PERIYAR UNIVERSITY

SALEM – 636011

DEGREE OF BACHELOR OF SCIENCE

CHOICE BASED CREDIT SYSTEM

Syllabus for

B.SC. BOTANY

(SEMESTER PATTERN)
(For Candidates admitted in the Colleges affiliated to Periyar University from 2023-2024 onwards)

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DEFINITION

PROGRAMME:

"Programme" means core degrees offered in various disciplines.

COURSE:

"Course" refers to the courses offered under the degree programme spread over the complete Programme of study as under.

Part I -Refers Foundation Language "Tamil/other languages" offered under the programme.

Part II -Refers Foundation Language "English" offered under the programme.

Part III-Refers CC- Core Course subjects related to the programme concerned including Practicals.

Part III -Refers EC- Generic elective-Allied subjects offered as Generic elective, which is interdisciplinary in nature(allied) but related to the programme.

Part III -Refers EC- Discipline Specific elective-core subject electives offered as elective, which is Botany disciplinary in nature of the programme concerned.

Part IV- Refers SEC -Generic-Non-Major Electives means option is being given to students who do not come under the programme concerned.

SEC-Discipline centric skill/Entrepreneurial- core specific skill based elective courses means the courses offered under the programmerelated to Advanced Skill acquisition for industrial application and for professional competency enhancement

Projects-Team or Group Projects in the concerned subject

Internship- to be carried out in the summer vacation 60 hours

Refers- EVS-Environmental studies

Refers- Value education- Yoga and Extension activity means all those activities which form part of NSS/NCC/Sports/YRC and other co and extracurricular activities.

Duration of the Course:

Currently for the undergraduate programme the duration of study is THREE years. The course of the degree of Bachelor of Science shall consist three academic years divided into six semesters. Each semester consists of 90 working days. Practical examinations will be at the end of each semesters. These regulations apply to the regular course of study in approved institutions of the University.

Credits:

Means the weightage given to each course of study (subjects) attributed by the experts of the Boardof Studies concerned.

Credit System:

Means, the course of study under this pattern, where weightage of credits are spread over to different semesters during the period of study and the Cumulative Grade Point Average will be awarded based on the credits earned by the students. The following are the total credit points:

For Undergraduate Programme (Three years) : 140

AIM AND SCOPE OF THE COURSE:

1. To acquire knowledge in different areas of plant science.
2. The topics included in different units of different papers would enable the students to develop technical skills in Basic Botany and its applied branches.
3. Skill based subjects like Mushroom cultivation, Herbal medicine, Global climate change, Botanical garden and landscaping, Herbal technology, Cultivation of algae, Fermentation technology, Environment Impact Analysis, have been included in order to provide opportunities in employment and research in Government and Private Organizations.
4. The above courses also provide internship and projects to lay foundation for enterprenership.
5. Practicals included in the syllabus will improve the skills of the students in Microscopic techniques, Observations, Drawing, instrumentation techniques and Physiological and Ecological Laboratory techniques.

ELIGIBILITY FOR ADMISSION:

Candidate for admission to the first year of the degree of Bachelor of Science Course shall be required to have passed the Higher secondary examination (Academic or vocational stream with Botany/Biology along with Chemistry under higher secondary board of examination Stream) conducted by the Government of Tamil Nadu or an Examination accepted by the Syndicate, Subject to such conditions may be prescribed therefore shall be permitted to appear and qualify for B.Sc degree examination in Botany.

PASSING MINIMUM:

The candidate shall be declared to have passed the examinations if he /she secures not less than 40marks.

CLASSIFICATION OF SUCCESSFUL CANDIDATES:

- Candidates who secure not less than 60 % of the aggregate marks in the whole examinations shall bedeclared to have passed the examinations in First class.
- Candidates who secure above 50 % and below 60 % shall be declared to have passed the examinations inSecond class.
- Other successful candidates who secure below 50% shall be declared to have passed the examination inThird class.

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(SBC)/Generic(NMEC)/ 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	• Exposure to industry moulds students into solution

	skill, Biostatistics, Statistical Quality Control, Official Statistics, Operations Research	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	4	6.1 Core Course – CC XIII	4	5
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	4	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	5	5	5. 3.Core Course CC -XI	4	4	6.3 Core Course – CC XV	4	6
1.4 Core Course – CC II	5	3	2.4 Core Course – CC IV	4	3	3.4 Core Course – CC VI	5	3	4.4 Core Course – CC VIII	5	3	5. 4.Core Course CC -XI	5	6	6.4 Core Course – CC XVI	3	3
1.5 Elective I Generic Allied Zoology	3	4	2.5 Elective II Generic Allied Zoology	3	4	3.5 Elective IV Generic Allied Chemistry	3	4	4.5 ElectiveV Generic Allied Chemistry	3	4	5. 5.Core Course –/ Project with viva-voce CC -XII	4	4	6.5 Elective -VII Discipline Specific	2	3
1.6 Elective III Generic Allied Zoology practical	-	2	2.6 Elective III Generic Zoology practical	2	2	3.6 Elective VI Generic Allied Chemistry Practical	2	-	4.6 Elective VI Generic Allied Chemistry Practical	2	2	5.6 ElectiveV Discipline Specific	3	4	6.6 Elective VIII Discipline Specific	2	3
1.7 Skill Enhancement Course SEC-1 Generic (NME)	2	2	2.7 Skill Enhancement Course S Generic (NME)EC-2	2	2	3.7 Skill Enhancement Course SEC-3, (Entrepreneurial Skill)	1	1	4.7 elective I Core Discipline Specific Industry Module	2	2	5.7 Elective V Discipline Specific I	3	4	6.7 Extension Activity	1	-
1.8 Skill Enhancement -(Foundation Course)	2	2	2.8 Skill Enhancement Course – SEC-3	2	2	3.8 E.V.S.	-	1	4.8 Skill Enhancement Course Discipline Specific SEC-4	1	1	5.8 Value Education	2	2	6.8 Skill Enhancement Professional Competency Skill SEC 5	2	4
									4.10 E.V.S	2	1	5.9 Summer Internship /Industrial Training	2				
	23	**30**		**23**	**30**		**22**	**30**		**25**	**30**		**26**	**30**		**21**	**30**
Total – 140 Credits																	

Methods of Evaluation Theory			
Internal Evaluation	Continuous Internal Assessment Test		25 Marks
	Assignments	5 marks	
	Tests	15 marks	
	Attendance and Class Participation	5 marks	
External Evaluation	End Semester Examination		75 Marks
	Total		**100 Marks**
	Methods of Evaluation Practicals		
	Continuous Internal Assessment Test	30 marks	40 Marks
	Attendance and Class Participation	10 marks	
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		

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the Course outcomes. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your Course outcomes.

- **Remember and Understanding – Lower level**
- **Apply and Analyze – Medium Level**
- **Evaluate and Create – Strong Level**

CBCS - COURSE PATTERN AND SYLLABUS
UG - BOTANY
(For students who join the programme from 2023-2024 onwards)

Part	Language/ Core/ elective	Name of the Course	Hours Per/ Week	Credit	Internal marks	External marks	Total Marks
First year- semester I							
I	Language	Language Paper I	6	3	25	75	100
II	Language	English– Paper I	6	3	25	75	100
III	Core 1	Core I -Plant Diversity I –Algae	5	6	25	75	100
III	Core	Major-Practicals	3	Assessment in the academic year end			
III	Allied 1	Allied: Zoology Paper – I	4	3	25	75	100
III	Allied	Allied: Zoology Practicals	2	Assessment in the academic year end			
IV	NMEC 1	1. Organic farming 2. Environmental Biotechnology 3. Nursery and Landscaping	2	2	25	75	100
IV	FC 1	Basics of Botany	2	2	25	75	100
		Total	**30**	**19**			**600**
First year- semester II							
I	Language	Language Paper I	6	3	25	75	100
II	Language	English– Paper I	4	3	25	75	100
II	**NMSDC**	**Overview of English Language Communication**	**2**	**2**	**25**	**75**	**100**
	Core 2	Core II -Plant Diversity II – Fungi, Bacteria, Viruses, Plant pathology and Lichens	5	6	25	75	100
III	Core 3	Core III Major-Practicals including Core I and Core II	3	5	40	60	100
III	Allied 2	Allied: Zoology Paper – II	4	3	25	75	100
III	Allied 3	Allied: Zoology Practicals	2	2	40	60	100
IV	NMEC 2	1. Mushroom cultivation 2. Herbal Medicine 3. Global Climate change	2	2	25	75	100
IV	SEC 1	Botanical garden and landscaping	2	2	25	75	100
		Total	**30**	**28**			**800**
Second year- semester III							
I	Language	Language Paper III	6	3	25	75	100
II	Language	English– Paper III	6	3	25	75	100
III	Core 4	Core IV-Plant Diversity III – Bryophytes and Pteridophyte s	5	6	25	75	100
III	Core	Major-Practicals	3	Assessment in the academic year end			
III	Allied 4	Allied: Chemistry Paper – I	4	3	25	75	100
III	Allied 5	Allied: Chemistry Practicals-I	2	1	40	60	100
IV	NMSDC	Digital skills for Employability-Digital Skills	2	2	25	75	100
IV	SEC 3	*Entrepreneurial Skill Entrepreneurial opportunities in botany	1	2	25	75	100
V	EVS	Environmental studies	1	Assessment in the academic year end			
		Health and Wellness					
		Total	**30**	**20**			**700**
Road map for SBEC3: Workshop on Entrepreneurship with hands-on training special lectures by experts/industrialists on entrepreneurial schemes and funding available from Central/State Government							
Second year- semester IV							
I	Language	Language Paper IV	6	3	25	75	100
II	Language	English– Paper IV	6	3	25	75	100
III	Core 5	Core V -Plant Diversity IV– Gymnosperms,	5	6	25	75	100

		Paleobotany and Evolution					
III	Core 6	Core VI Major-Practical's including Core III and Core IV	3	5	40	60	100
III	Allied 6	Allied: Chemistry Paper – II	4	3	25	75	100
III	Allied 7	Allied Chemistry Practicals -II	2	1	40	60	100
IV	SEC 4	Fermentation technology	2	2	25	75	100
IV	**SEC 5**	**Food Processing & Preservation Techniques**	**2**	**1**	**25**	**75**	**100**
V	EVS	Environmental studies	1	2	25	75	100
		Total	**30**	**26**			**900**
Second Year Vacation – **Internship** - 40 hours							
Third year- semester V							
III	Core 7	Core VII- Plant Morphology, Taxonomy and Economic Botany	5	4	25	75	100
III	Core 8	Core VIII - Plant Anatomy and Embryology	5	4	25	75	100
III	Core 9	Core IX - Cell Biology, Genetics and Plant Breeding	5	4	25	75	100
III	Core 10	Core X Major Practicals including Core VII Core VIII and Core IX	6	Assessment in the academic year end			
III	Project	Project with Viva-voce	4	4	40	60	100
III	Internship	Internship viva voce	-	2			100
III	Elective course 1	1. Bio-Analytical Techniques 2. Aquatic Botany 3. Entrepreneurial Botany	3	2	25	75	100
V	VE	Value Education	2	2	25	75	100
		Total	**30**	**22**			**700**
Third year- semester VI							
III	Core 11	Core XI– Plant Ecology and Phytogeography	5	4	25	75	100
III	Core 12	Core XII- Plant Biotechnology and Molecular Biology	5	4	25	75	100
III	Core 13	Core XIII-Plant Physiology and Plant Biochemistry	5	4	25	75	100
III	Core 10	Core X-Major Practicals including Core VII, VIII and Core IX	-	4	40	60	100
III	Core 14	Core XIV- Major Practicals including Core XI+XII+XIII practical	6	4	40	60	100
III	Elective course 2	1. Horticulture 2. Natural Resource Management 3. Forestry	3	2	25	75	100
III	Elective course3	1. Bionanotechnology 2. Computer application in Botany 3. Forensic Botany	3	2	25	75	100
IV	SEC 6	Training for Competitive examinations • Botany for Competitive examinations (2 hours) • General Studies for Competitive examinations (2 hours) Botany for Advanced Studies (4 hours)	3	2	25	75	100
V	EA	Extension activity	-	1			
		Total	**30**	**27**			**800**
		GRAND TOTAL		**142**			**4500**

Practical Exams will be held in the academic year end i.e., II, IV and VI semester

CORE-I PLANT DIVERSITY I ALGAE

Title of the Course		**PLANT DIVERSITY I ALGAE**					
Paper Number		**CORE I.**					
Category	Core	**Year**	I	**Credits**	6	**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	Definition of algae. Characteristic features of Algae w.s.r.t. cell wall, flagella eye spot, pigmentation and reserve food materials in algae. algal distribution. Habit and Habitat (Hydrophytes: Benthophytes, Epactiphytes, Thermophytes, planktophytes, Halophytes, Epizoophytes; Edaphophytes: saprophytes, cryptophytes; Aerophytes;Cryptophytes; symbionts; Endozoophytes; Parasites;Fluviatile). Thallus organization: (unicellular-colonial-filamentous- siphonous-parenchymatous). Reproduction and life-history: (haplontic-diplontic- diplohaplontic- and diplobiontic) Classification (Fritsch-1935-1945), criteria for classification.	
II	A general study of Thallus organization; Reproduction-Vegetative, asexual, sexual reproduction and life histories a the following genera: Anabaena, *Chlorella, Volvox, Oedogonium*, *Chara*.	

III	A general study of Thallus organization; Reproduction-Vegetative, asexual, sexual reproduction and life histories a the following genera: *Caulerpa*, *Ulva* Diatoms, *Sargassum, Gracilaria*.
IV	Inorganic nutritional requirements of algae and algal culture media. Algal cultivation methods indoor cultivation methods and large-scale cultivation of algae, Algal production systems; harvesting of algae and value added products.
V	Algae as food and feed: Agar-agar, Alginic acid and Carrageenan; 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 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	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/
9	https://www.doc-developpement-durable.org/file/Culture/culture-algues/algoculture/Algal%20Culture%20and%20Biotechnology.pdf

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 (Assessed in semester II)**						
Paper Number	CORE III(Assessed in II semester)						
Category	Core	**Year**	I	**Credits**	Assessed in II semester	**Course Code**	
		Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	1	-	2	3			
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 various techniques in algal cultures						
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	K2						

from algal mixture.	
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.
7. Algal culture methods(demonstration only).

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 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. 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 (10^{th} 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, 5^{th} 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)**

CORE-II PLANT DIVERSITY II FUNGI, BACTERIA, VIRUSES, PLANT PATHOLOGY AND LICHENS

Title of the Course	**PLANT DIVERSITY – II: FUNGI, BACTERIA, VIRUSES, PLANT PATHOLOGY AND LICHENS**						
Paper Number	CORE II						
Category	Core III	**Year**	I	**Credits**	6	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	1	--	5		
Pre-requisite		Students should be familiar with the basics of fungi, bacteria, viruses and lichens.					

Learning Objectives	
C1	To describe the common characteristics of fungi as being heterotrophic, unicellular/multicellular.
C2	To understand the biology of fungi and to discuss the importance of fungi in various ecological roles
C3	To understand lichen structure, function, identification, and ecology; Comprehend the events of symbiosis and lichenization and to demonstrate the use of lichens as bioindicator species.
C4	To identify the main groups of plant pathogens, their symptoms.
C5	To understand the various types of plant diseases.
Course outcomes:	Programme outcomes

On completion of this course, the students will be able to: CO	
1. Recognize the general characteristics of microbes, fungi and lichens and disease symptoms.	K1
2. Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies based on structural organization.	K2
3. Identify the common plant diseases, according to geographical locations and device control measures.	K3

4. Analyze the emerging trends in fungal biotechnology with special reference to agricultural and pharmaceutical applications.	K4
5. Determine the economic importance of microbes, fungi and lichens.	K5

UNIT	CONTENTS
I	**FUNGI** Classification of fungi - (Alexopoulos and Mims, 1979), criteria for classification, Characteristic features, thallus organization, mode of nutrition, structure, reproduction and life-history of classes, each with one suitable example: Zygomycotina (*Pilobolus, Mucor, Rhizopus*), Ascomycotina (*Aspergillus, Saccharomyces, Peziza*), Basidiomycotina (*Agaricus, Pleurotus, Puccinia*) and Deuteromycotina (*Cercospora, Alternaria*).
II	**ECONOMIC IMPORTANCE OF FUNGI:** Cultivation of mushroom – *Pleurotus* (food). Fungi in agriculture application (biofertilizers including VAM): Mycotoxins (biopesticides), Production of industrially important products from fungi- alcohol (ethanol), organic acids (citric acid), enzymes (protease). Vitamins (Vitamin B-complex and Vitamin B-12), Applications of fungi in pharmaceutical products (Penicillin). Harmful effects of Fungi: Mycotoxins
III	**BACTERIA, VIRUS:** General characters of Bacteria. Morphology and ultra structure of bacteria. Mode of Nutrition in Bacteria: Heterotrophic-parasitic, saprophytic, symbiotic; autotrophic-chemosynthetic, Photosynthetic. Reproduction in bacteria. Classification (Bergey's, 1994). Economic importance of bacteria: Agriculture, Industry-butter, cheese, vinegar, alcohol, tobacco and tea curing, tanning, retting; sewage, medicines etc. Mycoplasma: History, general characters and cell structure of Mycoplasma Virology -Viruses general characters, structure and reproduction of plant viruses. Structure of reproduction of Bacteriophage.
IV	**PLANT PATHOLOGY:** General symptoms of plant diseases; Geographical distribution of diseases; Etiology; Host-Pathogen relationships; Disease cycle and environmental relation; Prevention and control of the following plant diseases. **Bacterial diseases** – Citrus canker and Bacterial blight of paddy **Viral diseases** – Tobacco Mosaic and Vein clearing of Papaya **Fungal diseases** – Blast disease in rice and Tikka disease of groundnut

V	**LICHEN:** Classification (Hale, 1969). Habitat, nature of association, Structure, Nature of Mycobionts and Phycobionts, Study of growth forms of lichens (crustose, foliose and fruticose), types, distribution, thallus organization, reproduction and ecological significance of lichens with special reference to *Usnea*. **Economic importance of Lichens**: food, fodder and nutrition, flavor, tanning and dyeing, cosmetics and perfumes, Brewing and distillation, minerals, Natural products, medicine (Ayurvedic, Siddha), pharmaceutical products, biodegradation agent, air pollution and biomonitoring, soil formation, nitrogen fixation, Harmful aspects, poison from lichens,
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 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. Pandey, B.P. 1997. College Botany. Vol. I Fungi & Pathology. 2. Mehrotra, R.S and Aneja, K.R. 2003. An introduction to mycology. New age International (P) Ltd, Publishers, New Delhi. 3. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer. 4. Satyanarayana T and Johri B.N. 2005. Microbial diversity, Current Perspectives and Potential Applications, IK International. 5. Nair, L.N. 2007. Topics in Mycology and Pathology, New Central Book agency, Kolkata. 6. Sharma, P.D. 2011. Plant Pathology, Rastogi Publication, Meerut, India. 7. Mahendra Rai. 2009. Advances in Fungal Biotechnology. I.K. International Publishing House, New Delhi.
Reference Books	1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. 1996. Introductory Mycology. 4th edition. John Wiley & Sons (Asia) Singapore. 2. Webster, J and Weber, R. 2007. Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge. 3. Sharma, O.P. 2011. Fungi and allied microbes The McGraw –Hill companies, New Delhi. 4. Burnett, J.H. 1971.The fundamentals of Mycology. ELBS Publication, London. 5. Bessey, E.A. 1979. Morphology and Taxonomy of fungi, Vikas publishing House Pvt. Ltd, New Delhi. 6. Dharani Dhar Awasthi. 2000. A Handbook of Lichens Vedams eBooks (P) Ltd. New Delhi. 7. Pelzer, M.J., Chan, E.C.S and Krieg, N.R. 1983. Microbiology , Tata MaGraw Hill Publishing House, New Delhi. 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. Mishra, A. and Agarwal, R.P. 1978. Lichens – A Preliminary Text. Oxford and IBH. 10. Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company
Web Resources	1. https://www.amazon.in/Fungi-Sarah-C-Watkinson-ebook/dp/B0199YFDFE 2. http://www.freebookcentre.net/biology-books-download/A-text-book-of-mycology-and-plant-pathology.html 3. http://www.freebookcentre.net/Biology/Mycology-Books.html 4. https://www.kobo.com/us/en/ebook/introduction-to-fungi 5. http://www.freebookcentre.net/biology-books-download/Introductory-Mycology.html 6. http://www.freebookcentre.net/biology-books-download/Fungi-(PDF-15P).html

Mapping with Programme Outcomes:

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

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

CORE-III- PLANT DIVERSITY II: FUNGI, BACTERIA, VIRUSES, PATHOLOGY AND LICHENS – MAJOR PRACTICAL-I

Title of the Course	**Plant diversity** – i: **Fungi, Bacteria, Viruses, Plant Pathology and Lichens – Major Practical I (Including Core I +II)**						
Paper Number	CORE III						
Category	Core	**Year**	I	**Credits**	5	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		1	-		2	3	
Pre-requisite	Students should be familiar with the basics of fungi and lichens.						

