginners-Practical-botanical-horticulture-landscape-ebook/dp/B00MOURUNY 2. https://www.e-booksdirectory.com/listing.php?category=323 3. http://www.freebookcentre.net/Biology/Agriculture-Books.html 4.https://casfs.ucsc.edu/about/publications/Teaching-Organic-Farming/PDF- downloads/TOFG-all.pdf 5. https://www.amazon.in/s?k=the+organic+farming+manual&hvadid=72636563575133&hvbmt=bb&hvdev=c&hvqmt=b&tag=msndeskstdin-21&ref=pd_sl_6sbf0qtxcy_b

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2	1	2	2	2	2
CO 2	3	3	2	1	2	3	2	3	2	3
CO 3	2	2	3	3	1	2	2	3	2	3
CO 4	3	2	1	1	2	3	2	3	2	3
CO 5	3	3	2	3	1	2	3	3	3	3

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

2. ENVIRONMENTAL BIOTECHNOLOGY

Title of the Course	**ENVIRONMENTAL BIOTECHNOLOGY**					
Paper Number	Non-Major Elective-I					
Category	Elective	**Year**	I			**CourseCode**
		Semester	I			
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	
		2	-	-	2	
Pre-requisite	To understand the various applications of environmental biotechnology.					

Learning Objectives	
C1	To introduce the student to the various developed and applications of environmental biotechnology.
C2	To provide knowledge about the scope of bioremediation and bioleaching using GMOs.
C3	To study about pollution of water bodies.
C4	To know about bioremediation.
C5	To study about biomineralization.
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize the various causes of pollution and control measures.	**K1**
2. Explain about the beneficially role of GMOs on environment.	**K2**
3. Reflect upon various sustainable environmental protection strategies.	**K3**
4. Analyze the different methods of air, water, and soil quality monitoring process.	**K4**
5. Evaluate the implications of international legislations and policies for environmental protection.	**K5**
UNIT	**CONTENTS**
I	**Introduction:** The environment-soil, water and air, Pollution and its causes (outline only)
II	**Source and treatment of polluted waters and effluents:** Pollution of water bodies by heavy metals and pesticides – removal of heavy metals and pesticides by Biosorption. Removal of oil spills by using microbes. Biological

	treatment of sewage – characteristics of sewage and objectives in sewage treatment – Anaerobic digestion.
III	**Soil and air pollution and their treatment:** Soil pollution by Xenobiotics. Degradation of Xenobiotics – pathways of phenol, pentachlorophenol and polychlorinated biphenyl degradation.
IV	**Bioremediation:** Introduction to bioremediation, *ex situ* and *in situ* bioremediation.
V	**Biometallurgy and related topics:** Biomineralization – bioleaching - Biofilms and biocorrosion.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Alan Scragg. 1999. Environmental Biotechnology. Pearson Education Limited. 2. Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication. 3. Joseph C. Deniel. 1996. Environmental aspects of microbiology, British Sun Publication. 4. Keeshav Thehan. 1997. Biotechnology, New age international)P) Limited, New Delhi. 5. Chandra, A.M and Ghosh, S.K. 2010. Remote sensing and Geographical Information System, Narosa Publishing House Pvt. Ltd. New Delhi.
Reference Books:	1. Sharma, P.D. 2005. Environmental Microbiology, Narosa Publishing House Pvt. Ltd., New Delhi. 2. Raina Maier M. Iran Pepper L., Charles P. Gerba, 2000, Environmental Microbiology, Academic press, U.K. 3. Alexander N. Glazer and Hiroshi Nikaido. 1994. Microbial Biotechnology. 4. Special issue on Bioremediation and biodegradation. Indian Journal of Experimental Biology, September 2003. Vol. 41(9). National Institute of Science Communication and Information Resources, CSIR New Delhi. 5. Keddy, P.A. 2017. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge University Press. ISBN. 978-1107114234.
Web Resources	1. https://www.elsevier.com/books/environmental-biotechnology/vallero/978-0-12-407776-8

	2. http://www.freebookcentre.net/biology-books-download/Environmental-Biotechnology.html 3. https://www.amazon.in/INTRODUCTION-ENVIRONMENTAL-BIOTECHNOLOGY-K-Chatterji-ebook/dp/B00K7YGIWI 4. https://books.google.co.in/books/about/Textbook_of_Environmental_Biotechnology.html?id=Q2ROFx0WtBQC&redir_esc=y 5. http://library.umac.mo/ebooks/b28045907.pdf

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	3	2	1	2	2	1	3
CO 2	3	3	2	2	2	3	2	3	2	2
CO 3	2	2	3	3	1	2	1	3	3	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	3	3	2	3	2	3	3	3	2	3

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

NON-MAJOR ELECTIVE-I

3. NURSERY AND LANDSCAPING

Title of the Course	**NURSERY AND LANDSCAPING**						
Paper Number	Non-Major Elective-I						
Category	Elective	**Year**	I			**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		2		-	-	2	
Pre-requisite	Students should know about the fundamental concepts of nursery and landscaping.						

Learning Objectives	
C1	To recognize the importance of growing plants and practice the knowledge gained by developing kitchen garden and ornamental garden.
C2	To be able to design gardens and become entrepreneur in Horticulture.
C3	To study the methods of propagation.
C4	To know about nursery structure.
C5	To learn about gardening.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize the basic principles and components of gardening.	K1
2. Explain about bio-aesthetic planning and conceptualize flower arrangement.	K2
3. Apply techniques for design various types of gardens according to the culture and art of bonsai.	K3 & K6
4. Compare and contrast different garden styles and landscaping patterns.	K4
5. Establish and maintain special types of gardens for outdoor and indoor landscaping.	K5 & K6

UNIT	**CONTENTS**
I	Introduction, prospects and scope of nursery and landscaping.
II	Methods of Propagation – cutting, layering, grafting, budding, Floriculture – Rose, Chrysanthemum, Jasmine – cultivation.

III	Gardening – formal garden, informal garden, vegetable garden, landscaped layout designing – formation and maintenance of lawn.
IV	Nursery structures – Green house – Shade house, Mist chamber – Topiary, Bonsai culture.
V	Manures, composting – vermicomposting.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts	1. Amarnath V. 2006. Nursery and Landscaping, M/s IBD Publishers, New Delhi. 2. Butts, E and Stensson, K. 2012. Sheridan Nurseries: One hundred years of People, Plans, and Plants. Dundurn Group Ltd. 3. Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi. 4. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil. 5. Butts, E. and Stensson, K. 2012.Sheridan Nurseries: One hundred years of People,Plans, and Plants. Dundurn Group Ltd.
Reference Books	1.Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co. New Delhi. 2. Agrawal, P.K. 1993. Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi. 3. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co.,San Francisco, USA. 4. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers. 5. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd.
Web Resources	1. https://www.kopykitab.com/higher-education-ebooks/higher-education-ebooks/Agricultural-Industry-agriculture-eBooks/Nursery-And-Landscaping-by-V-Amarnath 2. https://www.amazon.in/Nursery-Landscaping-Veena-Amarnath/dp/8177542788 3. https://www.amazon.in/Gardening/b?ie=UTF8&node=1637077031 4. https://in.pinterest.com/pin/496733033900458021/?lp=true 5. https://www.gardenvisit.com/ebooks

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2	1	2	2	1	3
CO 2	3	3	2	2	3	3	2	2	2	2
CO 3	2	2	3	1	1	1	1	3	3	1
CO 4	3	2	2	1	3	2	1	3	2	1
CO 5	3	3	2	3	2	1	2	3	2	3

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