Learning Objectives	
C1	To enable students to identify microscopic and macroscopic fungi.
C2	To prepare microslides of fungi and lichens.
C3	To know the presence of pathogen inside the plant tissues through microscopic sections.
C4	To identify the fungi and lichens based on the morphology, and microslides.
C5	To know the economic importance of the microbes studied.

Course outcomes On completion of this course, the students will be able to: **CO**	**Programme Outcomes**
1. Identify microbes, fungi and lichens using key identifying characters	K1
2. Develop practical skills for culturing and cultivation of fungi.	K2
3. Identify and select suitable control measures for the common plant diseases.	K3
4. Analyze the characteristics of microbes, fungi and plant pathogens	K4
5. Access the useful role of fungi in agriculture and pharmaceutical industry.	K5

EXPERIMENTS

1. Microscopic observation of vegetative and reproductive structures of types prescribed in the syllabus through temporary preparations and permanent slides.
2. Identifying the micro slides relevant to the syllabus.
3. Herbarium specimens of bacterial diseases/photograph.
3. Protocol for mushroom cultivation.
4. Inoculation techniques for fungal culture (Demonstration only).
5. Study of economically important products obtained from fungi: Fungal biofertilizers, biopesticides, biofungicide (*Trichoderma*), edible mushroom/Yeast, organic acids (citric acid) enzymes (protease), antibiotics and vitamins.
6. Mycorrhiza: ecto-mycorrhiza and endo-mycorrhiza (Photographs)
7. Visit to fungal biotechnology laboratories.
8. Ultra sturcture of bacteria.
9. Simple and Gram staining of Bacteria
10. Structure of bacteriophage.
11. Micro-preparation of *Usnea* to study vegetative and reproductive structures.
12. Identifying the micro slides relevant to the syllabus.
13. Study of thallus and reproductive structures (apothecium) through permanent slides.
14. Economic importance of Lichens - Dye and perfume.

Recommended Texts:

1. Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. AuthorHouse, Bloomington, USA.
2. Das, S and Saha, R. 2020. Microbiology Practical Manual. CBS Publishers andDistributors (P) Ltd., New Delhi, India.
3. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress, Cambridge.
4. Nair, L.N. 2007. Topics in Mycology and Pathology, New Central Book agency, Kolkata.
5. Nair, L.N. 2007. Topics in Mycology and Pathology, New Central Book agency, Kolkata.

Reference Books:

1. Alexopoulos, J and Mims, W. 1985. Introductory Mycology, Wiley Eastern Limited NewDelhi.
2. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany 1 (10th ed). Rastogi Publications, Meerut.
3. Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.
4. Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
5. Satyanarayana T and Johri B.N. 2005. Microbial diversity, Current Perspectives and Potential Applications, IK International.

Web resources:

1. https://www.amazon.in/Practical-Manual-Fungi-Fungicides/dp/B0025AEFP4
2. https://books.google.co.in/books/about/Practical_Mycology.html?id=5ycJAQAAMAAJ&redir_esc=y
3. https://www.flipkart.com/colour-handbook-practical-plant-pathology/p/itmefsn6dyhfhs9b
4. https://books.google.co.in/books/about/Practical_Botany.html?id=T5narQEACAAJ&redir_esc=y
5. https://www.kobo.com/us/en/ebook/introduction-to-fungi

Mapping with Programme Outcomes:

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

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

CORE-IV PLANT DIVERSITY III BRYOPHYTES AND PTERIDOPHYTES

Title of the Course	**PLANT DIVERSITY-III BRYOPHYTES AND PTERIDOPHYTES**						
Paper Number	CORE IV						
Category	Core	**Year**	II	**Credits**	6	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	1		-	5	
Pre-requisite	Students should be familiar with the basics of Bryophytes and Pteridophytes.						
Learning Objectives							
C1	To enable the students to have an overview of Non-vascular and Vascular cryptogams.						
C2	To understand the morphological diversity of Bryophytes and Pteridophytes.						
C3	To know the evolution of Bryophytes and Pteridophytes.						
C4	To understand the economic importance of the Bryophytes and Pteridophytes.						
C5	To understand anatomy and reproduction of Bryophytes and Pteridophytes.						
Course outcomes: On completion of this course, the students will be able to:**CO**	**Programme Outcomes**						
1. Recognize morphological variations of Bryophytes and Pteridophytes.	K1						
2. Explain the anatomy and reproduction of Bryophytes and Pteridophytes.	K2						
3. Compare and contrast the variations in the internal cellular organization, gametophyte and sporophyte of Bryophytes and Pteridophytes.	K3						
4. Decipher the stages of plant evolution and their transition to land habitat.	K4						
5. Access the useful role of Bryophytes and Pteridophytes.	K5						
UNIT	**CONTENTS**						

I	**BRYOPHYTES** General characters of Bryophytes, classification (Watson, 1971) (up to family). criteria for classification. Structure, reproduction and life histories of the following classes each with a suitable example: Hepaticopsida (*Marchantia, Porella*);
II	Structure, reproduction and life histories of the following classes each with a suitable example: Anthocerotopsida (*Anthoceros*) and Bryopsida (*Polytrichum*). Evolution of Bryophytes. Progressive evolution theory and Regressive evolution theory. Economic importance of Bryophytes – Ecological importance (Pollution indicators and monitoring), Medicinal uses, horticulture and industrial uses.
III	**PTERIDOPHYTES** General Characters of Pteridophytes - Classification (Reimer, 1954). Criteria for classification. Apogamy and apospory. Morphology, anatomy and reproduction of reproduction of the taxa belonging to each of the following classes: Psilotopsida (*Psilotum*), Lycopsida (*Selaginella*).
IV	Morphology, anatomy and reproduction of reproduction of the taxa belonging to each of the following classes: Sphenopsida (*Equisetum*), Pteropsida (*Marsilea*). Homospory and heterospory. Heterospory and seed habit.
V	Origin and evolution of Pteridophytes: origin of vascular cryptogams: Anthocerotean theory, Protocorm theory, Phyton theory. Origin of sporophyte: Telome theory, Enation theory. Stelar Evolution. Economic importance of Pteridophytes- as food, as fibre, as horticulture plant, as weed, as biofertilizer, as medicine etc.
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	Knowledge, Problem Solving, Analytical ability, Professional
course	Competency, Professional Communication and Transferrable Skill

Recommended Texts	1. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd. Delhi. 2. Alam, A. 2020. Contemporary Research on Bryophytes Book Series: Recent Advances in Botanical Science. 10.2174/97898114337881200101. 3. Alain Vanderpoorten. 2009. Introduction to Bryophytes, 1st Edition, Cambridge University Press. 4. Chopra, R. N. 2005. Biology of bryophytes. New Age International (P) Ltd. New Delhi, India. 5. Prem Puri. 2001. Bryophytes– morphology growth and differentiation. Atma Ram & Sons. Lucknow, India.
Reference Books	1. Eames, A. 1963. Morphology of lower vascular plant, McGraw Hill, Chennai. 2. Parihar. N.S. 1967. An introduction of Embryophyta, Vol.III – Pteriodophyta, Central book depot, Allahabad. 3. Smith, G.M. 1955. Cryptogamic Botany, Volume-II– McGraw Hill, Chennai 4. Sporne, K.L. 1976. Morphology of Pteridophytes, 4th edition, B.I. Publication. Chennai. 5. Watson, E.V. 1963. The structure and Life of Bryophytes. Hutchinson & Co, UK. 6. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad. 7. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes.Central Book Depot, Allahabad.
Web Resources:	1. http://www.bryoecol.mtu.edu/ 2. https://www.amazon.in/Introduction-Bryophytes-Alain-Vanderpoorten-ebook/dp/B007NWFWQK 3. http://scitec.uwichill.edu.bb/bcs/bl14apl/bryo1.htm 4. http://www.bsienvis.nic.in/Database/Pteridophytes-in-India_23432.aspx 5. http://www.botany.ubc.ca/bryophyte/mossintro.html 6. aeTIUC&redir_esc=y

Mapping with Programme Outcomes:

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

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

CORE-VI PLANT DIVERSITY III BRYOPHYTES AND PTERIDOPHYTES – PRACTICAL-II

Title of the Course	**PLANT DIVERSITY III BRYOPHYTES AND PTERIDOPHYTES - PRACTICAL-II(Assessed in IV semester)**						
Paper Number	CORE VI						
Category	Core	**Year**	II	**Credits**	Assessed in IV semester	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		1	-		2	3	
Pre-requisite		Students should be familiar with the basics of Bryophytes and Pteridophytes.					

Learning Objectives	
C1	To enable students gain expertise in hand sectioning technique.
C2	To study diversity of Bryophytes and Pteridophytes.
C3	To understand the anatomical structure of the Bryophytes and Pteridophytes.
C4	Develop comprehensive skills in sectioning and micro preparation.
C5	Describe the structure of fossil forms prescribed in the syllabus.

Course outcomes: On successful completion of this course the student will be able to: CO	**Programme Outcomes**
1.Recognize the major groups of Non-vascular and Vascular cryptogams	K1
2. Describe the structure of Bryophytes and Pteridophytes forms prescribed in the syllabus.	K2
3.Identify and illustrate the morphological and anatomical features of bryophytes and Pteridophytes.	K3
4. Develop comprehensiv e skills in sectioning and micropreparation.	K4
5.Interpret the significance of reproductive structures in Bryophytes and Pteridophytes.	K5

EXPERIMENTS

Bryophytes

1. Study of morphology, anatomy and structure of the vegetative and reproductive organs of Bryophytes genera included in the theory syllabus.
2. Hepaticopsida *Marchantia*, *Porella*); Anthocerotopsida (*Anthoceros*) and Bryopsida (*Polytrichum*) (need not study developmental aspects).

Pteridophytes

3. Study of morphology, anatomy and structure of the vegetative and reproductive organs of Pteridophytes genera and fossils included in the theory syllabus.
   Psilotopsida (*Psilotum*), Lycopsida (*Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (*Marsilea*). Identifying the micro slides relevant to the syllabus.
4. Botanical excursion.

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. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi. 2. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi. 3. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication. 4. Prem Puri. 2001. Bryophytes– morphology growth and differentiation. Atma Ram & Sons. Lucknow, India. 5. Tuba Z., Slack N.G. and Stark L.R. 2011. Bryophyte Ecology and Climate Change. Cambridge university press, Cambridge.
Reference Books	1. Ashok, M. Bendre and Kumar. 2010. A text book of Practical Botany, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperms and Palaeobotany. Revised edition. Published by Rakesh Kumar Rastogi publication. 2. Mohammed Gufran Khan, Shite Gatew and Bedilu Bekele. 2012. Practical manual for Bryophytes and Pteridophytes. Lambert Academic Publishing. 3. Puri, P. 1980. Bryophytes. Atma Ram and Sons, New Delhi. 4. Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd. Chennai. 5. Vashista.P.C. 1971. Botany for Degree students: Pteridophyta. S.Chand & Co. New Delhi.
Web resources	1. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4 2. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883 3. http://www.eeb.uconn.edu/people/goffinet/Classificationmosses.html 4. https://www.vitalsource.com/products/introduction-to-bryophytes-alain-vanderpoorten-v9780511738951?duration=perpetual 5. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/

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	2
CO 2	3	3	2	2	3	3	2	3	3	2
CO 3	2	2	3	3	1	2	1	3	2	1
CO 4	3	3	3	3	3	2	3	2	2	3
CO 5	3	3	2	3	2	3	3	3	3	3

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

CORE-V PLANT DIVERSITY V GYMNOSPERMS, PALEOBOTANY AN EVOLUTION

Title of the Course	**PLANT DIVERSITY V GYMNOSPERMS, PALEOBOTANY AND EVOLUTION**						
Paper Number	CORE V						
Category	Core	**Year**	II	**Credits**	6	**Course Code**	
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	-	5		
Pre-requisite	Students should know about the fundaments of Gymnosperms, fossil records and evolution.						

Learning Objectives	
C1	To enable the students to understand thallus organization,
C2	To enable the students to understand internal and the reproductive structures of Gymnosperms and the importance of evolution.
C3	to acquaint students with evidences of the past history of plant groups and significance of the fossilization.
C4	To know the scope of pleobotany, types of fossils and geological time scale.
C5	Understand the various fossil genera representing different fossil groups.
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Relate to the general characteristics of Gymnosperms and fossil forms	K1
2. Explain about the morphology and anatomy Gymnosperms.	K2
3. Compare and contrast the reproductive structures of Gymnosperms & fossil forms.	K3
4. Analyze the anatomy and reproduction Gymnosperms along with their ecological and economical importance.	K4
5. Determine the various fossilization methods and their significance in paleobotany.	K5

UNIT	CONTENTS
I	**GYMNOSPERMS** General characteristics of Gymnosperms. Classification of Gymnosperms (Sporne, 1954) (up to family). Criteria for classification. Economic importance of Gymnosperms with special reference to oil, resin, timber, etc. Morphology, anatomy and reproduction of the taxa belonging to each of the following orders: Cycadales (*Cycas*),
II	**GYMNOSPERMS** Morphology, anatomy and reproduction of the taxa belonging to each of the following orders: Coniferales (*Pinus*). Gnetales (*Gnetum*).
III	**PALEOBOTANY** Introduction to fossils and fossilization processes such as compression, casts, molds, petrification, impressions and coal balls. Geological time scale. Radiocarbon dating. Contribution of Birbal Sahni
IV	P**ALEOBOTANY** Study of the following fossils: Rhynia, Lepidodendron, Lepidocarpon, Calamites and Williamsonia sewardiana.
V	**EVOLUTION** Evolution - origin of life, chemosynthetic theory - evidences (any five). Theories of evolution - Darwin, Lamark and De veries, modern synthetic theory. Variation - analysis and sources, adaptive radiation, Concept of species - Allopatric and sympatric.
Extended Professional Component	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)
(is a part of internal component only,Not to be included in the External Examination question paper)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts	1. Gupta, M.N. 1972. The Gymnosperms (2nd Edition) Shiva Lal Agarwala & Co., Agra. 2. Vashista, P.C. 1976. Gymnosperms, S.Chand & Co. New Delhi. 3. Bhatnagar, S.P and Moitra, A. 1996. Gymnosperms. New Age International Publishers, New Delhi, India. 4. Anil Kumar. 2006. Gymnosperms. S. Chand & Company Pvt. Ltd. New Delhi. 5. Bhatnagar S.P and Alok Moitra. 2013. Gymnosperms. Publisher: New Age International Pvt Ltd Publishers. New Delhi.
Reference Books	1. Sporne, K.R.1991. The Morphology of Gymnosperme. B.I. Publications, New Delhi. 2. Bhatnagar, S.P and Moitra, A. 1996. Gymnosperms, New Age Int. Pvt. Ltd., New Delhi. 3. Stewart, W.N and Rathwell, G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press. 4. Raup, D.M and Steven, M. Stanley. 2004. Principles of paleontology. San Francisco: W.H. Freeman, 1971. 5. Bhatnagar S.P and Alok Moitra. 2013. Gymnosperms. Publisher: New Age International Pvt Ltd Publishers. New Delhi.
Web Resources	1. https://books.google.co.in/books?hl=en&lr=&id=Pn7CAAAQBAJ&oi=fnd&pg=PA1&dq=Introduction+to+Gymnosperms&ots=sfYSzCL02&sig=ysX1KRvetV0bAza4Sq6RWau4XU8&redir_esc=y#v=onepage&q=Introduction%20to%20Gymnosperms&f=false 2. https://books.google.co.in/books/about/Botany_for_Degree_Gymnosperm_Multicolor.html?id=HTdFYFNxnWQC&redir_esc=y 3. https://books.google.co.in/books/about/Gymnosperms.html?id=4dvyNckni8wC 4. https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf 5. https://www.palaeontologyonline.com/

Mapping with Programme Outcomes:

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

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

CORE-VI PLANT DIVERSITY IV GYMNOSPERMS, PALEOBOTANY AND EVOLUTION - PRACTICAL-II

Title of the Course	**PLANT DIVERSITY IV GYMNOSPERMS, PALEOBOTANY AND EVOLUTION – MAJOR PRACTICAL-III(including Core IV+V)**						
Paper Number	CORE VI						
Category	Core	**Year**	II	**Credits**	5	**CourseCode**	
		Semester	IV				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	1	-	2	3			
Pre-requisite	Students should be familiar with the fundamentals of Gymnosperms, Paleobotany.						

Learning Objectives	
C1	To enable students observe and record the morphological features of selected species of Gymnosperms.
C2	To enable students observe and record the anatomical features of selected species of Gymnosperms.
C3	To develop the skill of preparation of microslides of the gymnosperm samples.
C4	To enable students to gain insights into the basics of paleobotany and methods of fossilization.
C5	To understand the anatomy of the fossil plants through microscopy.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Analyze and observe and record the morphological features of selected species of Gymnosperms..	K1
2. Describe the structure of fossil forms prescribed in the syllabus.	K2
3. Identify and Illustrate the morphological and anatomical features of gymnosperms.	K3
4. Develop comprehensive skills in sectioning and micro preparation.	K4

5. Interpret the significance of reproductive structures in gymnosperms.	K5

EXPERIMENTS

1. Study of morphology, anatomy and structure of the vegetative and reproductive organs of *Cycas, Pinus* and *Gnetum.*

2. Identifying the micro slides relevant to the syllabus.

3. Field visit to study the habitat (Hill station).

4.Study the following fossil members: *Rhynia, Lepidodendron, Lepidocarpon, Calamites* and *Williamsonia sewardiana* through permanent slides.

5. Photograph of evolution scientists: Darwin, Lamark and De veries.

6. Photograph related to evolution theory: Darwinism, Lamarkism and De veries, modern synthetic theory.

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 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. Sharma O.P and S, Dixit. 2002. Gymnosperms. Pragati Prakashan. 2. Gangulee, H.C and A.K. Kar. 2013. College Botany. Vth Edition. S. Chand.
	3. Sharma, O.P. 2012. Textbook of Pteridophyta, TATA MacMillan India Ltd., New Delhi. 4. Chamberlain, C.J. 1934. Gymnosperms: Structure and Evolution. Chicago Reprinted 1950). New York. 5. Bhatnagar, S.P and Moitra, A. 1996. Gymnosperms. New Age International Publishers, New Delhi, India.
Reference Books	1. Smith, G.M. 1955. Cryptogamic Botany Vol.II. Tata McGraw Hill. New Delhi. 2. James.W. Byng. 2015. The Gymnosperms practical hand book. A practical guide to extant families and genera of the world. Published by plant Gateway, Tol Bot Street, Herford, SG137BX, United Kingdom. 3. Sharma, O.P. 2012. Textbook of Pteridophyta, TATA MacMillan India Ltd., New Delhi. 4. Chamberlain, C.J. 1934. Gymnosperms: Structure and Evolution. Chicago Reprinted 1950). New York. 5. Kirkaldy, J.E. 1963. The study of Fossils. Hutchinson Educational, London.

Web resources	1. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=en&gbpv=1&dq=gy mnosperms&printsec=frontcover 2. https://www.amazon.in/Paleobotany-Biology-Evolution-Fossil-Plants/dp/0123739721 3. https://books.google.co.in/books/about/Paleobotany.html?id=HzYUAQAAIAAJ 4. https://trove.nla.gov.au/work/11471742?q&versionId=46695996 5. http://www.freebookcentre.net/Biology/Evolutionary-Biology-Books.html.

Mapping with Programme Outcomes:

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

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

CORE VII PLANT MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY

Title of the Course	**PLANT MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY**						
Paper Number	CORE VII						
Category	Core	**Year**	III	**Credits**	4	**CourseCode**	
		Semester	V				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	1	-	5

Pre-requisite	Prior knowledge on morphological, anatomical characteristics and uses of plants.
Learning Objectives	
C1	Students will have extensive knowledge of the morphology (vegetative structures and floral structures) of flowering plants.
C2	Students will know about the basic concepts of classification of plants.
C3	Understand major evolutionary trends in Angiospermic plants.
C4	To know the characteristic features of the selected families.
C5	To know the economic importance of plants.
Course outcomes: On completion of this course, the students will be able to: **CO**	**Programme Outcomes**
1. Define the concepts in plant morphology and rules of IUCN in botanical nomenclature.	K1
2. Classify systems of plant classification and recognize the importance of herbarium and virtual herbarium.	K2
3. Describe the core concepts of economic Botany and relate its applications in human life.	K3
4. Analyze the characters of the families according to the Bentham and Hooker's system of classification.	K4
5. Assess terms and concepts related to Phylogenetic Systematics.	K5

UNIT	CONTENTS
I	Morphology – root system – modifications. Shoot system – modifications – (Aerial, sub-aerial and underground). Leaf-Types-simple and compound- phyllotaxy, modifications (phyllode, pitcher), tendrils, stipules. Inflorescences – definition and types – racemose, cymose, mixed and special types. Fruits - classification.
II	History of Angiosperm classification – Artificial (Linneaus), Natural (Bentham and Hooker) and Phylogenetic (Thakthjan) system of classification(Including merits and demerits). An outline of Bentham and Hooker system of classification, an overview of APG Classification. Herbarium technique–collection, pressing, drying, mounting and preservation of plant specimens, digital herbarium. Botanical Survey of India. Botanical nomenclature–rules, typification and author citation.
III	Study of the following families based on the Natural system and their economic importance: Annonaceae, Nymphaeaceae, Capparidaceae, Rutaceae, Leguminosae (Fabaceae/Fabaoideae, Caesalpinaceae/ Caesalpinioideae, Mimosaceae/Mimosoideae), Cucurbitaceae, Asteraceae, Apocynaceae and Asclepiadaceae.
IV	Study of the following families based on the natural system and their economic importance: Convolvulaceae, Acanthaceae, Lamiaceae, Verbenaceae, Amaranthaceae, Euphorbiaceae, Liliaceae, Orchidaceae and Poaceae.
V	Source, cultivation method (brief) and the processing of the economically important products of the following – Cereal (Rice), Pulses (Black gram), Sugar (Sugarcane), Beverage (Coffee), Oil seed (Groundnut), spices (Cardamom), essential oil (Rose), natural rubber(Hevea brasiliensis) and timber plants (Teak) and Fibre (Cotton).
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 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. Lawrence, G.H.M. 1985. An Introduction to Plant Taxonomy, Central Book Depot, Allahabad. 2. Porter, C.L. 1982. Taxonomy of Flowering Plants, Eurasia Publications House, New Delhi 3. Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The MacMillan Co-collier-MacMillan Ltd., London. 4. Solbrig, O.T and Solbrig, D.J. 1979. Population Biology and Evolution, Addison-Weslley Publicating Co. Ind USA. 5. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York. 6. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall. New Jersey. 7. Rajni Gupta. 2012. Plant Taxonomy: Past, Present and Future. Vedams (P) Ltd. New Delhi.

Reference Books	1. Hutchinson, J. 1973. The Families of Flowering plants , Oxford University press, London. 2. Gamble, J.S., Fisher, L.E.F.1967. The Flora of The presidency of Madras (Vol-III) BSI, Calcutta 3. Davis, P.H and Heywood, V.M. 1965. Principles of Angiosperm Taxonomy, Oliver and Boyd Edinburgh. 4. Clive AS.1989. Plant Taxonomy and Biosystematics, Chapman and Hall Inc. New York. 5. Harborne, J.B and Turner, B.L. 1984. Plant Chemosystematics, Acad. Press, London. 6. Lawrence, G.H. 1955. Taxonomy of Vascular Plants, MacMillan Co., USA. 7. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-HilI Book Co., New York.
Web Resources	1. https://books.google.co.in/books/about/Plant_Taxonomy_2E.html?id=_px_WAwHiZIC&redirhttps://books.google.co.in/books/about/Plant_Taxonomy_and_Biosystematics.html?id=VfQnuwh3bw8C&redir_esc=y_esc=y 2. https://books.google.co.in/books/about/PLANT_TAXONOMY_2E.html?id=Roi0lwSXFnUC&redir_esc=y 3. https://books.google.co.in/books/about/Plant_Taxonomy.html?id=0bYs8F0Mb9gC&redir_esc=y 4. https://books.google.co.in/books/about/Economic_Botany.html?id=2ahsDQAAQBAJ&redir_esc=y 5. https://books.google.co.in/books/about/Textbook_Of_Economic_Botany.html?id=XmZFJO_JHv8C&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	2	1	2
CO 2	3	3	2	2	3	3	2	3	3	2
CO 3	2	2	3	3	1	2	1	3	2	1
CO 4	3	3	3	3	3	2	3	2	2	3
CO 5	3	3	2	3	2	3	3	3	3	3

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

CORE X- PLANT MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY- PRACTICAL-III

Title of the Course	**PLANT MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY-PRACTICAL-III(Assessed in VI Semester)**						
Paper Number	CORE X						
Category	Core	**Year**	III	**Credits**	Assessed in VI Semester	**CourseCode**	
		Semester	V				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	1	-	2	3

Pre-requisite	Theoretical understanding of plant taxonomy as well as basic laboratory skills for the relevant core course.

Learning Objectives	
C1	To study morphological characters of the families.
C2	Able to describe the plant technically using the floral characteristics.
C3	To preserve the plants and prepare herbarium sheets.
C4	To be able to identify the local flora.
C5	To understand the economic importance of the plants.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize the distinguishing plant morphological characters.	K1
2. Identify locally available plants to their respective families.	K2
3. Develop comprehensive skills in field identification, collection of specimens,	K3
writing technical description, botanical drawings and herbaria preparation.	
4. Construct floral diagram and write floral formula for a given flower.	K4
5. Validate the plant specimen by analyzing and dissecting the vegetative and floral characters.	K5

EXPERIMENTS

1. Morphology of root, stem and leaf modification, types of inflorescence and fruits.
2. Plants of local flora included under theory syllabus and family identification and derivation based on reasoning(Bentham and Hooker Classification).
3. Dissection, identification, observation and sketching the floral parts of the plants belonging to the families included in the syllabus.
4. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.
5. Twenty (20) Herbarium sheets, field notebook and bonafide record to be submitted.
6. Study the products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.
7. Field trips to places for observation, study and collection of plants prescribed in the syllabus for 2 to 5 days under the guidance of faculties.

Extended Professional Component (is a part of internal component only,Not to be included in the External	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)
Examination question paper)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi. 2. Gokhale, S.B., Kokate, C.K. and Gokhale, A. 2016. Pharmacognosy of Traditional Drugs. Nirali Prakashan, 1st Edition. ISBN: 9351642062. 3. Rendle, A.B. 1980. The Classification of Flowering Plants (Vol. I & II), Vikas Students Education. 4. Pandely, B.P. 1987. Taxonomy of Angiosperms. 5. Nordenstam, B., EI Gazaly, G and Kassas, M. 2000. Plant Systematics for 21st Century. Portlant Press Ltd., London.

Reference Books	1. Mann J. Davidson, R.S and J.B. Hobbs, D.V. Banthorpe, J.B. Harborne.1994. *Natural Products*. Longman Scientific and Technical Essex. 2. Gopalan, C., B.V. Ramasastri and S.C. Balasubramanian. 1985. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad. 3. Grant, W.E. 1984. Plant Biosystematics. Academic Press, London. 4. Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Rieman Educational Book Ltd., London. 5. Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptations in Plant Species. Hiemand & Co. Educational Books Ltd. London.
Web resources	1. https://www.amazon.in/Practical-Taxonomy-Angiosperms-R-Sinha/dp/9380578210 2. https://www.wileyindia.com/plant-science/practical-taxonomy-of-angiosperms-2ed.html 3. https://www.flipkart.com/practical-taxonomy-angiosperms/p/itm194794e7a76e8 4. https://books.google.co.in/books/about/Plant_Taxonomy.html?id=uWg76rCqA68C 5. https://www.amazon.in/PLANT-TAXONOMY-Sharma/dp/0070141592 6. https://www.kopykitab.com/Economic-Botany-By-Manoj-Kumar-Sharma-eBook.

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	3	3	2	3	2	2
CO 3	2	2	3	3	1	2	1	2	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)

CORE VIII PLANT ANATOMY AND EMBRYOLOGY

Title of the Course	**PLANT ANATOMY AND EMBRYOLOGY**						
Paper Number	CORE VIII						
Category	Core	**Year**	III	**Credits**	4	**Course Code**	
		Semester	V				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		4		1		-	5
Pre-requisite		To acquire knowledge on the anatomical structure and reproductive phase of angiosperms.					

Learning Objectives	
C1	To know fundamental concepts of plant anatomy and embryology.
C2	To understand the internal tissue organization of various plant organs.
C3	To differentiate normal and abnormal secondary growth.
C4	To comprehend the structural organization of flower with relevance to the process of pollination and fertilization.
C5	To know embryology of plants.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Relate to the fundamental concepts of plant anatomy and embryology.	K1
2. Describe the internal tissue organization of various plant organs.	K2
3. Elucidate the stages of normal and abnormal secondary growth.	K3
4. Compare the structural organization of flower in relation to the process of pollination and	K4

fertilization.	
5. Access the various anatomical adaptations in plants.	K5
UNIT	**CONTENTS**
I	Cell wall - structure, and function. Tissues - Definition, types - Simple tissue system - parenchyma, collenchyma and sclerenchyma (fibers and sclereids). Complex tissue system - xylem and phloem. Meristem: definition, structure, function and classification. Apical organization and theories: Apical cell theory, Histogen theory and Tunica-Corpus theory. Root apex: Histogen theory and Korper-Kappe theory.
II	Primary structure of root and stem (Dicot and monocot). Epidermal tissue system: epidermis, cuticle, trichome, bulliform cells, periderm and silica cells. Ground tissue systems: cortex, endodermis, pericycle, pith and pith rays. Vascular tissue systems: different types of vascular bundles and their arrangement in oot and stem. Nodal anatomy: leaf trace, leaf gap, branch trace and branch gap-types
III	Secondary thickening in monocots and dicots, Secondary thickening in monocot and dicot root. Anomalous secondary growth of stem- *Boerhaavia, Nyctanthes* and *Dracaena*. Leaf - anatomy of dicot and monocot leaf. Periderm structure and development: Phellem, Phellogen, Phelloderm, Rhytidome and lenticels. Stomatal types.
IV	Structure and development of anther - development of male gametophyte. Ovule: Structure of mature ovule**,** types of ovules; female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (*Polygonum* type); Organization and ultra structure of mature embryo sac.
V	Double fertilization and triple fusion. Endosperm and its types - free nuclear, cellular, helobial, endosperm haustoria. Polyembryony - types, apomixis, parthenogenesis and parthenocarpy. Seed structure and its importance.
Extended Professional Component	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)

(is a part of internal component only,Not to be included in the External Examination question paper)	
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Bhojwani, S.S and Bhatnagar, S.P. 1994. Embryology of Angiosperms, Vikas. 2. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4^{th} revised and enlarged edition). Vikas Publishing House, New Delhi. 3. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge. 4. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag, New York. 5. Vimla Singh and Alok Abhishek. 2019. Plant Embryology and Experimental Biology. Educational Publishers and Distributors. New Delhi. 6. Pandey, B.P.2015. Plant Anatomy S. Chand Publ. New Delhi. 7. Bhatnagar,S.P., Dantu, P.K, Bhojwani, S.S. 2014. The Embryology of Angiosperms 6th edition Vikas Publishing House. Delhi. 8. Waisel, Y., Eshel, A and Kafkaki, U. (eds.). 1996. Plant Roots : The Hidden Hall (2nd edition). Marcel Dekker, New York.
Reference Books	1. Esau, K. 1985. Anatomy of Seed Plants –John Willey. 2. Cutter, E.G. 1989. Plant Anatomy – Part I – Addison – Wesley Publishing Co.. 3. Maheswari, P.1991. An Introduction to Embryology of Angiosperms, Tata McGraw Hill Publishing Co. Ltd., 4. Swamy, B.G.L and Krishnamoorthy. K.V.1990. From Flower to Fruits, Tata McGraw Hill Publishing Co. Ltd. 5. Dickison, W.C. 2000. Integrative Plant Anatomy. Harcourt Academic Press, USA. 6. Fahn, A. 1974. Plant Anatomy. Pergmon Press, USA. 7. Mauseth, J.D. 1988. Plant Anatomy. The Benjammin/Cummings Publisher, USA. 8. Evert, R.F. 2006. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John

	Wiley and Sons, Inc. Any local/state/regional flora published by BSI or any other agency. 9. Swamy, B.G.L and Krishnamurthy,K.V.1980. From flower to fruit .Tata McGraw Hill Co. Pvt. Ltd, New Delhi
Web Resources	1. https://www.amazon.in/PLANT-ANATOMY-EMBRYOLOGY-BIOTECHNOLOGY-ebook/dp/B07H5JYFBJ/ref=asc_df_B07H5JYFBJ/?tag=googleshopdes-2 2. https://www.kobo.com/us/en/ebook/a-textbook-of-plant-anatomy 3. https://archive.org/EXPERIMENTS/plantanatomy031773mbp 4. https://www.amazon.in/Embryology-Angiosperms-6th-S-P-Bhatnagar-ebook/dp/B00UN5KPQG 5. https://www.worldcat.org/title/embryology-of-angiosperms/oclc/742342811 6. https://books.google.co.in/books/about/Embryology_of_angiosperms.html?id=uYfwAAAAMAAJ&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	2	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	3	2	3	3	3	2	3

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

CORE IX CELL BIOLOGY, GENETICS AND PLANT BREEDING

Title of the Course	**CELL BIOLOGY, GENETICS AND PLANT BREEDING**					
Paper Number	CORE IX					
Category	Core	**Year**	III	**Credits**	4	**CourseCode**
		Semester	V			

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	1	-	5

Pre-requisite	To acquire knowledge on cell and expose the students a fundamental of the various techniques used in plant breeding.
Learning Objectives	
C1	To enable students to gain insights into cell wall organization and its functions.
C2	To familiarize with various cell organelles and their functions.
C3	To gain knowledge in classical genetics.
C4	To know about sex linked inheritance.
C5	To have knowledge about plant breeding techniques for crop improvement.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Enumerate the structure and functions of cells, cellular structures and organelles.	K1
2. Explain about cell cycle, cell division and lawsof inheritance with suitable examples.	K2
3. Elucidate concepts of sex determination and sex linked inheritance	K3
4. Analyze the importance ofgenes interactions at population and evolutionary levels.	K4

5. Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.	K5
UNIT	**CONTENTS**
I	Introduction- scope- cell organisation- Ultra structure of Prokaryotic cell and Eukaryotic cell. Plant cell structure and function. Cell boundaries- cell wall- gross layer i.e. middle lamella, primary wall, secondary wall- Structure, chemistry and functions of cell wall, pits- (simple and bordered), Plasmodesmata. Plasma membrane- occurrence, structure (fluid mosaic model) chemistry, function and origin. Properties of Cytoplasm Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.
II	Occurrence, structure, function and origin of Endoplasmic reticulum, Golgi apparatus, Lysosomes, Ribosomes, Mitochondria, Chloroplast and Micro bodies. Semi genetic autonomy of Mitochondria and Chloroplast. Ultrastructure and functions of Nucleus, nuclear envelope, nuclear pore complex, nucleolus, chromosomes structure molecular organization of chromatin, Euchromatin, heterochromatin, Polytene and Lampbrush chromosomes-, Centromere: types. cell inclusion. Cell cycle, Cell division, Mitosis and Meiosis- their significance.
III	Mendelian genetics – monohybrid, dihybrid crosses. Laws of Mendel, Reciprocal cross - Back cross and Test cross. Incomplete dominance - *Mirabilis jalaba.* Interaction of factors – Complementary genes, Supplementary genes, inhibitory genes, epistasis (dominant and recessive), duplicate genes and multiple alleles. Multiple alleles. ABO Blood grouping in Human. Chromosome theory of linkage, crossing over, recombinations and mapping of genes on chromosomes. Sex determination in plants.
IV	Sex linked inheritance – Haemophilia and colour blindness. Polyploidy origin, types and significance. Mutation-types and significance. chromosomal aberration – addition, deletion, inversion, duplication and translocation . Extra nuclear inheritance and its significance - Male sterility in corn , Maternal inheritance – Plastid Inheritance in *Mirabilis jalaba*. Genetics of *Neurospora*. Population genetics – Hardy – Weinberg principle.

V	Principles involved in plant breeding. Plant introduction and acclimatization. Methods of crop improvement: selection (mass, pure line and clonal), hybridization techniques. Heterosis – Interspecific and intergeneric, causes and effects. Brief account of Mutation in plant breeding, polyploidy in plant breeding and its applications. Breeding for crop improvement for paddy and sugarcane. A brief outline of biotechnological approaches in crop improvement eg. Transgenics – Bt- Cotton (only scope and its limitations).
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 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. Verma, P.S and V.K. Agarwal. 2002. Cytology. S. Chand & Co. Ltd., New Delhi-55. 2. Sinnott, EW., Dunn, L.L and Dobzhansky, T. 1997. Principles of Genetics, Tata Mc Graw Hill Publishing Co. New Delhi. 3. Cohn.N.S.1979, Elements of Cytology, Freeman Book Co. 4. Singh, R. J. 2016. Plant Cytogenetics, 3rd Edition. CRC Press, Boca Raton, Florida, USA. 5. Singh, R.J. 2017. Practical Mannual on Plant Cytogenetics. CRC Press, Boca Raton, Florida, USA.
Reference Books	1. De Robertis and De Robertis. 1990. Cell and Molecular Biology, Saunders College, Philadelphia, USA. 2. Gardner, E.J., Simmons, M.J and Snustad, D. 1991. Principles of Genetics, John Wiley Sons Inc., 8th Edn., New York. 3. Hackett, P.B., Fuchs, J.A and Messing, J.W. 1988. An Introduction to Recombinant. DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co. Inc., Menlo Park, California. 4. Cooper, G.M and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C. Sinauer Associates, MA.

	5. Becker, W.M., Kleinsmith, L.J., Hardin. J and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 6. Klug, W.S., Cummings, M.R., Spencer, C.A. 2009. Concepts of Genetics. 9th edition. Benjamin Cummings, U.S.A. 7. Lewin. 2007. Gene IX. Jones and Barlett Pub. ISBN. O 7637 52223. 8. Strickberger, M.W. 1999.Genetics.Prentice Hall of India Pvt Ltd, New Delhi.
Web Resources	1. http://www.freebookcentre.net/Biology/Cell-Biology-Books.html 2. https://www.us.elsevierhealth.com/medicine/cell-biology 3. https://www.amazon.in/Cell-Biology-Thomas-D-Pollard-ebook/dp/B01M7YAL2A 4. http://www.freebookcentre.net/medical_text_books_journals/genetics_ebooks_online_texts_download.html 5. https://www.us.elsevierhealth.com/medicine/genetics 6. https://libguides.uthsc.edu/genetics/ebooks 7. https://www.kobo.com/us/en/ebook/principles-of-plant-genetics-and-breeding 8. http://sharebooks.com/content/plant-breeding-ebooks-raoul-robinson

Mapping with Programme Outcomes:

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

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

CORE X COVERING PRACTICAL COVERING – CORE VIII AND IX - PRACTICAL-III

Title of the Course	**MAJOR PRACTICAL-III (including Core VII+VIII+IX) to be assessed in VI semester**						
Paper Number	CORE X Major Practical III						
Category	Core	**Year**	III	**Credits**	4 To be assessed in VI semester	**CourseCode**	
		Semester	V				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		-		-	3	3	
Pre-requisite		Theoretical understanding of anatomy, embryology, cell biology, genetics and plant breeding as well as basic laboratory skills for the relevant core course.					

Learning Objectives	
C1	To study the anatomy of the plant organs using various techniques.
C2	To study the embryology of the plant.
C3	To identify the structure of various cell organelles.
C4	To understand genetics through problem solving.
C5	To study various plant breeding techniques.
Course outcomes: On completion of this course, the students will be able to: **CO**	**Programme Outcomes**
1. Identify the structure of cell organelles and stages of cell division.	K1
2. Classify the types of stomata and ovules.	K2
3. Compare the functions of various ergastic substances present in plant tissues.	K3
4. Perform free hand sectioning of plant materials and decipher the internal tissue organization.	K4

5. Interpret the given genetic data to develop genetic map based on the principles of Mendelian inheritance and gene interaction.	K5

EXPERIMENTS

Anatomy

1. Study of simple and complex (Primary and Secondary) tissues by maceration.
2. Study the internal structure of primary (young) and secondary (old) stems dicot and monocot stem and root.
3. Anomalous secondary growth in the stems of *Boerhaavia, B**ignonia,** Nycthanthes* and *Dracaena*.
4. T.S of dicot and monocot leaves.
5. Study of stomatal types by leaf peeling.

Embryology

1. T.S of (young and mature) anther (section from *Datura* or *Cassia* flower).
2. Observation of pollinia –Calotropis.
3. Types of ovules- Anatropous, Orthotropous, Circinotropous, Amphitropous, Campylotropous (Permanent slides).
4. Types of Endosperm - Nuclear, cellular and helobial

(Permanent slides).

5. Dissection and display of any two stages of embryo in

Tridax

Cell biology

1. Study of the photomicrographs of cell organelles.
2. Ergastic substances - starch grains, aleurone grains, crystals – cystolith and raphide(Permanent slides).
3. Study the polytene and lamp brush chromosome structure through photograph.
4. Identification of different stages of mitosis by using squash and smear techniques – Onion root tip.

Genetics

1. Genetic problems – test cross, back cross and allelic interaction.
2. Construction of chromosome map – three point test cross
3. Multiple alleles problems.

Plant Breeding

1. Emasculation technique.
2. To test the viability of seeds using Tetrazolium chloride.
3. Genetic models of heterosis.
4. Phenotype of heterosis (Maize).

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 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. Sundara, R. S. 2000. Practical manual of plant anatomy and embryology. Anmol Publ. PVT LTD, New Delhi. 2. Panshin, A.J and C. de Zeeuw.1980.Textbook of wood technology. Structure, identification and uses of the commercial woods of the United States and Canada. Fourth Edition. New York: McGraw-Hill Book Company. 3. Sharma, H.P. 2009. Plant Embryology: Classical and Experimental, Bombay Popular Prakashan, ISBN-8173199698, 9788173199691. 4. Gupta P.K. 2017. Cell and Molecular Biology (5th ed.), Rastogi Publications, Meerut. 5. Krebs J.E., Goldstein E.S and Kilpatrick S.T. 2017. Lewin's GENES XII (12thed.). Jones & Bartlett Learning. 6. Jackson, S.A., Kianian, S.F., Hossain, K.G and Walling, J.G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York.
Reference Books	1. Sundara Rajan, S, 2003. Practical Manual of Plant Anatomy and Embryology 1st ed, Anmol Publications, ISBN-812610668. 2. Katherine Esau. 2006. Anatomy of Seed Plants. 2nd edition, John Wiley and Sons. 3. Allen, Sarah et al., 2016. Plant Anatomy Lab Manual, Fall. 4. Gardener, J, Simmons, H.J and Snustad, D.P. 2006. Principle of Genetics, John Wiley & Sons, New York.
	5. De Robertis E.D.P. and De Robertis E.M.P. 2017. Cell and Molecular Biology (8thed.) (South Asian Edition), Lea and Febiger, Philadelphia, USA. 6. Jackson, S.A., Kianian, S.F., Hossain, K.G., and Walling, J. G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York, NY.
Web resources	1. https://www.amazon.in/Practical-Anatomy-Adriance-1901-1973-Foster/dp/1341784509 2. https://books.google.co.in/books/about/Practical_Manual_Of_Plant_Anatomy_And_Em.html?id =Cq1KPwAACAAJ&redir_esc=y 3. https://www.amazon.in/Cell-Biology-Dr-Renu-Gupta/dp/8193651219 4. https://www.amazon.in/Practical-Handbook-Genetics-Vikas-Pali/dp/932727248X 5. https://www.amazon.in/Practical-Handbook-Plant-Breeding-Vikas/dp/9327272498

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	3	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)**

CORE XI PLANT ECOLOGY AND PHYTOGEOGRAPHY

Title of the Course	**PLANT ECOLOGY AND PHYTOGEOGRAPHY**						
Paper Number	CORE XI						
Category	Core	**Year**	III	**Credits**	4	**Course Code**	
		Semester	VI				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		3		2		-	5
Pre-requisite		Understanding the environmental factors impacting biodiversity is crucial after taking this course.					

Learning Objectives	
C1	To relate to the significance of the biotic and abiotic components of the ecosystems.
C2	To understand the energy flow in ecosystem.
C3	To conceptualize the biodiversity.
C4	To know implication of pollution on the environment.
C5	To familiarize with the phytogeography.

Course outcomes: On completion of this course, the students will be able to: **CO**	**Programme Outcomes**
1. Relate to the significance of the biotic and abiotic components of the ecosystems and energy flow.	K1
2. Summarize the phytogeographical division of India.	K2
3. Explain the implication of pollution on the environment.	K3
4. Analyze the implications of functional and behavioral ecology in natural and man-made areas, biodiversity and conservation.	K4

5. Develop mitigations for the effective conservation of biodiversity and disaster management.	K5
Unit	**CONTENTS**
I	Biotic and abiotic factors and their influence on vegetation – a brief account of microbes, plants, animals, soil, wind, light, temperature, rainfall, and fire. Autecology and Synecology – Vegetation – Units of Vegetation – Formation, Association, Consociation, Society – development of vegetation. Migration – ecesis, colonization, Methods of study of vegetation (Quadrat and transect). Plant succession –Hydrosere and Xerosere. Ecological classification of plants: Morphological and anatomical features of plants and their correlation to the habitat factors.
II	Structure, trophic organization; food chains and food web, energy flow in an ecosystem. Types of ecosystems: pond, forest and grassland. Ecological pyramids and Biogeochemical cycles of carbon and nitrogen and phosphorus.
III	**Plant Biodiversity** and its importance. Definition, levels of biodiversity-genetic, species and ecosystem. Biodiversity hotspots- Criteria, Biodiversity hotspots of India. Loss of biodiversity – causes and conservation (*In situ* and *ex situ* methods). Seed banks - conservation of genetic resources and their importance. Consequences of deforestation and exploitation of targeted species; Forest conservation, Social forestry and Participatory Management of Forest. Concept of degeneration and regeneration of plants.
IV	**Pollution:** Types of pollution: Primary and secondary and their impacts: Air - Green house effect, global warming, ozone depletion, acid rain, Water, soil- causes and consequences. Remedial measures – Green building. Disaster management.
V	**Phytogeography** Definition,Introduction, Principles of phytogeography. Concept, Scope and significance of phytogeography. Continuous and discontinuous distribution w.s.r.t. Endemism, Age Area Hypothesis and continental drift. Phytogeography of India, Vegentational regions of India,. Plant indicators. Diversification of land plants. Speciation Changing Earth. Island Biogeography.

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 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. Singh, J.S., Singh, S.P., Gupta, S. 2006. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India. 2. Sharma, P.D. 2010. Ecology and Environment. Rastogi Publications, Meerut, India.8th edition. 3. Krishna Iyer.V.R. 1992. Environmental protection and legal defence. Sterling Publishers Pvt. Ltd., 4. Shukla, R.S and Chandel,PS.1990. Plant Ecology, S.Chand & Co. Pvt. Ltd., 5. Krishnamurthy, K.V. 2003. An advanced text book on Biodiversity - Principle and Practice. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 6. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publications.
Reference Books	1. Odum, E.P. 2005. Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition. 2. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A. 3. Kumar,H.D. 1990. Modern concepts of Ecology, Vikas Publishing House Pvt. Ltd., 4. Smith,W.H. 1981. Air pollution and forest : Interactions between air contaminants and forest ecosystems. 5. Vickery, M.L. 1984. Ecology of Tropical plants, John Wiley and Sons. 6. Melchias, G., 2001. Biodiversity and Conservation, Science Publishers Inc. USA. 7. Asthana, D.K and Meera Asthana. 2006. A text book of Environmental studies. S.Chand and Company Ltd. New Delhi. 8. Brian Groombridge. 1992. Global Biodiversity, Chapman and Hall, UK.
	9. IUCN. 1985. The World Conservation Strategy, IUCN, Switzerland. 10. Ambasht, R.S. 2017. A textbook of plant ecology 15ed (pb 2019). CBS Publishers Distributors.

Web Resources	1. https://www.kobo.com/us/en/ebook/plant-ecology-3. 2. https://www.worldcat.org/title/plant-ecology/oclc/613206385 3. https://books.google.co.in/books/about/Plant_Ecology.html? 4. https://www.kopykitab.com/Plant-Ecology-by-Agrawal-AK-And-Deo-PP 5. http://www.freebookcentre.net/Biology/Ecology-Books.html 6. https://www.amazon.in/Plant-Ecology-Ernst-Detlef-Schulze/dp/354020833X 7. https://www.tandfonline.com/toc/tped20/current (Plant Ecology and Diversity) 8. https://link.springer.com/journal/11258 (Plant Ecology)

Mapping with Programme Outcomes:

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

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

CORE XII BIOTECHNOLOGY AND MOLECULAR BIOLOGY

Title of the Course	**PLANT BIOTECHNOLOGY AND MOLECULAR BIOLOGY**						
Paper Number	CORE XII						
Category	Core	**Year**	III	**Credits**	4	**CourseCode**	
		Semester	VI				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5

Pre-requisite	To empower students recognize and appreciate the basic principles that sustain biotechnology as an interdisciplinary domain of learning and research.

Learning Objectives	
C1	To know various aspects of biotechnology
C2	To know the concept and techniques of plant tissue culture.
C3	To familiarize with the gene transfer techniques.
C4	To know about DNA replication and repair.
C5	To familiarize with gene regulation.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize the fundamentals concepts of plant biotechnology and genetic engineering.	K1
2. Explain various steps in transcription, protein synthesis and protein modification.	K2
3. Elucidate gene cloning and evaluate different methods of gene transfer.	K3
4. Analyze the major concerns and applications of transgenic technology.	K4
5. Develop their competency on different types of plant tissue culture.	K5

UNIT	**CONTENTS**
	Biotechnology – definition, history and scope. Application of plant biotechnology in various fields. Agriculture -

I	Biofertilizers, Biopesticides. Medicine – Antibiotics (Penicillin) Recombinant vaccines, insulin and interferons. Environment – Bioremediation and Biofuel. Industry – ethanol production (yeast), citric acid production (*Aspergillus niger*) and Proteases production (*Bacillus sps*).
II	Plant tissue culture - introduction, scope and importance, concept of totipotency, aseptic techniques in plant tissue culture. Composition of media, types of media, sterilization, explant preparation and inoculation. Callus induction and micropropogation. Application of plant tissue culture in agriculture, horticulture and forestry. Synthetic seed technology.
III	Vectors; plasmid, bacteriophage, viral vectors, cosmids. Restriction enzymes. Recombinant DNA technology, gene transfer – indirect method, *Agrobacterium* mediated gene transfer. Direct method – Biolistic method. Development of transgenic plants with reference to insect resistance, Pros and cons of GM food.
IV	Nature and function of genetic materials, Nucleic acid – base paring – Chargaff's rule, DNA – structure. Types, denaturation - renaturation. Replication of DNA in prokaryotes. RNA structure and types. DNA repair mechanism.
V	Transcription – Enzymology – RNA polymerase – classes of RNA molecules – transcription in prokaryotes. Protein synthesis – Genetic code – characters – codons and anticodons. Gene regulation in Prokaryotes – *lac* operon and *trp* operon
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 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	. Bhajwani, S and Razdan, 1984. Plant tissue culture. Theory and practice. *2.* *Verma P.S and Agarwal V.K. 2010. Molecular Biology. S Chand Publishers.* *3.* Ignacimuthu, S.J. 2003. Plant Biotechnology. Oxford & IBH Publishing, New Delhi. *4.* Bhojwani, S.S and Razdan, M.K. 2004. Plant Tissue Culture, Read Elsevier India Pvt. Ltd. *5.* Purohit, S.S. 2010. Plant tissue culture, Student edition, Jodhpur. *6.* Bajaj, Y.P.S. 1987. Biotechnology in agriculture and forestry. Springer – Verlag

Reference Books	1. Bernard R Glick and Jack J Pasternak. 2001. Molecular biotechnology-principles and applications of recombinant DNA, (2nd Edition), ASM Press, Washington, D.C. 2. Jogdand, SN. 1997. Gene biotechnology, Himalaya Publishing House, New Delhi. 3. Ernst L. Winnaccker. 2002. From Genes to Clones-introduction to gene technology, VCR Pub., Weintein. 1. James, D Watson et al., 1992. Recombinant DNA (2nd Edition), WH Freeman and Co., New York. 5. Maniatis and Sambrook. 2003. Molecular Cloning- A lab manual Vol.I, II & III, Coldspring Harbor Laboratory Press, New York. 6. Old, RW and Primrose, SB. 2001. Principles of Gene Manipulation-an introduction to genetic engineering, Black Well Science Ltd., New York. 7. Halder, T and Gadgil, V.N.1981. Plant cell culture in crop improvement. Plenum, New York. 8. Neuman, K.H., Barz, W and E. Reinhard. 1985. Primary and secondary metabolism of plant cell cultures – Springer – Verlag, Berlin. 9. Barz, W., Reinhard, E and Zenk, M.H. 1977. Plant tissue culture and its biotechnology application – Springer – Verlag, Berlin. 10. Hu, C.Y and P.J.Wang. 1984. Handbook of plant cell culture Vol.1. Mac million, New York. 11. Hammond, J.C. McGarvey and V. Yusibov. 2009. Plant Biotechnology, Springer Verlag. New York.
	1. http://www.freebookcentre.net/Biology/BioTechnology-Books.html ***2. https://books.google.co.in/books/about/Introduction_to_Plant_Biotechnology.html?id=RqQLISN8zT8C*** ***3.*** https://www.kobo.com/us/en/ebook/plant-biotechnology-1 ***4. https://www.kobo.com/us/en/ebook/plant-biotechnology-1*** ***5. https://www.worldcat.org/title/molecular-biology/oclc/1062496183*** ***6.*** http://www.freebookcentre.net/Biology/Molecular-Biology-Books.html ***7.*** https://www.amazon.in/Molecular-Biology-Multicolour-Verma-Agarwal-ebook/dp/B06XKVVWT3

Mapping with Programme Outcomes:

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

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

CORE XIII PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY

Title of the Course	**PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY**						
Paper Number	CORE XIII						
Category	Core	**Year**	III	**Credits**	4	**Course Code**	
		Semester	VI				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	3	2	-	5
Pre-requisite	Basic knowledge on physiological processes in plants and primary and secondary plant metabolites and enzymes.			

Learning Objectives	
C1	To relate to water relation of plants with respect to various physiological phenomenon.
C2	To know the pathways of photosynthesis.
C3	To familiarize with respiration and nitrogen metabolism.
C4	To know about plant growth regulators.
C5	To familiarize with plant biochemistry.

Course outcomes: On completion of this course, the students will be able to: **CO**	**Programme Outcomes**
1. Relate to water relation of plants with respect to various physiological phenomenon.	K1
2. Explain the process and significance of photosynthesis and respiration.	K2
3. Elucidate properties of nutrients and their deficiency symptoms in plants.	K3
4. Analyze the biological role of plant growth regulators, carbohydrates, proteins, lipids, nucleic acids and enzymes.	K4

5. Decipher the phenomenon of seed dormancy and germination in plants.	K5

UNIT	CONTENTS
I	**Water Relations:** Properties of water—imbibition, diffusion, osmosis and plasmolysis- ascent of sap, mechanism of water absorption – active and passive, apoplast and symplast pathway. Transpiration – types and factors affecting transpiration and significance. Opening and closing of stomata- mechanisms and theories of transpiration.
II	**Photosynthesis:** Radiant energy, Photosynthetic unit, photosynthetic pigments and their role, photo systems, path of carbon in photosynthesis - Light reaction, electron transport system in the chloroplast (Z-Scheme). Dark reaction - C3 cycle, C4 cycle, CAM pathway, Photorespiration
III	**Respiration** Aerobic, Glycolysis, Krebs Cycle, Electron Transport System, oxidative phosphorylation, respiratory quotient, Anaerobic- fermentation - Respiratory quotient. **Nitrogen Metabolism** Biological nitrogen fixation, nitrification and denitrification. Nitrate assimilation- Synthesis of amino acids - Reductive amination and Transamination. Nitrogen cycle.

IV	**Growth:** Growth – plant growth regulators (auxins, gibberellins, cytokinins, ethylene and abscisic acid) - Practical applications - Photo morphogenesis – photoperiodism – vernalization – dormancy- phytochromes. **Stress Physiology:** Concepts of plant responses to stresses (water, salt, temperature).
V	**Plant Biochemistry:** Classification, properties and biological role of carbohydrates, proteins, lipids and nucleic acids. Enzyme – properties – classification – nomenclature of enzymes – mode of enzyme action – factors influencing enzyme action.
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 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. Noggle and Fritz. 1976. Introductory Plant Physiology, Prentice Hall, New Delhi. 2. Pandey, SN and Sinha, BK. 1989. Plant Physiology, Vikas Publishing House Ltd., New Delhi. 3. Robert M. Devlin. 1970. Plant Physiology, East West Press, New Delhi. 4. Westhoff, P. 1998. Molecular Plant Development from Gene to Plant. Oxford University Press, Oxford, UK. Jain, JL. 1979. Fundamentals of Biochemistry, Chand & Co. Ltd., New Delhi. 5. Jain, V.K. 2006. Fundamentals of Plant Physiology, S.Chand and CompanyLtd., New Delhi. 6. Conn, E and Stumpf, PK. 1979. Outline of Biochemistry Niley Easdtern Ltd., New Delhi. 7. Metz, E.T. 1960. Elements of Biochemistry. V.F & S (P) Ltd., Bombay.
	8. Verma,V. 2008. Textbook of plant Physiology, Ane's student edition, New Delhi.

Reference Books	1. Buchanan, B.B., Gruissem, W and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA. 2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D and Layzell, D.B. (Eds) 1997. Plant Metabolism (second edition). Longman Essex, England. 3. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA. 4. Hooykaas, P.J.J., Hall M.A and Libbenga, K.R. (eds). 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amsterdam, The Netherlands. 5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. 6. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (second edition). Springer-Verlag, NewYork, USA. 7. Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology (second edition), Academic Press, San Diego, USA. 8. Salisbury, F.B and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA. 9. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D and Govindjee. 1999. Concepts in Photobiology: Photosynthesis and Photo morphogenesis. Narosa Publishing House, New Delhi. 10. Taiz, L and Zeiger, E. 1998. Plant Physiology (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA. 11. Thomas, B and Vince-Prue, D. 1997. Photoperiodism in Plants (second edition). Academic Press, San Diego. USA.
Web Resources	1. https://www.kobo.com/us/en/ebook/biochemistry-and-molecular-biology-of-plants 2.https://www.amazon.in/Plant-Biochemistry-Hans-Walter-Heldt-ebook/dp/B004FV4RS6 3. https://www.kobo.com/us/en/ebook/plant-biochemistry 4. https://www.kobo.com/us/en/ebook/a-textbook-of-plant-physiology-1 5.https://www.amazon.in/Advances-Plant-Physiology-P-Trivedi-ebook/dp/B01JP5L0YA 6.https://www.crcpress.com/Plant-Physiology/Stewart-Globig/p/book/9781926692692 7.https://www.amazon.com/Introduction-Plant-Physiology-William-Hopkins-ebook/dp/B006R6I850

Mapping with Programme Outcomes:

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

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

CORE XIV PRACTICAL COVERING – CORE XI, XII AND XIII - PRACTICAL-IV

Title of the Course	**PRACTICAL-IV (including core XI+XII+XIII)**						
Paper Number	CORE XIV						
Category	Core	**Year**	III	**Credits**	4	**Course Code**	
		Semester	VI				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	1+1		-		2+2	6	
Pre-requisite	Practicals pertaining to above subjects is important to get knowledge on various physiological functions of plants.						
Learning Objectives							
C1	To study morphological and anatomical adaptations of plants of various habitats.						
C2	To demonstrate techniques of plant tissue culture.						
C3	To familiarize with the structure of DNA, RNA.						
C4	To carryout experiments related with plant physiology.						
C5	To perform biochemistry experiments.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Relate to the distribution and adaptions of plants pertaining to their habitat	K1						
2. Demonstrate skills in green planning and callus culture.	K2						
3. Elucidate the basic principles involved in the plant physiology and biochemistry experiments.	K3						
4. Appreciate the structure and functions of DNA and RNA.	K4						
5. Estimate the biochemical components and	K5						

determine the factors controlling photosynthesis and transpiration of plants.	

EXPERIMENTS

Plant Ecology and Phytogeography

1. Study of morphological and anatomical adaptations of locally available hydrophytes, xerophytes, mesophytes and halophytes and correlate to their particular habitats.
   Hydrophytes : *Nymphaea, Hydrilla*
   Xerophytes : *Nerium, Casuarina*
   Mesophytes : *Tridax, Vernonia*
   Halophytes : *Avicennia, Rhizophora (only permanent slides)*
   Epiphytes : *Vanda(only permanent slides)*
2. Map of the phytogeographical regions of India.
3. Quadrate study and line transect.
4. Plan for a green building.
5. Field trip to any one scrub jungle or wetland (nearby forests).

Plant Biotechnology - Demonstration

1. Sterilization techniques in plant tissue culture.
2. MS - Media preparation.
3. Explant sterilization, Callus induction, Plantlet, hardening.

Molecular Biology – Photographs

1. DNA Structure
2. tRNA
3. DNA – Replication
4. DNA – Repair
5. Genetic code

Plant Physiology and Plant Biochemistry

1. Determination of water potential by plasmolytic method.
2. Effect of chemicals on membrane permeability.
3. Effect of environmental factors on rate of transpiration by Ganong's photometer
4. Separation of plant pigments by paper chromatography.
5. Study the rate of photosynthesis under different light intensities by using Willmott's bubble counter.
6. Study of rate of photosynthesis under different wavelengths (red & blue) of light.
7. Comparison of rate of respiration of different respiratory substrates(flower bud and germinating seeds).
8. Measurement of pH of expressed cell sap(lemon, tomato…) and different soils using pH meter.
9. Enzyme activity – catalase.

Biochemical test for carbohydrates, proteins and lipids-Priliminary qualitative tests.

Demonstration – Experiments

1. Study the rate of transpiration by using gravimetric method.
2. Demonstration of stomatal movement(opening and closing).
3. Induction of roots in leaves by auxins.
4. Potato osmoscope.
5. Anaerobic respiration (Khune's method).

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. Sharma, P.D. 2017. Ecology and Environment- Rastogi Publication,Meerut. 2. Bhojwani, S.S and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands. 3. Jackson, S.A., Kianian, S.F., Hossain, K.G and Walling, J.G. 2012. Practical laboratory exercises for plant molecular cytogenetics. In Plant Cytogenetics (pp. 323-333). Springer, New York. 4. Plummer, D. 1988. An introduction to Practical Biochemistry, Tata McGraw–HillPublishing Company Ltd., New Delhi. 5. Palanivelu, P. 2004. Laboratory Manual for analytical biochemistry and separationtechniques, School of Biotechnology, Madurai Kamaraj University, Madurai.

	6. Jayaraman.J.1981. Laboratory Manual in Biochemistry. Whiley Eastern Limited,New Delhi. 7. Bendre, A.M. and Ashok Kumar, 2009. A text book of practical Botany. Vol. I & II.Rastogi Publication. Meerut. 9th Edition.
Reference Books	1. Mick Crawley. 1996. Plant Ecology, 2nd Edition Wiley-Blackwell. 2. Gamborg, O.L and G.C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual. 3. Glick, B.R and J.E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida. 4. Bala, M., Gupta, S., Gupta, N.K and Sangha, M.K. 2013. Practicals in plant physiology and biochemistry. Scientific Publishers (India). 5. Wilson, K and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4th Edition) Cambridge University Press, Cambridge. 6. Bendre, A.M and Ashok Kumar. 2009. A text book of practical Botany. Vol. I & II.Rastogi Publication. Meerut. 9th Edition. 7. Manju Bala, Sunita Gupta, Gupta, N.K. 2012. Practicals in Plant Physiology andBiochemistry. Scientific Publisher.
Web resources	1. https://www.amazon.com/Practical-plant-ecology-beginners-communities/dp/B00088FDQK 2. https://www.amazon.in/Practical-Biotechnology-Plant-Tissue-Culture/dp/8121932009 3. https://www.elsevier.com/books/molecular-biology-techniques/carson/978-0-12-815774-9 4. https://www.amazon.in/Practical-Physiology-Biochemistry-Sunita-Sangha/dp/9386102633 5. https://www.amazon.in/Practical-Biochemistry-Muriel-Wheldale-Onslow/dp/1107634318

Mapping with Programme Outcomes:

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

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

ELECTIVE ALLIED BOTANY-I

Title of the Course	ALLIED BOTANY-I						
Paper Number	Core-Allied-I						
Category	Core	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	3		1		-	4	
Pre-requisite	To study basics of botany.						

Learning Objectives	
C1	To study morphological and anatomical adaptations of plants of various habitats.
C2	To demonstrate techniques of plant tissue culture.
C3	To familiarize with the structure of DNA, RNA.
C4	To carryout experiments related with plant physiology.
C5	To perform biochemistry experiments.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Increase the awareness and appreciation of human friendly algae and their economic importance.	K1
2. Develop an understanding of microbes and fungi and appreciate their adaptive strategies	K2
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.	K3
4.Compare the structure and function of cells and explain the development of cells.	K4

5.Understand the core concepts and fundamentals of plant biotechnology and genetic engineering.	K5

UNIT	CONTENTS
I	**Algae and Bryophytes:** General characters of algae - Structure, reproduction and life cycle of the following genera - *Anabaena* and *Sargassum* and economic importance of algae. General characters of Bryophytes, Structure and life cycle of *Funaria*.
II	**Fungi, Lichens, Bacteria and Virus:** General characters of fungi, structure, reproduction and life cycle of the following genera - *Penicillium* and *Agaricus* and economic importance of fungi. A brief account of Lichens Bacteria - general characters, structure and reproduction of *Escherichia coli* and economic importance of bacteria. Virus - general characters, structure of TMV, structure of bacteriophage.
III	**Bryophytes, Pteridophytes and Gymnosperms:** General characters of Pteridophytes, Structure and life cycle of *Lycopodium*. General characters of Gymnosperms, Structure and life cycle of *Cycas*.
IV	**Cell Biology:** Prokaryotic and Eukaryotic cell- structure /organization. Cell organelles - ultra structure and function of chloroplast, mitochondria and nucleus. Ergastic substances- starch grains, aleurone, raphides, cystoliths. Cell division - mitosis and meiosis.
V	**Genetics and Plant Biotechnology:** Mendelism - Law of dominance, Law of segregation, Incomplete dominance. Law of independent assortment. Monohybrid and dihybrid cross - Test cross - Back cross. Plant tissue culture - *In vitro* culture methods. Plant tissue culture and its application in biotechnology.
Extended Professional Component (is a part of internal component only, Not to	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)
be included in the External Examination question paper)	

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Singh, V., Pande, P.C and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications,Meerut. 2. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru. 3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd. Delhi. 4. Lee, R.E. 2008. Phycology, IV Edition, Cambridge University Press, New Delhi. 5. Rao, K., Krishnamurthy, K.V and Rao, G.S. 1979. Ancillary Botany,S. Viswanathan Pvt. Ltd., Madras.
Reference books:	1. Parihar, N.S. 2012. An introduction to Embryophyta –Pteridophytes - Surjeet Publications, Delhi. 2. Alexopoulos, C.J. 2013. Introduction to Mycology. Willey Eastern Pvt. Ltd. 3. Vashishta, P.C. 2014. Botany for Degree Students Gymnosperms. Chand & Company Ltd, Delhi. 4. Coulter, M. Jhon, 2014. Morphology of Gymnosperms. Surjeet Publications, Delhi. 5. Vashishta, P.C. 2014. Botany for Degree Students Algae. 2014. Chand & Company Ltd, Delhi. 6. Parihar, N.S. 2013. An introduction to Embryophyta –Bryophytes -, Surjeet Publications, Delhi. 7. Pandey B.P. 1986, Text Book of Botany (College Botany) Vol I &II, S.Chand and Co. New Delhi.
Web Resources	1. https://www.kobo.com/us/en/ebook/the-algae-world 2. http://www.freebookcentre.net/biology-books-download/Fungi-(PDF-15P).html 3. http://scitec.uwichill.edu.bb/bcs/bl14apl/bryo1.htm 4. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/ 5. https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf 6. https://www.us.elsevierhealth.com/medicine/cell-biology 7. https://www.us.elsevierhealth.com/medicine/genetics 8. https://www.kobo.com/us/en/ebook/plant-biotechnology-1

Mapping with Programme Outcomes:

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

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

ELECTIVE ALLIED BOTANY-II

Title of the Course	ALLIED BOTANY-II						
Paper Number	Core-Allied-II						
Category	Core	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	3	1	-	4			
Pre-requisite	To study basics of botany.						
Learning Objectives							
C1	To be familiar with the basic concepts and principles of plant systematics.						
C2	Learn the importance of plant anatomy in plant production systems.						
C3	Understand the mechanism underling the shift from vegetative to reproductive phase.						
C4	To learn about the physiological processes that underlie plant metabolism.						
C5	To know the energy production and its utilization in plants.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Understand the fundamental concepts of plant anatomy and embryology	K1						
	K2						

Analyze and recognize the different organs of plants and secondary growth	
Understand water relation of plants with respect to various physiological processes	K3
Classify aerobic and anaerobic respiration	K4
	K5

5. Classify plant systematics and recognize the importance of herbarium and virtual herbarium	

UNIT	CONTENTS
I	**MORPHOLOGY OF FLOWERING PLANTS:** Plant and its parts. Structure and function of root and stem. Leaf and its parts. Leaf type: simple and compound. Phyllotaxy and types. Inflorescence - Racemose, Cymose and Special type. Terminology with reference to flower description.
II	**TAXONOMY:** Study of the range of characters and plants of economic importance in the following families: Leguminosae(3 sub families included), Asclepiadaceae, Acanthaceae, Euphorbiaceae and Poaceae
III	**ANATOMY** Tissue and tissue systems: Simple and complex tissues. Anatomy of monocot and dicot of monocot roots. Anatomy of monocot and dicot stems - anatomy of dicot and monocot leaves.

IV	**EMBRYOLOGY** Structure of mature anther and ovule - Types of ovules, structure of embryo sac, pollination and double fertilization, structure of dicotyledonous and monocotyledonous seeds.
V	**PLANT PHYSIOLOGY** Absorption of water, photosynthesis - light reaction - Calvin cycle; respiration – Glycolysis- Krebs cycle- electron transport system. Transpiration. Growth hormones - auxins and cytokinins and their application
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 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. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies. 2. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi. 3. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi. 4. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont. 5. Ting, I.P. 1982. Plant Physiology. Addison Wesley Pb. Philippines.

Reference Books	1.Lawrence.G.H.M. 1985. An Introduction to Plant Taxonomy, Central Book Depot, Allahabad. 2. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi. 3. Pandey, B.P. 2012. Plant Anatomy. S Chand Publishing. 4. Jain, VK. 2006. Fundamentals of Plant Physiology, S. Chand and Company Ltd. 5. Rajni Gupta. 2012. Plant Taxonomy: Past, Present and Future. Vedams (P) Ltd. New Delhi. 6. Jain, V.K. 2006. Fundamentals of Plant Physiology, S.Chand and Company Ltd., New Delhi. 7. Verma, S.K. 2006. A Textbook of Plant Physiology, S.K.Chand & Co., New Delhi.
Web Resources	https://books.google.co.in/books/about/Plant_Taxonomy.html?id=0bYs8F0Mb9gC&redir_esc=y 2. https://books.google.co.in/books/about/PLANT_TAXONOMY_2E.html?id=Roi0lwSXFnUC&redir_esc=y 3. https://archive.org/EXPERIMENTS/plantanatomy031773mbp 4. https://www.amazon.in/Embryology-Angiosperms-6th-S-P-Bhatnagar-ebook/dp/B00UN5KPQG 5. https://www.crcpress.com/Plant-Physiology/Stewart-Globig/p/book/9781926692692

Mapping with Programme Outcomes:

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

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

ELECTIVE ALLIED BOTANY PRACTICALS

Title of the Course	Allied Botany PRACTICALS						
Paper Number	Core Allied Practicals						
Category	Core	**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	-	-	2	2

Pre-requisite	Practicals pertaining to above subjects is important to get knowledg e on various aspects of plants.
Learning Objectives	
C1	To enhance information on the identification of each taxonomical group by developing the skill-based detection of the morphology and microstructure of microorganisms, algae, and fungi.
C2	To comprehend the fundamental concepts and methods used to identify Bryophytes, Pteridophytes and Gymnosperms through morphological changes and evolution, anatomy and reproduction.
C3	To be familiar with the basic concepts and principles of plant systematics.
C4	Understanding of laws of inheritance, genetic basis of loci and alleles.
C5	To learn about the physiological processes that underlie plant metabolism.
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. To study the internal organization of algae and fungi.	K1
2. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperm s..	K2

3. To study the classical taxonomy with reference to different parameters.	K3
4. Understand the fundamental concepts of plant anatomy and embryology	K4
5. To study the effect of various physical factors on photosynthesis.	K5

EXPERIMENTS

Make suitable micro preparation of the types prescribed in Algae, Fungi, Bryophytes,

Pteridophytes and Gymnosperms.

2. Micro photographs of the cell organelles ultra structure.

3. Simple genetic problems.

4. To describe in technical terms, plants belonging to any of the family prescribes and to identify the family.

6. To dissect a flower, construct floral diagram and write floral formula.
7. Economic importance of Families studied
8. Demonstration experiments
1. Ganong's Light screen
2. Ganong's respiroscope
3. Ganong's Potometer
9. To make suitable micro preparations of anatomy materials prescribed in the syllabus.
10. Spotters - Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperm anatomy, Embryology, Cell biology and Biotechnology.

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	Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd, New Delhi. 2. Sharma, O.P. 2012. Pteridophyta, Tata McGraw-Hills Ltd, New Delhi. 3. Subramaniam, N.S. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt. Ltd., New Delhi. 4. Benjamin, A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freen an and Company, New York, England. 5.Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice H all of India, New Delhi.

Reference Books	Strickberger, M.W. 2005. Genetics (III Ed). Prentice Hall, New Delhi, Ind a. 2. Nancy Serediak and M. Huynh. 2011. Algae identification lab Guide. Accompanying manual to algae identification field guide, Ottawa Agriculture and Agri food Canada publisher. 3. Mohammed Gufran Khan, Shite Gatew and Bedilu Bekele. 2012. Practical manual for Bryophytes and Pteridophytes. Lambert Academic Publishing. 4. Aler Gingauz. 2001. Medicinal Chemistry. Oxford University Press & Wiley Publications. 5. Steward, F.C. 2012. Plant Physiology Academic Press, US
Web resources	1. https://www.amazon.in/Practical-Manual-Pteridophyta-Rajan-Sundara/dp/8126106883 2. https://www.google.co.in/books/edition/Gymnosperms/3YrT5E3Erm8C?hl=&gbpv=1&dq=gy mnosperms&printsec=frontcover 3. https://www.amazon.in/Computational-Phytochemistry-Satyajit-Dey-Sarker-ebook/dp/B07CV96NZJ 4. https://medlineplus.gov/genetocs/understanding/basics/cell/ 5. https://apan.net/meetings/apan45/files/17/17-01-01-01.pdf 6. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf 7. https://www.amazon.in/Manual-Practical-Bryophyta-Suresh-Kumar/dp/B0072GNFX4

Mapping with Programme Outcomes:

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

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

NON-MAJOR ELECTIVE-I

1. ORGANIC FARMING

Title of the Course	**ORGANIC FARMING**					
Paper Number	Non-Major Elective-I					
Category	Elective	**Year**	I	**Credits**	2	**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 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**
. Recognize the different forms of biofertilizers and their uses.	**K1**
. Explain and interpret the components, patterns, and processes of bacteria for growth in crop production.	**K2**
. 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**
. Develop new strategies to enhance growth and quality check of medicinal herbs	**K5**

considering the practical issues pertinent to India.	

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 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 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. Vayas,S.C, Vayas, S. and Modi, H.A. 1998. Bio-fertilizers and organic Farming Akta Prakashan, Nadiad. Dongarjal, R.P and Zade, S.B. 2019. Insect Ecology and Integrated Pest Management Akinik Publications, New Delhi.
Reference Books:	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. 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)**

NON-MAJOR ELECTIVE-I

1. ENVIRONMENTAL BIOTECHNOLOGY

Title of the Course	**ENVIRONMENTAL BIOTECHNOLOGY**					
Paper Number	Non-Major Elective-I					
Category	Elective	**Year**	I	**Credits**	2	**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	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)

to be included in the External Examination question paper)	
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

2. NURSERY AND LANDSCAPING

Title of the Course	**NURSERY AND LANDSCAPING**						
Paper Number	Non-Major Elective-I						
Category	Elective	**Year**	I	**Credits**	2	**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	K4

garden styles and landscaping patterns.	
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 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. 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)

NON-MAJOR ELECTIVE-II

1. MUSHROOM CULTIVATION

Title of the Course	**MUSHROOM CULTIVATION**					
Paper Number	Non-Major Elective-II					
Category	Elective	**Year**	I	**Credits**	2	**CourseCode**
		Semester	II			
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		2	-		-	2
Pre-requisite		Basic knowledge on structure and function of various groups of mushrooms.				

Course Objectives	
C1	To learn and develop skills in mushroom cultivation.
C2	To understand and appreciate the role of mushrooms in Nutrition, Medicine and health.
C3	To cultivate mushroom cultivation in small scale industry.
C4	To learn about diseases and post harvest technology.
C5	To study new methods and strategies to contribute to mushroom production.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recall various types and categories of mushroom.	K1
2. Explain about various types of food technologies associated with mushroom industry.	K2
3. Apply techniques studied for Cultivation of various types of mushroom.	K3
4.Analyze and decipher the environmental factor and Economic value associated with mushroom cultivation	K4

5. Develop new methods and strategies to contribute to mushroom production.	K5 & K6

UNIT	CONTENTS
I	Introduction: Morphology, Types of Mushroom, identification of edible and poisonous mushroom, Nutritive values, life cycle of common edible mushrooms.
II	Mushroom cultivation, prospects and scope of Mushroom cultivation in small scale Industry.
III	Life cycle of *Pleurotus spp* and *Agaricus spp.*
IV	Spawn production, growth media, spawn running and harvesting of mushrooms and marketing.
V	Diseases and post harvest technology, Insect pests, nematodes, mites, viruses, fungal competitors and other important diseases.
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 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. Handbook of Mushroom Cultivation. 1999. TNAU publication. 2. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. 1991. Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural
	University, Coimbatore. 3. Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018. 4. Sing. 2005. Modern Mushroom Cultivation, International Book Distributors, Dehradun. 5. Verma, 2013. Mushroom: edible and medicinal: cultivation conservation, strainimprovement with their marketing. Daya Publishing House.

Reference Books	1. Handbook of Mushroom Cultivation. 1999. TNAU publication. 2. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. 1991. Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore. 3. Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018. 4. Nita Bahl. 2002. Handbook on Mushroom 4th edition Vijayprimlani for oxford & IBH publishing co., Pvt., Ltd., New Delhi. Dr.C. Sebastian Rajesekaran Reader in Botany Bishop Heber College, Trichy – 17. 5. Suman. 2005. Mushroom Cultivation Processing and Uses, M/s. IBD Publishers and Distributors, New Delhi.
Web Resources	1. https://www.amazon.in/Mushroom-Cultivation-India-B-C/dp/817035479X 2. http://nrcmushroom.org/book-cultivation-merged.pdf 3. http://agricoop.nic.in/sites/default/files/ICAR_8.pdf 4. http://www.agrimoon.com/mushroom-culture-horticulture-icar-pdf-book/ 5. https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir_esc=y

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S			S	M	L	M	M
CO 2	S			M		S	M	S
CO 3	M			S		M		S
CO 4	S	S	S	S		M		S
CO 5	S	S	M				S	S

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

NON-MAJOR ELECTIVE-II
2. HERBAL MEDICINE

Title of the Course		**HERBAL MEDICINE**					
Paper Number		Non-Major Elective-II					
Category	Elective	**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		2		-		-	2
Pre-requisite		To understand the importance of herbal medicine.					
Learning Objectives							
C1		To understand the nuances of medicinal plants and their phytoconstituents of commercial value					
C2		To design and develop medicinal garden.					
C3		To apply the knowledge to cultivate medical plants.					
C4		To know the pharmacological importance of medicinal plants.					
C5		To enlist phytochemicals and secondary metabolites of market and commercial value.					
Course outcomes: On completion of this course, the students will be able to: CO		**Programme Outcomes**					
1. Define and describe the principle of cultivation of herbal products.		K1					
2. Explain about the phytochemistry of economically important medicinal herbs		K2					
3. Apply techniques for evaluation of drug adulteration through biological testing.		K3					
4. Formulate the value added processing / storage / quality control for the better use of herbal medicine.		K4					
5. Develop the skills for cultivation of plants and their value added processing/storage/quality control.		K5 & K6					

UNIT	CONTENTS
I	Importance and Relevance of Herbal drugs in Indian System of Medicine, Pharmacognosy – Aim and scope.
II	Medicinal gardening – Gardens in the Hills and plains; House gardens; plants for gardening – Poisonous plants – Types of plant poison; action of poisons; treatment for poisons, some poisonous plants; their toxicity and action.
III	Adulteration of crude drugs and its detection – methods of adulteration; types of adulteration. Medicinal plants of export values; rejuvenating herbs; Medicinal uses of Non-flowering plants.
IV	Botanical description and active principles of Root drugs; Rhizomes woods and bark drugs (Two examples for each plant organs).
V	Botanical description and active principles of leaves; Flowers; Fruits seed and entire plants as drugs. Taxonomic study of some selected herbals (Two examples for each plant organs).
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. Somasundaram, S. 1997. Medicinal botany (Maruthuvar Thavaraviyal) – (Tamil Medium Book). 2. Wallis, T.E. 1967. Text Books of Pharmacognosy. J. & A. Churchill Ltd., London, 3. Jains, S.K.. 1996. Medicinal Plants. Deep Publications, New Delhi. 4. Srivastava, A.K. 2006, Medicinal Plants, International Book Distributors, Dehradun. 5. Agarwal,O.P. 1985, Vol. II, Chemistry of organic – natural products. S Chand & Company, New Delhi. 6. Gamble, J.S. and Fisher, 1921, CEC I, II, III Flora of the Presidency, Madras Volumes. 7. Mathew K.M., 1988, Flora of the Tamilnadu and Carnatic.
Reference Books	1. Nair, N.C and Henrry, A.N. 1983, Flora of Tamil Nadu, India, Botanical Survey of India. 2. Chopra, R.N., Nagar S.L., and Chopra, I.C. 1956, Glossary of Indian Medicinal Plants. 3. Chopra, R.N., Chopra, I.C., Handa, K.L., and Kapur L.D., 1994, Indigenous drugs of India. 4. Chopra, R.N., Badhuvar R.L and Gosh, G. 1965. Poisonous plants in

	India. 5. Miller, L and Miller, B. 2017. Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. *Motilal Banarsidass, Fourth edition.* 6. Patri, F and Silano, V. 2002. Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp 218.
Web Resources	1. https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine-natural-healing/herbal-medicine/_/N-ry0Z8qaZ11iu 2. https://www.springer.com/gp/book/9783540791157 3. https://www.gpatonline.com/gpat/book-reference-pharmacognosy 4. https://www.researchgate.net/publication/334670695_Book_review-_Herbal_Drug_Technology 5. http://www.eurekaselect.com/node/173492/herbal-medicine-back-to-the-future

Mapping with Programme Outcomes:

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

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

NON-MAJOR ELECTIVE-II

3. GLOBAL CLIMATE CHANGE

Title of the Course	**GLOBAL CLIMATE CHANGE**					
Paper Number	Non-Major Elective-II					
Category	Elective	**Year**	I	**Credits**	2	**CourseCode**
		Semester	II			
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	
		2	-	-	2	
Pre-requisite	To understand the implications of carbon and ecological footprint.					

Learning Objectives	
C1	To gain insights on the impact of greenhouse effect on global climate change and mitigation measures.
C2	To understand the implications of carbon and ecological footprint.
C3	To apply the knowledge to green house effects.
C4	To know the rain and its effects on plants.
C5	To know about Global Environmental change issues.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Relate to the anthropogenic pressure on the environment andcarbon footprint.	K1
2. Explain about the physical basis of natural green gas house effect on man and materials.	K2
3. Evaluate human influenced driver of our climate system and its applications	K3
4. Analyze the causes and Effects of depletion of the stratospheric ozone layer.	K4
5. Develop new strategies to mitigate issues of global environmental change.	K5 & K6

UNIT	**CONTENTS**

I	Global Environmental change issues. UNFCC, IPCC, Koyoto protocol, CDM, Carbon footprint and ecological footprint.
II	Stratospheric ozone layer: Evolution of ozone layer; Causes of depletion and consequences; Effects of enhanced UV-B on plants, microbes, animals, human health and materials; Global efforts for mitigation ozone layer depletion.
III	Climate change: Green house effects; causes; Green house gases and their sources; Consequences of climate, oceans, agriculture, natural vegetation and humans; International efforts on climate change issues.
IV	Atmospheric deposition: Past and present scenario; Causes and consequences of excessive atmospheric deposition of nutrients and trace elements; Eutrophication.
V	Acid rain and its effects on plants, animals, microbes and ecosystems.
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. Adger, N. Brown, K and Conway, D. 2012. Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.
	2. Turekian. K. K. 1996. Global Environmental Change-Past, Present, and Future. Prentice-Hall. 3. Eugene Odum, 2017. Fundamentals of Ecology 5th Ed. Cengage, Bengaluru. 4. Sharma P.D. 2019. Plant ecology and phytogeography, Rastogi Publications, Meerut. 5. Neeraj Nachiketa. 2018 Environmental & Ecology A Dynamic approach. 2nd Edition GKP Access Publishing.
Reference Books	1. Matthew. R.A. 2009. Jon Barnett, Bryan McDonald. Global Environmental Change and Human Security. MIT Press., USA. 2. Hester, R.E and Harrison, R.M. 2002. Global Environmental Change. Royal Society of Chemistry. 3. Keddy, P.A. 2017. Plant Ecology: Origins, processes, consequences. 2nd ed. Cambridge University Press. ISBN. 978-1107114234. 4. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity-Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi. 5. Kormondy, E.J. 2017. Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.

Web Resources	1. https://www.ebooks.com/en-us/subjects/the-environment-climate-change-ebooks/2074/ 2. http://www.ebooks-for-all.com/bookmarks/detail/Climate-Change/onecat/Electronic-books+Environment-and-nature/0/all_items.html 3. https://www.smashwords.com/books/category/4727/newest/0/free/any 4. https://www.free-ebooks.net/environmental-studies-academic/Global-Warming 5. https://www.nap.edu/catalog/14673/climate-change-evidence-impacts-and-choices-pdf-booklet

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	2	1	2	3	3	2	3	1	2
CO 3	2	2	3	1	1	2	3	2	3	1
CO 4	3	3	3	2	1	1	3	2	3	2
CO 5	3	2	2	3	2	3	1	2	2	3

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

ELECTIVE COURSE I

1. BIO-ANALYTICAL TECHNIQUES

Title of the Course	**BIOANALYTICAL TECHNIQUES**					
Paper Number	Elective-I					
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**
		Semester	V			
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		3	-		-	3
Pre-requisite		To impart expertise about analysis and research.				
Learning Objectives						
C1	To understand the principle, operation and maintenance of various tools/equipment in the laboratory.					
C2	Perform experiments using the laboratory instruments, formulate experiments for project work and evaluate critically the acquisition of data.					
C3	To equip students to collect, analyze and evaluate data generated by their own inquiries in a scientific manner.					
C4	To give an exposure to various forms of field research and data analysis techniques.					
C5	To provide an overview on modern equipments that they would help students gain confidences to instantly commence research careers and/or start entrepreneurial ventures.					
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**					
1. Relate to the various biological techniques and its importance.	K1					
2. Explain the principles of Light microscopy, compound microscopy, Fluorescence	K2					

microscopy and electron microscopy	
3. Apply suitable strategies in data collections and disseminating research findings.	K3
4. Compare and contrast the significance of different types of chromatography techniques.	K4
5. Develop methodologies for extraction and analysis of biochemical compounds.	K5 & K6

UNIT	CONTENTS
I	**I MICROSCOPY:** Principles of microscopy; Light microscopy; compound microscopy, bright field microscope, dark field microscope, phase-contrast microscope, Fluorescence microscopy; Transmission and Scanning electron microscopy. Microscopic measurements-micrometry, Microscopy drawing: Camera Lucida.
II	**CHROMATOGRAPHIC PRINCIPLES AND APPLICATIONS:** Principle; Paper chromatography, Thin Layer Chromatography (TLC), Column chromatography, Gas chromatography – Mass spectrometry (GCMS), High Performance Liquid Chromatography (HPLC).
III	**ELECTROPHORESIS AND PH METER:** Basic principle, construction and operation of pH meter. Polyacrylamide gel electrophoresis (PAGE), Agarose Gel Electrophoresis.

IV	**IV SPECTROPHOTOMETRY AND CENTRIFUGATION TECHNIQUE:** Principle and law of absorption, construction, operation and uses of colorimeter and UV–Visible spectrophotometer, Principles, methods of centrifugation, types of centrifuge and applications.
V	**BIOSTATISTICS:** Data collection methods, population, samples, parameters; Representation of Data: Tabular, Graphical– Histogram – frequency curve – Bar diagram–measures of central tendency – Mean, Median and Mode; Standard deviation, Standard error, Chi-square test and goodness of fit –t–test.
Extended Professional	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved
Component (is a part of internal component only, Not to be included in the External Examination question paper)	(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. Sharma, V.K. 1991. Techniques in microscopy and cell biology, Tata McGraw Hill, New Delhi.

2. Sawhney, S.K and Randhir Singh. 2000. Introductory practical biochemistry , Narosa Publishing House.

3. Asokan, P. 2001. Basics of analytical biochemistry. Chinna Publications.

4. Bajpai, P.K. 2006. Biological instrumentation and methodology. S. Chand & Company, New Delhi.

5. Veerakumari, L. 2009. Bioinstrumentation. MJP Publications.

6. Palanivelu, P. 2013. Analytical Biochemistry and Separation techniques, 20th century publications, Palkalai nagar, Madurai.

Reference Books	1. Rana, S.V.S. 2009. Biotechniques: Theory and Practice. Rastogi Publications 2. Zar, J.H. 2012. Biostatistical Analysis. 4th edition. Pearson Publication. U.S.A. 3. Sundar Rao, P.S.S and Richard, J. 2011. Introduction to Biostatistics and research methods, PHI learning Private Ltd., New Delhi. 4. Johansen, D.A. 1940. Plant Micro technique, TATA McGraw Hill Book Co. , Ins., New Delhi. .Peter Gray. 1964. Handbook of Basic Micro technique. McGraw hill publication, New York. 6. Cooper, T.G. 1991. The Tools of Bio - chemistry, John Wiley & sons, Lond 7. Dey, P.M and Harborne, J.B. 2000. Plant Biochemistry Harcourt Asia Pvt. L 8. Plummer, D.T. 2003. An introduction to practical Biochemistry. 3rd Edn. Ta McGraw Hill Publishing Company Ltd. New Delhi. 9. Zar, J.H. 1984. Biostatistics Analysis, Prentice Hall International, England C New Jersy.
Web Resources	1. https://www.kobo.com/in/en/ebook/bioinstrumentation-1 2. https://www.worldcat.org/title/bioinstrumentation/oclc/74848857 3. https://www.amazon.in/Bioinstrumentation-M-H-Fulekar-Bhawana-Pandey-ebook/dp/B01JP3M9TW 4. https://www.amazon.in/Handbook-Biomedical-Instrumentation-R-S-Khandpur-

Mapping with Programme Outcomes:

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

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

ELECTIVE I
1. AQUATIC BOTANY

Title of the Course	**AQUATIC BOTANY**					
Paper Number	Elective-I					
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**
		Semester	V			
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		3	-		-	3
Pre-requisite	To understand ecological functions and economic uses of aquatic plants.					
Learning Objectives						
C1	To give an overview of the distribution of lower plants forms and its ecological significance.					
C2	To enable students to understand the ecological functions and economic uses of aquatic plants.					
C3	To equip students to collect, analyze and identify the planktons.					
C4	To give an exposure to various forms seaweeds.					
C5	To know about the values and uses of aquatic plants..					
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**					
1. Recognize aquatic plants and their ecological importance.	K1					
2. Explain about commonly occurring marine and limnetic algae of the Indian coasts.	K2					
3. Apply techniques for conservation of aquatic plants	K3					

for value addition.	
4. Analyze and decipher the significance and properties of mangroves, other aquatic angiosperms and microalgae.	K4
5. Develop new strategies to conserve mangroves and device innovative methods for cultivation of aquatic plants.	K5 & K6

UNIT	CONTENTS
I	**MARINE AND LIMNETIC MACRO ALGAE:** Common seaweeds of Indian subcontinent: *Ulva, Caulerpa, Sargassum, Gracilaria,* etc. Common terrestrial algae, including cyanobacteria and lichen photobionts of Indian subcontinent and its life cycle, ecology and taxonomy: *Anabaena, Chlorella, Scenedesmus.*
II	**MANGROVES:** Mangrove forests of India, including Sundarbans, Pichavaram, Kerala mangroves, Rathnagiri mangroves. Common species of mangroves and mangrove associated plants, including *Avicennia, Rhizophora, Acanthus* and *Aegiceras*. Ecological significance of mangroves.
III	**PHYTOPLANKTONS, CYANOBACTERIA, DINOFLAGELLATES AND DIATOMS:** Common marine microalgae of India, including phytoplanktons and picoplanktons, Common diatoms and dinoflagellates of Indian Ocean, Common limnetic and terrestrial cyanobacteria of India.
IV	**AQUATIC ANGIOSPERMS:** Common aquatic angiosperms of India, including Lotus, Water Lilly, Water hyacinth. Ecology, life cycle, taxonomy and economic importance of aquatic angiosperms.
V	**VALUES AND USES OF AQUATIC PLANTS:** Economic importance of aquatic plants, Ecosystem services of aquatic plants, including biogeochemical cycles, oxygen production and carbon sequestration and so on, edible seaweed and algal resources of India, aesthetic, cultural, spiritual importance of aquatic plants.
Extended Professional	Questions related to the above topics, from various competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved

Component (is a part of internal component only, Not to be included in the External Examination question paper)	(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. Lee, R.E. 2008. Phycology. 4th edition. Cambridge University Press, Cambridge. 2. Wile, J.M, Sherwood, L.M and Woolverton, C.J. 2013.. Prescott's Microbiology. 9th Edition. Mc Graw Hill International. 3. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi. 4. Hoek, C. Van, D. 1999. An Introduction to Phycology. Cambridge University Press. 5. Daubenmire, R.F.1973. Plant and Environment. John Willey. 6. Sharma, J.P.2004. Environmental Studies, Laxmi Publications (P) Ltd. New Delhi. 7. Bast, F. 2014. Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044.
Reference Books	1. Kathiresan, K and S.Z. Qasim 2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited. 2. Allan, J.D. and Castillo, M.M. 2009. Stream Ecology (Second Ed.). Springer, Netherlands. 3. Barnes, R.S.K. 1974. Fundamentals of Aquatic Ecosystems, (R.S.K. Barnes & K.H. Mann,eds.), Blackwell Sci. Publ., London, 229 pp. 4. Bennet, G.W. 1971 Management of Lakes and Ponds. von Nostrand Reinhold Co.,NY.375 pp. 5. Goldman, C.R. & A.J. Horne 1983. Limnology.McGraw Hill Internat.Book.Co.Tokyo,464 pp. 6. Boney, A.D., 1975. Phytoplankton. Edward, Arnold, London.
Web Resources	1. http://kyry6.gq/73447c/aquatic-botany-published-by-elsevier-science.pdf 2. http://fuls7.gq/82442e/aquatic-botany-published-by-elsevier-science.pdf 3. https://www.springer.com/gp/book/9788132221777 4. http://dwit21.cf/7744a1/aquatic-botany-published-by-elsevier-science.pdf

	5. https://www.amazon.in/Aquatic-Plants-iFlora-Plant-Guide-ebook/dp/B07NS9V7LN

Mapping with Programme Outcomes:

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

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

ELECTIVE I

2. ENTREPRENEURIAL BOTANY

Title of the Course	**ENTREPRENEURIAL BOTANY**					
Paper Number	Elective-I					
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**
		Semester	VI			
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	
		3	-	-	3	
Pre-requisite	To develop innovative ideas to exploit the economically useful plant products for commercial purposes.					

Learning Objectives	
C1	To enable students to develop innovative ideas to exploit the economically useful plant products for commercial purposes.
C2	To inculcate entrepreneurial values to start a new business. To enlighten people about bioventure.
C3	To comprehend the molecular processes.
C4	To expose the students a fundamental of the various value added products.
C5	To introduce the entrepreneurial opportunities.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize the significance of government agencies for entrepreneurship development.	K1
2. Explain about entrepreneurial values, risk assessment and solutions	K2

3. Make use of entrepreneurial opportunities.	K3
4. Analyze and decipher the significance of bioventure and value added products.	K4
5. Devise innovative methods for making value added products.	K5& K6

UNIT	CONTENTS
I	**NTRODUCTION:** Need - definition and concept - Types and characterization - entrepreneurial values- motivation and barriers-entrepreneurship as innovation, risk assessment and solutions.
II	**BIOVENTURE:** Industry - overview of *Spirulina*, *Pleurotus*, Natural dyes, Banana fibers, Wine, Hydroponics, Drumstick and coconut - Straight Vegetable Oil (SVO) and Pure Plant Oil (PPO) -methods and marketing - fresh and dry flowers for aesthetics.
III	**VALUE ADDED PRODUCTS:** Canning of fruits - process and equipment, fruit and vegetable based products (squash) - ready to serve (RTS) (syrup, pulp, paste, ketchup, soup, vegetable sauces, jam and jellies), Palmyrah Palm products, Perfumes from Rose/Jasmine - Bamboo and cane based products-virgin coconut oil, jasmine oil production, nutraceuticals, standards and quality management.
IV	**ORGANIZATIONS AND AGENCIES:** TIIC, DIC, NABARD, MICROSTAT, DBT - case study - sarvodaya – SIDCO – Micro Small and Medium Enterprises – support structure for promoting entrepreneurshoip – various government schemes.
V	**ENTREPRENEURIAL OPPORTUNITIES:** Understanding a market and assessment, selection of an enterprise, business planning, mobilization of resources, Break Even Analysis, project proposal (guidelines, collection of information and preparation of project report), steps in filing patents, trademarks and copyright, Intellectual Property Rights, export and import license.

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 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. Taneja,S.and Gupta,S.L.2015. Entrepreneurship development, New venture creation, Galgeha publication company, New Delhi.ISSN: 2321-8916. 2. Desai,V.,2015. Entrepreneurship development, First edition.Himalaya publication house, Mumbai. ISBN:9789350973837. 3. Khanna,S.S. 2016. Entrepreneurial development.S.Chand company limited, New Delhi.ISBN:9788121918015. 4. Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany 1 (10th ed). Rastogi Publications, Meerut. 5. Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.

Reference Books	1. Manohar,D.1989. Entrepreneurship of small scale industries,vol.III.Deepanddeep publication, New Delhi. ISSN: 09735925. 2. Lal,G.,Siddhapa,G.S.andTandon,G.L.,1988.Preservation of fruits and vegetables. Indian Council of Agricultural Research (ICAR). ISSN:0101-2061. 3. Ranganna,S.,2001.Handbook of analysis and quality control of fruits and Vegetable products, Second edition, Tata Mc Graw hill, New Delhi.ISBN: 780074518519. 4. Gupta. P.K.,1998. Elements of Biotechnology. Rastogi publications, Meerut. 5. Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co.New Delhi.

Web Resources	1. https://store.pothi.com/book/ebook-priya-lokare-botanical-entrepreneurship/ 2. https://www.taylorfrancis.com/chapters/mono/10.1201/b14920-15/value-added-products-microalgae-faizal-bux 3. https://www.amazon.in/Microalgae-Biotechnology-Health-Value-Products-ebook/dp/B0845QXPY3 4. https://www.elsevier.com/books/value-addition-in-food-products-and-processing-through-enzyme-technology/kuddus/978-0-323-89929-1 5. https://www.oreilly.com/library/view/selling-today-partnering/9780134477404/xhtml/fileP70010119400000000000000000001DEB.xhtm

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	2
CO 2	3	1	3	2	1	3	1	3	3	1
CO 3	2	2	3	3	1	1	2	3	1	2
CO 4	3	3	2	2	3	2	3	3	2	3
CO 5	3	3	2	3	1	2	3	3	2	3

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

ELECTIVE-II

1. HORTICULTURE

Title of the Course	**HORTICULTURE**					
Paper Number	Elective-II					
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**
		Semester	VI			
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		2	1		-	3
Pre-requisite		Students should know fundamental knowledge on horticulture applications.				

Learning Objectives	
C1	To gain an understanding of the fundamentals of horticulture and techniques needed to grow and maintain plants.
C2	To develop skills in students to work as gardeners, therapists, designers, growers and technical advisors in the food and non-food sectors of horticulture.
C3	To know about hydroponic culture.
C4	To develop the various horticultural crop protection.
C5	To impart the knowledge on market preparation.
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Enumerate the concepts in horticulture and nursery management.	K1
2. Demonstrate a working knowledge on biology of soil, compost making, designing and planning of garden, pest, diseases and nutrient management practices.	K2
3. Appraise the importance of floriculture and evaluate the contribution of spices and condiments on economy.	K 3
4.Analyze different methods of weed control in horticultural crops.	K4

5. Develop their competency on pre and post- harvest technology in horticultural crops.	K5 & K6

UNIT	CONTENTS
I	Importance and scope of horticulture. Classification of horticultural crops –fruits and vegetables. Essentials of nursery Management - Soil management: Garden soil, Physical and chemical properties of soil, Organic matter, Compost, Cultural practices; Water management: Water quality, Irrigation, Mulching. Nursery structures**:** Protected cultivation (greenhouses), environment controls.
II	Hydroponic culture-types of container. Use of manures and fertilizers in Horticultural crop production. Principles of organic farming. Environmental factors influencing vegetable and fruit production.
III	Horticultural crop protection; physical control - pruning. Chemical control- pesticides, fungicides. Plant propagation - cutting, layering, budding, grafting. Types of gardens: formal, informal, kitchen and Terrace. Indoor gardening-bottle garden. Floriculture, ornamental gardening.
IV	A brief account of annual, biennials and perennials with reference to ornamental gardens. Green house, terrarium, water garden, rockery plants, bonsai techniques. Landscaping, principles and basic components.
V	Technology of horticultural crops - market preparation: harvesting and handling, packaging and transport, storage; chemical treatment. Economics of cultivation Crops: Cardamom, pepper, clove. Food processing - freezing, bottling and canning, drying and chemical preservation.
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 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. Hartmann, H.T and D.E. Kester. 1989. Plant propagation – principles and practices. Half of India. New Delhi. 2. Bose, T.K and Mitra and Sadhu. 1991. Propagation of tropical and subtropical horticultural crops. Naya Prakash. 3. Singh, S.P. 1989. Mist propagation Metropolitan book Co., New Delhi. 4. Chadha, K.L. 1986. Ornamental horticulture in India ICAR, Krishi Bhavan, New Delhi. 5. Bose, T.K and Mukharjee, D. 1977. Gardening in India. Oxford & IBH Pub., Co., Calcutta. 6. Gopalswamy Iyyangar. 1970. Complete gardening in India, Kalyan Printers, Bangalore. 7. Rangaswami, G and Mahadevan, A. 1999. Diseases of Crop Plants in India (4th edition). Prentice Hall of India Pvt. Ltd., New Delhi
Reference Books	1. Arditti, A. 1977. Orchid biology, Gornell Univ., Press. Ithaca. 2. Bailey, S. 1971. Perpectual flowering carnation, Fabner and Fabner, London. 3. Laurie, A., Kiplingr, D.D and Nelson, K.S. 1968. Commercial flower forcing. Mc Graw-Hill Book, London. 4. Cumming, R.W. 1964. The chrysanthemum Book. D.Van., Nostrand Inc. 5. Biswas, T.D. 1984. Rose growing – Principles and Practices – Assoc., Pub., Co., New Delhi. 6. Hartman, H.T and Kester, D.E. 1989. Plant propagation. Printice Hall Ltd., New Delhi. 7. Abraham, A and Vatsala, P. 1981. Introduction to Orchids. Trop. Bot. Garden, Trivandrum. 8. Bose, T.K and Yadav, L.P. 1989. Commercial flowers. Naya Prakash, Calcutta. 9. Mc Daniel, G.L. 1982. Ornamental horticulture. Reston Publ., London.
	10. Helleyer, A. 1976. The Collingridge Encyclopedia of gardening Chartwell Book, Inc., New Jercy.
Web Resources	1. https://www.kopykitab.com/Precision-Horticulture-by-Archarya-SK 2. https://www.ebooks.com/en-us/subjects/science-horticulture-ebooks/423/ 3. http://www.agrimoon.com/horticulture-icar-ecourse-pdf-books/ 4. https://www.worldcat.org/title/handbook-of-horticulture/oclc/688653648 5. https://cbseportal.com/ebook/vocational-books-horticulture 6. http://www.digitalbookindex.org/_search/search010agriculhortigardena.asp

Mapping with Programme Outcomes:

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

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

ELECTIVE-II

2. NATURAL RESOURCE MANAGEMENT

Title of the Course	**NATURAL RESOURCE MANAGEMENT**						
Paper Number	Elective-II						
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**	
		Semester	VI				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		2		1	-	3	
Pre-requisite	To understand the concept of different natural resources and their utilization.						

Learning Objectives	
C1	To develop an appreciation for the natural resources and their ecological and economic impact.
C2	To gain an understanding of various strategies of natural resource management.
C3	To understand the concept of different natural resources and their utilization.
C4	To create the models of natural resource conservation and maintenance.
C5	To study the significance of natural resources pertaining to economy and environment.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Relate to significance of natural resources pertaining to economy and environment	K1
2. Understand the concept of different natural resources and their utilization.	K2
3. Evaluate the management strategies of different natural resources.	K3
4. Critically analyze the sustainable utilization land, water, forest and energy resources.	K4
5. Design new models of natural resource conservation and maintenance.	K5 & K6

UNIT	CONTENTS
I	Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management.
II	Forest resources: forest vegetation, status and distribution, major forest types and their characteristics. Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people, forest management. Developing and developed world strategies for forestry. Land resources: Land as a resource. Dry land, land use classification, land degradation, man induced landslides, soil erosion and desertification.
III	Landscape impact analysis, wetland ecology & management. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Water ecology and management. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case-studies. Fish and other marine resources: Production, status, dependence on fish
	resource, unsustainable harvesting, issues and challenges for resource supply, new prospects.
IV	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Resource Management Paradigms: Resource management the evolution and history of resource management paradigms. Resource conflicts: Resource extraction, access and control system. Approaches in Resource Management: Ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies. Poverty and implications in Resource Management in developing countries – Poverty in developing countries, causes and link with resources scarcity and poverty.
V	Management of Common International Resources: Ocean, climate, International fisheries and management commissions; Antarctica: the evolution of an international resource management regime. Case Studies: 1. Resource management in mountain ecosystem 2. Dry-land ecosystem 3. The management of marine and coastal resources 4. Case study of shifting Cultivation 5. Mangrove ecosystem and their management.

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. Vasudevan, N. 2006. Essentials of Environmental Science. Narosa Publishing House, New Delhi. 2. Singh, J. S., Singh, S.P. and Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi. 3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. 2008. An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi. 4. United States Government Accountability Office.2008. Natural Resource Management. Nova Science Publishers Inc, 10th Edition 5. Stacy Keach. 2016. Natural Resources Management. Syrawood Publishing House 6. Rathor, V.S. and Rathor B. S. 2013. Management of Natural Resource for Sustainable Development. Daya Publishing House, New Delhi.
Reference Books	1. Coastal Ecology & Management, Mann, K.H. 2000. Ecology of Coastal Waters with Implications for Management (2nd Edition).Chap. 2-5, pp.18-78 & Chap. 16, pp.280-303. 2. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876. 3. Agarwal, K.C., 2001. Environmental Biology, Nidhi Publication Ltd. Bikaner.
	4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publishing House. 5. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press. 6. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB). 7. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science. 8. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd. 9. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p.

Web resources	1. https://books.google.co.in/books/about/Natural_Resource_Management.html?id=Tz9iDMhttps://books.google.co.in/books/about/Natural_Resource_Management.html?id=Tz9iDM6crLIC&redir_esc=y 2. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y 3. https://www.amazon.in/MANAGING-NATURAL-RESOURCES-FOCUS-WATER-ebook/dp/B00OPTWHOE 4. https://www.kobo.com/us/en/ebooks/natural-resources 5. https://www.igi-global.com/chapter/natural-resources-management/195183 6. 6crLIC&redir_esc=y 7. https://books.google.co.in/books/about/Natural_Resource_Conservation_and_Enviro.html?id=T2SRuhxpUW8C&redir_esc=y 8. https://www.amazon.in/MANAGING-NATURAL-RESOURCES-FOCUS-WATER-ebook/dp/B00OPTWHOE 9. https://www.kobo.com/us/en/ebooks/natural-resources 10. https://www.igi-global.com/chapter/natural-resources-management/195183

Mapping with Programme Outcomes:

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

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

ELECTIVE-II

3. FORESTRY

Title of the Course	**FORESTRY**					
Paper Number	Elective-II					
Category	Elective	**Year**	II	**Credits**	2	**CourseCode**
		Semester	VI			
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		2	1		-	3
Pre-requisite		Prior knowledge on trees, forests and their importance.				

Learning Objectives	
C1	To study the distribution pattern, composition and diversity of forest ecosystem
C2	To understand the method of forest management principles and conservation.
C3	To enable them to meaningfully contribute in the forest conservation.
C4	To raise student awareness of the need to create a sustainable way of living and the current global issues with forestry caused by human interference.
C5	To provide a platform to appreciate biodiversity and the importance.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Relate to the basic concepts related to forest distribution, degradation, protection, management and resource utilization.	K1
2. Understand complex interactions of humans and forest ecosystems in a global context.	K2
3. Demonstrate skills for ecological measurements and interpretation of forest ecology management.	K3

4. Examine and decipher the factors influencing forest vegetation, forest degradation and methods of wood preservation	K4
5. Develop new strategies and apply the knowledge gained for problem-solving analysis in the conservation and management of forest ecosystems.	K5 & K6

UNIT	CONTENTS
I	**SILVICULTURE:** Forests - definition. Extent of forests in India and other countries. Forest types of India and Tamil Nadu - revised classification - pure and mixed stands - even and uneven aged stands. Role of forests. Factors of locality - climatic - edaphic - topographic - biotic - interaction of forest with the environment. Silviculture - objectives - scope - general principles. Regeneration - natural and artificial. Nursery techniques - containerized seedling production - techniques and
	methods. Vegetative and clonal propagation techniques and methods - macro and micro propagation techniques.
II	**FOREST MENSURATION AND MANAGEMENT:** Forest Mensuration - Definition and objectives. Measurement of diameter, girth, height, crown and volume of trees - methods and principles - tree stem form - form factor. Volume estimation of stand - age - basal area determinations Stem and Stump Analysis. Forest inventory - sampling techniques and methods - measurement of crops - sample plots. Yield calculation - CAI and MAI - volume, yield and stand tables preparation.
III	**FOREST UTILIZATION AND WOOD TECHNOLOGY:** Logging - extraction of timber - felling rules and methods - conversion methods - conversion season. Implements used - cross cutting system - sawing - different types - extraction methods. Grading of timbers. Transportation of timbers - major and minor transportation methods Storage and sales of logs - sales depot - management of depots. Recent trends in logging - Ergonomics and RIL. Forest products - Timber - timber, fuel, pulp, paper, rayon and match. Wood Composites - plywood, particle board, fiber boards, MDF, hardboard, insulation boards - production technology. Non timber forest products (NTFP) - collection - processing and storage of NTFP - fibres and flosses - bamboos and canes - katha and bidi leaves - essential oils and oil seeds - gums and resins - tans and dyes - drugs - insecticides - lac and shellac - tassar silk - role of tribal co-operative societies.

IV	**FOREST BIOLOGY AND BOTANY:** Forest ecology - definition - biotic and abiotic components - forest ecosystem - forest community - concepts - succession - primary productivity - nutrient cycling. Composition of forest types in India - classification of India's forests - species composition - association and diversity. Restoration ecology - global warming - green house effects - ozone layer depletion - acid rain - role of trees in environmental conservation. Biodiversity - Definition, origin, types - factors endangering biodiversity - biodiversity hotspots - endemism - Red Data Book. Biodiversity assessments - principles and methods.
V	**FOREST BOTANY:** Importance of botany - taxonomic classification of plant species - identification of species - composition and association. Dendrology - principles and establishment of herbaria and arboreta. Tree Improvement - Forest Genetics and Tree Breeding - Definition and concepts - Steps in tree improvement - Variation and selection - Progeny Evaluation Test (PET) - Candidate Tree, Plus Tree, Elite trees - use of provenances and seed sources - heritability and genetic gains - hybrids in tree improvement - heterosis exploitation. Seed production Area and seed orchards - types and establishment. In situ and ex situ gene
	conservation. Exotics - role of exotic forest trees in India - application of biotechnological methods in forestry. **AGRO FORESTRY AND SOCIAL FORESTRY:** Agro forestry - definition, concept and objectives. Classification of agro forestry systems - primary systems and subsystems - inheritance effects. Tree-crop interactions - above and below ground - competition for space, water, light and nutrients. Microclimatic modifications - nutrient cycling and soil fertility improvement - Allelopathy and allelochemicals. - Ecological aspects of agro forestry - benefits and limitations of agro forestry. Agro forestry practices for different agro-climatic zones of Tamil Nadu. Agro forestry practices for wasteland reclamation. Social forestry - objectives and scope and necessity - its components and implementation in local and national levels - social attitudes and community participation. JFM - principles, objectives and methodology - choice of species for agro forestry and social forestry. Urban Forestry - definition and scope - benefits - choice of tree species - planting techniques and management.

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 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. Manikandan, K and S. Prabhu. 2013. Indian forestry, a breakthrough approach to forest service. Jain Bros. 2. Roger Sands. 2013. Forestry in a global context, CAB international. 3. Balakathiresan. S.1986. Essentials of Forest Management. Natraj Publishers, Dehradun. 4. Agarwala, V.P. 1990. Forests in India, Environmental and Protection Frontiers. Oxford & IBH Publishing Co. New Delhi. 5. Chundawat, B.S. and Gautham, S.K. 1996. Text book of Agro forestry. Oxford and IBH publisher, New Delhi. 6. Singhi, G.B. 1987. Forest Ecology of India, Publisher: Rawat. 7. Ramprakash. 1986. Forest management. IBD Publishers, Debra Dun. 8. Tiwari, K.M. 1983. Social forestry in India. Nataraj Publishers, Dehra Dun.
	9. Mehta, T. 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi. 10. Nair, N.C and Henry, A.N. 1983. Flora of Tamilnadu, India. Series: 1,Analysis, Vol.1. BSI, Coimbatore, India.

Reference Books	1. Donald L. Grebner.Jacek P. Siry and Pete Bettinger. 2012. Introduction to forestry and Natural resources Academic press 2. West, P.W. 2015. Tree and forest measurement, Springer international publishing Switzerland. 3. Kollmann, F.F.P and Cote, W.A. 1988. Wood science and Technology. Vol. I & II Springer Verlag, New York. 4. Agarwala, V.P. 1990. Forests in India, Environmental and Protection Frontiers. OxfordIBH Publishing Co., New Delhi. 5. Belcher, B.M. 1998. A production-to-consumption systems approach: Lessons from thebamboo and rattan sectors in Asia. In: Wollenberg, E and A. Ingles (Eds.). Incomes from the forest: methods for the development and conservation of forest products for localcommunities. Center for International Forestry Research (CIFOR), Bogor, Indonesia. 6. Chomitz, K.M., with P. Buys, G. De Luca, T.S. Thomas, and S. WertzKanounnikoff. 2007. Incentives and constraints shape forest outcomes. In: At loggerheads? Agricultural expansion, poverty reduction and environment in tropical forests. The World Bank, Washington, DC. 7. Rao, K.R. and Juneja, K.B.S. 1992. Field identification of 50 important timbers of India. ICFRE Publi. Dehradun 123 p.
Web resources	1. http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2006/10/19/000112742_2006 1019150049/Rendered/PDF/367890Loggerheads0Report.pdf. 2. https://www.britannica.com/science/forestry 3. https://en.wikipedia.org/wiki/Forestry. 4. https://www.biologydiscussion.com/forest/essay-forest-importance.major-products-and-its-conservation/25119 5. https://academic.oop.com 6. https://www.cbd.int>development>doc. 7. https://www.sciencedirect.com/topics/agriculture-and-biological-science-forest-product.

Mapping with Programme Outcomes:

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

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

ELECTIVE-III

1. BIONANOTECHNOLOGY

Title of the Course	BIONANOTECHNOLOGY					
Paper Number	Elective-III					
Category	Elective	**Year**	III	**Credits**	2	**Course Code**
		Semester	VI			
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	2	1	-	3		
Pre-requisite	To provide an insight into the principles of nanotechnolgoy in biological and medical research.					
Learning Objectives						
C1	To provide students with comprehensive knowledge of basics in nanotechnology.					
C2	To enable the students understand and appreciate the various applications of nanoparticles.					
C3	To give perspective to researchers and students who are interested in nanoscale physical and biological systems and their applications in medicine.					
C4	To introduce the concepts in nanomaterials and their use with biocomponents to synthesize and interact with larger systems.					
C5	To impart knowledge on the most recent molecular diagnostic and therapeutic tools used to treat various diseases.					
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**					
1. Relate to the essential features of biology and nanotechnology that are converging to create the new area of bionanotechnology	K1					
2. Explain the synthesis of nanomaterials and their applications.	K2					
3. Apply the knowledge gained to develop nanomaterials	K3					

4. Compare the advantages and disadvantages of nanoparticles in health, medicine and environment.	K4
5. Construct various types of nanomaterial for application and evaluate the impact on environment.	K5 & K6

UNIT	CONTENTS
I	**INTRODUCTION TO NANOTECHNOLOGY:** History, Concepts, Prospects and Challenges. Scope of nanotechnology in Indian and global perspectives. Definition - Nanoscience, Nanotechnology. Classification based on the dimensionality- basic understanding of 1D, 2D and 3D nanostructures. Overview of nanoparticles, nanoclusters - nanotubes, nanowires and nanodots. Biotemplates – DNA to build nanocubes and hinges – smart glue, DNA as wire template.
II	**SYNTHESIS OF NANOPARTICLES:** Synthesis of nanoparticles - Top down and bottom up approach. Methods of synthesis: Physical, Chemical reduction – reducing agents, capping agents, stabilizing of nanoparticles and Biological – Novel synthetic methods using plant extracts, bacteria and fungi.
III	**FOREST UTILIZATION AND WOOD TECHNOLOGY:** **PROPERTIES & CHARACTERIZATION OF NANOPARTICLES:** Nano size effects - optical, electrical, mechanical, magnetic and catalytic activity. Characterization of nanoparticles using UV-Visible spectroscopy, SEM, TEM, Atomic force microscopy, Scanning tunnel microscopy, NMR, X-ray Crystallography and Photoluminescence.
IV	**NANOCARRIERS:** Introduction. Nanocarriers for drug delivery (DDS) – Polimeric nanotubes and solid lipid nanoparticles (SLN) as carriers, controlled release, site specific targeting. Magnetic nanoparticles as drug carriers and its applications.
V	**APPLICATIONS OF NANOPARTICLES:** Textiles, Food industry - nutraceutical, Medicine - antimicrobial activity, wound healing and dressing; Environment – green manufacturing. Agriculture - nanofertilizers and nanopesticides. Smart biosensors – Components and its application.

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 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. Charles, P. Poole, Jr. & Frank J. Owens. 2003. Introduction to Nanotechnology, A John Wiley & Sons, INC., Publication. 2. George, K. Knopf & Amarjeet S. Bassi. 2006. Smart Biosensors. CRC Press. 3. Pradeep, T. 2007. Nano: The Essentials, Understanding Nanoscience and 4. Sulabha, K. Kulkarni. 2007. Nanotechnology: Principles and Practices. Capital 5. Christof, M. Niemayer, Chad A. Mirkin. 2004. Nanobiotechnology: Concepts, applications and perspectives, Wiley VCH publishers. 6. Jain, K.K. 2001. Nanobiotechnology: Molecular Diagnosis, Taylor Francis Group. 7. Sharma P.K. 2008. Understanding Nanotechnology. Vista International Publishing House, Delhi. 8. Viswanathan B. 2009. Nano Materials. Narosa Publishing House, New Delhi.
Reference Books	1. Claudio Nicolini. 2009. Nanotechnology Nanosciences, Pon Stanford Pub.Pvt.Ltd, 2. Robert, A and Ferias, Jr. 1999. Nanomedicine, Volume I: Basic capabilities, Landes Bioscience. 3. Barbara Panessa-Warren. 2006 Understanding cell-nanoparticle interactions making nanoparticles more biocompatible. Brookhaven National Laboratory. 4. European Commission, SCENIHR. 2006. Potential risks associated with engineered and adventitious products of nanotechnologies, European Union.

	5. Gysell Mortimer, 2011. The interaction of synthetic nanoparticles with biological systems PhD Thesis, School of Biomedical Sciences, Univ.of Queensland. 6. Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. 2013. Textbook of Nanoscience and Nanotechnology. Spirnger Publication. 7. Prashant Kesharwani. 2019. Nanotechnology-Based Targeted Drug Delivery Systems for Lung Cancer. Academic Press. An imprint of Elsevier.
Web resources	1. https://onlinelibrary.wiley.com/doi/book/10.1002/3527602453 2. https://www.elsevier.com/books/nanobiotechnology/ghosh/978-0-12-822878-4 3. https://www.routledge.com/Nanobiotechnology-Concepts-and-Applications-in-Health-Agriculture-and/Tomar-Jyoti-Kaushik/p/book/9781774635179 4. https://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php 5. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html 6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419715/ 7. https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html 8. http://www.particle-works.com/applications/controlled-drug-release/Applications

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
CO 2	3	3	3	3	3	3	2	1	2	1
CO 3	3	3	3	2	3	3	3	2	3	2
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

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

ELECTIVE-III

2. COMPUTER APPLICATIONS IN BOTANY

Title of the Course	**COMPUTER APPLICATIONS IN BOTANY**						
Paper Number	Elective-III						
Category	Elective	**Year**	III	**Credits**	2	**CourseCode**	
		Semester	VI				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		2	1		-	3	
Pre-requisite	To equip students with computational skills for drug design.						
Learning Objectives							
C1	To familiarize the student with the fundamentals conce						
C2	To equip students with computational skills for drug design.						
C3	To learn about the bioinformatics database, data format and data retrieval from online sources.						
C4	To develop interdisciplinary skills in using computers in botany to learn about the biological database.						
C5	Student is aware with the most recent technologies for sequencing and bioinformatics analysis and is able to apply them to the structural and functional genomics of plants.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Recognize advanced resources for accessing scholarly literature from the internet.	K1						
2. Explain the concept of databases and use of different public domainfor DNA and proteins sequence retrieval.	K2						
3. Apply various software resources with advanced functions to carry out analysis of data procured through research.	K3						

4. Decipher the effective utilization of bibliography management software while typing and downloading citations.	K4
5. Determine how the knowledge gained can be used for designing experiments and data interpretation.	K5 & K6
UNIT	**CONTENTS**
I	Introduction to computers and Bioinformatics. Introduction to Computers – classification, computer generation, low, medium and high level languages, software and hardware, operating systems personal, mini, main frame and super computers, characteristics and application, computer memory and its types, data representation and storage. Microsoft excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media
II	Biological Research on the web: Using search engines, finding scientific articles. Fundamentals of networking, internet, intranet, search engines- yahoo, Google, etc. telnet, ftp.
III	Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.
IV	Introduction to databases. Biological databases- NCBI, EMBL and DDBJ. Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez) DNA sequencing methods. protein sequencing Phylogenetic analysis Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.
V	**Applications:** Application of Taxonomic Software for preparation of Dichotomous Key. Phylogenetic analysis. Make line drawing of Plants for description. Usage of plant identification apps on android phones. Computer application in biostatistics - MS Excel and SPSS.Computer Aided Designing (CAD) for outdoor and indoor Land scaping. Exposure to CAD (Computer Aided Designing).

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 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. P.K. Gupta. Biotechnology and Henomics. 2016-2017. Rastogi Publications, 7th Reprint (1st Edition.
	2. Ghosh, Z., Mallick, B. 2008. Bioinformatics – Principles and Applications, 1st edition. New Delhi, Delhi: Oxford University Press. 3. Baxevanis, A.D. and Ouellette, B.F., John.2005. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc. 4. Roy, D. 2009. Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House. 5. Andreas, D., Baxevanis, B.F., Francis, Ouellette. 2004. Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition. New Jersey, U.S.: John Wiley and Sons. 6. Pevsner J. 2009. Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell. 7. Xiong J. 2006. Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
Reference Books	1. Gibas, C and Jambeck, P. 1999. Developing Bioinformatics Skills. O'Reilly Shroff Publishers and Distributors Pvt, Ltd., New York, US. 2. David W. Mount. 2004. Bioinformatics Sequence and Genome Analysis. 2nd Edition, Cold Spring Harbor Laboratory Press, New York, US. 3. Harshitha, D. 2006. Techniques of Teaching Computer Science, International Book Distributor, Dehradun. 4. Chwan-Hwa (John) Wu, J. David Irwin. 2016. Computer networks and cyber security. CRC Press. 5. Rui Jiang, Xuegong Zhang and Michael Q. Zhang. 2013. Basics of Bioinformatics. Springer-Verlag Berlin Heidelberg. 6. Ron Wehrens and Reza Salek. 2019. Metabolomics: Practical Guide to Design and Analysis. Chapman and Hall/CRC; 1st edition. 7. Simon, R. Miller and S.A. Garry. 1998. Internet for the Molecular Biologists. Volume III 2nd Edn. Horizontal Scientific Press, Norwich, UK.

Web Resources:	1. http://www.agrimoon.com/introduction-to-computer-applications-pdf-book/ 2. https://www.ebooks.com/en-us/subjects/computers/ 3. https://it.careers360.com/download/ebooks 4. http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20-%20Essential%20Bioinformatics%20send%20by%20Amira.pdf 5. http://www.freebookcentre.net/Biology/BioInformatics-Books.html 6. https://courses.cs.ut.ee/MTAT.03.242/2017_fall/uploads/Main/Basics_of_Bioinformatics.pdf

Mapping with Programme Outcomes:

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

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

ELECTIVE-III
3. FORENSIC BOTANY

Title of the Course	**FORENSIC BOTANY**						
Paper Number	Elective-III						
Category	Elective	**Year**	III	**Credits**	2	**Course Code**	
		Semester	VI				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	1	-	3

Pre-requisite	The course will provide basic knowledge about the application of Botany to Forensic investigations and legal disputes.

Learning Objectives	
C1	The provide basic knowledge about the application of Botany to Forensic investigations and legal disputes.
C2	To provide students with knowledge of palynology, dendrology, plant anatomy, pharmacognosy, molecular biology and toxic compounds from plants that could serve as leads in crime spots.
C3	To learn classification of plants from forensic point of view.
C4	To understand forensic importance of different parts of plants.
C5	To develop and identify main morphological and anatomical features of plants, which could be useful for forensic investigations.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Recognize morphological and anatomical features of plants, which could be useful for forensic investigations.	K1
2. Summarize the forensic importance of different parts of plants.	K2
3. Apply techniques for the collection and preserve of botanical evidences of crime.	K3
4. Analyze and decipher the significance of classic and DNA based forensic botany cases.	K4

5. Interpret and deduce new methods for the detection of plant poisons used in crime.	K5 & K6

UNIT	CONTENTS
I	General plant classification schemes, Sub specialization of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology, limnology, Plant architecture- roots, stems, flowers, leaves. Practical plant classification schemes: vegetables and herbs, fruits bearing trees and plants, landscaping plants: trees, shrubs and vines, grasses, plant cell structure and functions.
II	Various types of woods, timbers, seeds and leaves and their forensic importance, Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of fibers – forensic aspects of fiber examinations, Identification and comparison of man–made and natural fibres. Various types of planktons and diatoms and their forensic importance. Study and identification of pollen grains, Identification of starch grains, powder and stains of spices etc. Paper and Paper Pulp identification.
III	Various types of poisonous plants: *Abrus precatorius*, *Aconitum napellus*, *Anacardium occidentale*, *Argemone mexicana*, *Cannabis sativa*, *Claviceps purpuria*, *Croton tiglium*, *Atropa belladonna*, *Gloriosa superba*, *Jatropha curcas*, *Lathyrus sativus*, *Nerium indicum*, *Nicotiana tabacum*, *Strychnos nux vomica*, *Thevetia nerifolia*. Types of plants yielding drugs of abuse – opium, cannabis, coco, tobacco, datura, *Psilocybin* mushrooms.
IV	Collection and preservation of botanical evidences: Botanical samples, outdoor crime scene consideration.
V	Analysis of samples, DNA analysis, plant DNA typing, Classic forensic botany cases: Case histories by using Plant anatomy and systematic, Palynology, Plant ecology, Limnology, Plant Molecular Biology and DNA, Drug enforcement and DNA.
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 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. Coyle, H.M. 2005. Forensic Botany: Principles and Applications to Criminal Casework. CRC Press. 2. James, S.H., Nordby J.J., Bell, S. 2015. Forensic Science: An Introduction to Scientific and Investigative Techniques. CRC Press; 4 edition. 3. David W. Hall, Dr. Jason H. Byrd. 2012. Forensic Botany. Wiley-Blackwell; United Kingdom. 4. Jane H Bock, David Norris.2015. Forensic Plant Science. Elesvier. 5. Patricia E. J. Wiltshire.2012. Forensic Ecology, Botany, and Palynology: Some Aspects of Their Role in Criminal Investigation. Criminal and Environmental Soil Forensics pp 129–149
Reference Books	1. Hall, D.W and Byrd, J. 2012. Forensic Botany: a practical guide. Wiley-Blackwell, 1edition. 2. Bock, J.H and Norris, D.O. 2016. Forensic Plant Science, Academic Press. 3. Nicholas Marquez Grant, John Wiley. 2012. Forensic Ecology Handbook. Wiley Backwell. 4. David W. Hall, Jason Byrd. 2012. Forensic Botany: A Practical Guide. Wiley-Blackwell. 5. Heather Miller Coyle.2007.Forensic Botany: Principles and Applications to Criminal Casework is packed with details — David M. Jarzen, Florida Museum of Natural History, University of Florida, in AASP Newsletter, Vol. 40, No. 2.
Web Resources	1. https://www.kobo.com/us/en/ebook/forensic-botany 2. https://www.worldcat.org/title/forensic-botany-a-practical-guide/oclc/796086574 3. https://www.buecher.de/shop/pflanzenoekologie/forensic-botany-ebook-pdf/hall-david-w--byrd-jason/products_products/detail/prod_id/37354547/
	4. https://www.crcpress.com/Forensic-Botany-Principles-and-Applications-to-Criminal-Casework/Miller-Coyle/p/book/9780849315299 5. http://docshare02.docshare.tips/files/25818/258183613.pdf

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	1
CO 2	3	3	2	1	1	3	2	3	1	3
CO 3	2	1	2	3	1	2	1	3	1	2
CO 4	3	3	3	3	2	1	3	3	2	1
CO 5	3	3	2	3	2	3	1	2	2	3

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

SKILL ENHANCEMENT COURSE 1

BOTANICAL GARDEN AND LANDSCAPING

Title of the Course	**BOTANICAL GARDEN AND LANDSCAPING**						
Paper Number	Skill Enhancement-1						
Category	SEC	**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		2	-		-	2	
Pre-requisite		Students should know about the fundamental concepts of gardening and landscaping.					
Learning Objectives							
C1	To know about the fundamental concepts of gardening and landscaping.						
C2	To provide an overview of various gardening styles and its scope in recreation and bio-aesthetic planning.						
C3	To illustrate the significance of garden adornments and propagation structures.						
C4	To inculcate entrepreneurial skills in students for creative landscaping design using CAD software.						
C5	To create the design outdoor and indoor gardens and inculcate entrepreneurial skills for landscaping.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Recognize fundamental concepts of gardening and landscaping.	K1						
2. Explain about significance of garden adornments and propagation structures.	K2						

3. Apply techniques of landscaping for aesthetic purposes and gardening for recreation.	K3 & K6
4. Distinguish between formal, informal and free style gardens and their applications.	K4
5. Develop and design outdoor and indoor gardens and inculcate entrepreneurial skills for landscaping.	K5 & K6

UNIT	CONTENTS
I	Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse. Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, plating, climbers and creepers, palms, ferns, grasses and cacti succulents.
II	Flower arrangement: importance, production EXPERIMENTS and cultural operations, constraints, postharvest practices. Bioaesthetic planning, definition, need, round country planning, urban planning and planting avenues, schools, villages, beautifying railway stations, dam sites, hydroelectric stations, colonies, river banks, planting material for play grounds.
III	Vertical gardens, roof gardens. Culture of bonsai, art of making bonsai. Parks and public gardens. Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporate.
IV	Establishment and maintenance, special types of gardens, Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.
V	Computer Aided Designing (CAD) for outdoor and indoorscaping Exposure to CAD (Computer Aided Designing).

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 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. Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd. 2. Rao Manibhushan K. 1991. Textbook of horticulture. MaC Millan India Ltd. 3. Gangulee H. C. and Kar A. K. 2004. College Botany Vol II, New Central Book Agency 4. Sharma V. K. 1999. Encyclopaedia of Practical Horticulture, Vol I –IV, Deep And Deep Publ. Pvt. Ltd. 5. Singh, J. 2018. Fundamentals of Horticulture. Kalyani Publishers.
Reference Books	1. Berry, F. and Kress, J. 1991. Heliconia: An Identification Guide . Smithsonian Books. 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). 4. Acquaah, J. 2009. Horticulture – principles and practices, 4th edition, PHI learning Pvt. Ltd. 5. Edment Senn Andrews. 1994. Fundamentals of Horticulture.Tata. McGraw Hill Publishing Co., Ltd., Delhi.
Web resources	1. https://www.amazon.in/Gardening-Landscape-Design-and-Botanical-Garden/s?rh=n%3A1318122031%2Cp_27%3Aand+Botanical+Garden 2. https://www.overdrive.com/subjects/gardening 3. https://www.scribd.com/book/530538456/Opportunities-in-Landscape-Architecture-Botanical-Gardens-and-Arboreta-Careers 4. https://www.scribd.com/book/305542619/Botanic-Gardens 5. https://www.overdrive.com/subjects/gardening

Mapping with Programme Outcomes:

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

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

SKILL ENHANCEMENT COURSES SEC 2

HERBAL TECHNOLOGY

Title of the Course	**HERBAL TECHNOLOGY**						
Paper Number	Skill Enhancement-2						
Category	SEC	**Year**	II	**Credits**	2	**CourseCode**	
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		2	-		-	2	
Pre-requisite		To understand the importance of herbal technology.					
Learning Objectives							
C1	To provide students with knowledge of herbal drug industry, the quality of raw material, and guidelines for quality maintenance.						
C2	To gain an insight into the commercially important secondary products and significance of bioprospecting.						
C3	To understand various plants based drugs used in ayurvedha, unani, homeopathy, siddha etc.						
C4	To apply the knowledge to cultivate medical plants.						
C5	To know the pharmacological importance of medicinal plants.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Define and describe the principle of cultivation of herbal products.	K1						
2. List the major herbs, their botanical name and chemical constituents.	K2						

3. Apply techniques for monitoring drug adulteration through the biological testing.	K3
4. Analyze and decipher the significance of various methods of harvesting, drying and storage of medicinal herbs.	K4
5. Develop the skills for cultivation of plants and their value added processing / storage	K5 & K6
UNIT	**CONTENTS**
I	Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation - harvesting - processing - storage of herbs and herbal products.
II	Value added plant products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeticals and biopesticides, their Botanical names, plant parts used, major chemical constituents.
III	Pharmacognosy - Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, Catharanthus roseus, Withania somnifera, Centella asiatica, Achyranthes aspera, Kalmegh, Giloe (Tinospora), Saravar. Herbal foods, future of pharmacognosy.
IV	Analytical pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

V	Plant gene banks, Cultivation of Plants and their value added processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation of some medicinal plants (*Withania somnifera*, neem and tulsi),
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 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. AYUSH (www.indianmedicine.nic.in). About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India. 2. Evans, W.C. 2009: Trease and Evans PHARMACOGNOSY. 16th Edition, SAUNDERS / Elsevier. 3. Sivarajan, V.V. and India, B. 1994. Ayurvedic Drugs and Their Plant Sources.. Oxford & IBH Publishing Company, 1994 - Herbs - 570 pages. 4. Miller, L. and Miller, B. 2017. Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. Motilal Banarsidass,; Fourth edition . 5. Kokate, C.K. 2003. Practical Pharmacognosy. Vallabh Prakashan, Pune.
Reference Books	1. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. 2013. Current scenario of Herbal Technology worldwide: An overview. Int J Pharm Sci Res; 4(11): 4105-17. 2. Arbe r, Agnes. 1999. Herbal Plants and Drugs. Mangal Deep Publications, Jaipur. 3. Varzakas, T., Zakynthinos, G, and Francis Verpoort, F. 2016. Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods 5 : 88. 4. Aburjai, T. and Natsheh, F.M. 2003. Plants Used in Cosmetics. Phytotherapy Research 17 :987- 1000. 5. Patri, F. and Silano, V. 2002. Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp 218.

Web resources	1. https://www.kopykitab.com/Herbal-Science 2. https://kadampa.org/books/free-ebook-download-howtotyl?gclid=CjwKCAiA6vXwBRBKEiwAYE7iS5t8yenurClUCTdV9olKo9TbyAh4fsoFqPYWGs5qBTbytD22z7lo0BoCYnUQAvD_BwE 3. https://www.barnesandnoble.com/b/free-ebooks/nook-books/alternative-medicine-natural- healing/herbal-medicine/_/ N-ry0Z8qaZ11iu 4. http://cms.herbalgram.org/heg/volume8/07July/HerbalEBooks.html?t=1310004932&ts= 1579066352&signature=1dd0d5aef818b19bcdcd6c063a78e404 5. https://www.dattanibookagency.com/books-herbs-science.html 6. https://www.springer.com/gp/book/9783540791157

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
CO 2	3	3	3	3	3	3	3	1	3	1
CO 3	3	3	3	3	3	3	3	2	3	2
CO 4	3	3	3	3	3	3	3	1	3	1
CO 5	3	3	3	3	3	3	3	1	3	1

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

SKILL ENHANCEMENT COURSES SEC 3
***ENTREPRENEURIAL SKILL**

ENTREPRENEURIAL OPPORTUNITIES IN BOTANY

<table>
<tr><td>Title of the Course</td><td colspan="6">ENTREPRENEURIAL OPPORTUNITIES IN BOTANY</td></tr>
<tr><td>Paper Number</td><td colspan="6">Skill Enhancement-3</td></tr>
<tr><td>Category</td><td>SEC</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td></tr>
<tr><td></td><td></td><td>Semester</td><td>III</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td colspan="2">1</td><td>-</td><td>-</td><td>1</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="5">To understand the concept of Entrepreneurial Opportunities in Botany.</td></tr>
<tr><td>C1</td><td colspan="6">To enable students to understand about establishment of various ventures after graduates in Botany using medicinal plants, Biotechniques and marketing of bioproducts.</td></tr>
<tr><td>C2</td><td colspan="6">To create a mindset among students to start their own companies for income generation.</td></tr>
<tr><td>C3</td><td colspan="6">The students may understand about various fields of botany.</td></tr>
<tr><td>C4</td><td colspan="6">To develop the concept of Entrepreneurial Opportunities in Botany.</td></tr>
<tr><td>C5</td><td colspan="6">Describe the new strategies to describe marketing and business management strategy.</td></tr>
<tr><td>Course outcomes:

On completion of this course, the students will be able to: CO</td><td colspan="6">Programme Outcomes</td></tr>
<tr><td>1. Relate to how various fields of botany could be understood with an entrepreneurial approach.</td><td colspan="6">K1</td></tr>
<tr><td>2. Explain the concept of Entrepreneuria</td><td colspan="6">K2</td></tr>
</table>

l Opportunities in Botany.	
3. Make of the knowledge gained to start new venture using Plant tissue culture and plant products for commercial exploitations	K3
4. Decipher effective ways of making bioproducts like organic acids, solvents, beverages, enzymes, antibiotics, mushrooms, biogas and etc.	K4
5. Develop new strategies to describe marketing and business management strategy including the role of IPR and bioethics regulations for licensing.	K5 & K6

UNIT	CONTENTS
I	**INTRODUCTION TO ENTREPRENEURSHIP** Introduction to Entrepreneurship, Scope and identification of new ventures using plant resources, Mechanism of product selection and commercialization, General concept about the Govt. formalities, rules & regulation, Entrepreneurship skill development.
II	**TOOLS AND TECHNIQUES**

	Production of commercially viable plants through Plant tissue culture technique, Production of secondary metabolites, solvents, organic acids, beverages, enzymes, antibiotics.
III	**NEW VENTURE CREATION** Production of Biofertilizers, Vermicompost, Establishment of medicinal, herbal and zodiac gardens, Terrace & Kitchen garden, Spirulina and Azolla cultivation, Mushroom cultivation, Bonsai, Bouquet making, Terrarium.
IV	**PRODUCT DEVELOPMENT AND COMMERCIALIZATION** Product commercialization and business strategy, Dyes, Cosmetics and Perfumes, Gums, Resins & Latex, Areca Leaf Plates, cups & bags, Jute Products.
V	**BIO-BUSINESS PLANS, IPR AND BIOETHICS** Marketing and Business management strategy, Bank loan, Intellectual property rights, Patent laws - Bioethics and current legal issues, Marketing and public perceptions in product development – Technology licensing and branding concerns.
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 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. Gurinder Shahi. 2004. Bio-Business in Asia: How countries Can Capitalize on the Life Science Revolution, Pearson Prentice Hall, New Delhi, India. 2. Karthikeyan, S. and Arthur Ruf. 2009. Biobusiness, MJP Publications. Chennai, India. 3. Richard Oliver. 2000. The coming Biotech age: The Business of Biomaterials, McGraw Hill Publications, New York, USA.

	4. Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture. 5. Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
Reference books	1. Robin Lowe and Sue Marriott 2009. Enterprise: Entrepreneurship and Innovation: Concepts, Contexts and Commercialization, Routledge Publisher, London, UK. 2. Peter F.Drucker, 2009. Innovation and Entrepreneurship, Harper Collins Publisher, New York, US. 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. Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress, Cambridge
Web sources	1.https://www.brainkart.com/article/Entrepreneurial-Botany_38321/ 2.https://www.youtube.com/watch?v=hnBla1FfcLo 3.https://www.slideshare.net/krishnashah5891004/ram-power-point-presentation 4.http://www.brainkart.com/article/Economically-Useful-Plants-andEntrepreneurial-Botany_38301 4. https://www.ebooks.com/en-us/subjects/gardening/ 5. https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q

Mapping with Programme Outcomes:

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

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

ELECTIVE – INDUSTRY MODULE

CULTIVATION OF ALGAE

Title of the Course	**INDUSTRY MODULE - CULTIVATION OF ALGAE**					
Paper Number	**INDUSTRY MODULE**					
Category	Elective	**Year**	III	**Credits**	2	**Course Code**
		Semester	VI			

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	2	-	-	2
Pre-requisite	Students should know fundamental knowledge on algae and itsbiotechnological applications.			

Learning Objectives	
C1	To impart sufficient information about the culture and cultivation of algae under laboratory and outdoor conditions..
C2	To study the media composition for algae cultivation and high value products and its applications.
C3	To know about the important seaweeds and its cultivation practices.
C4	To study the SLF production and applications in agriculture crops.
C5	To understand about the Environment Impact Assessment of algal cultivation.

Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**
1. Obtain an in-depth knowledge on culture and mass cultivation of algae and its different methods.	K1
2. Exploration and recommendation of the commercial potential of algal products.	K2
3. Understand the applied facet of	K3

algology and acquire a complete knowledge about the cultivation methods in algae.	
4. Describe the preparation of seaweed liquid fertilizers and their applications in agriculture and horticulture.	K4
5. Acquiring the information about algal applications in different industries and agriculture fields in the current scenario.	K5 & K6

UNIT	CONTENTS
I	Morphology, life history and mass culture of microalgae: *Spirulina*, *Chlorella*,*Dunaliella* and *Botryococcus.*
II	High value products: Single Cell Protein (SCP), phycocyanin, β-carotene, astaxanthin –biofuel, media composition - scale up - lab to land - raceway ponds and photobioreactor.
III	Marine macroalgae: Morphology, life history and mass cultivation of *Gracilaria*, *Kappaphycus*, *Sargassum* and *Ulva.*
IV	Polysaccharides: agar, carrageen, alginate - economic importance - seaweed as food, feedand Seaweed Liquid Fertilizer (SLF).
V	Role of seaweeds in aquaculture: Environment Impact Assessment of algal cultivation.
Extended Professional Component (is a part of internal componentonly, 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. and Singh, H.N. 1976. A Text Book of Algae Affiliated East West Press Pvt. Ltd., New Delhi, Madras. 2. Kumar, H.D. 1990. Introductory Phycology, Affiliated East West

	Press (P) Ltd., New Delhi,Madras, Hyderabad, Bangalore. 3. Pandey, B.P. 1993. A Text book of Botany-Algae S. Chand & Co., (P) Ltd., New Delhi. 4. Sharma, O.P. 1990. Text Book of Algae Tata McGraw Hill Publishing Co., Ltd., New Delhi. 5. Vashista, B.R. 1988. Botany for degree students-Algae. S. Chand & Co., (P) Ltd., New Delhi
Reference Books	1. Bilgrami, K.S., and L.C. Saha. 1996. A Text Book of Algae, CBS Publishers & Distributors (P)Ltd., New Delhi. 2. Chapman, V.J. and Chapman, D.J., 1973. The Algae. 2nd Ed. ELBS & MacMillan, 498 pp., 3. Fritsch F.E. 1935. The Structure and Reproduction of Algae 1945. Cambridge University Press,Cambridge, U.K. Vol. I-791 pp., Vol. II-939 pp., 4. Round, F.E. 1973. Biology of the Algae. 2nd Ed. Edward Arnold, London. 278 pp., 5. Sharma, O.P. 1990. Text Book of Algae. Tata McGraw Hill Publishing Co., Ltd., New Delhi, 396
Web Resources	1. https://www.aiche.org/academy/videos/conference-presentations/study-culture-strategies-microalgae-continuous-photobioreactor-system-biofuel-production 2. https://link.springer.com/article/10.1007/s10811-013-9983-9 3. https://www.nrel.gov/docs/legosti/old/2360.pdf 4. file:///C:/Users/Lenovo/AppData/Local/Temp/alba2018.pdf 5. file:///C:/Users/Lenovo/AppData/Local/Temp/Seaweed_aquaculture_Cultivation_technologies_ch all.pdf

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	1
CO 2	3	2	1	2	1	3	2	3	1	3
CO 3	2	1	1	3	2	1	2	3	2	1
CO 4	3	3	3	3	1	2	1	3	1	2
CO 5	3	3	2	2	1	1	3	3	1	1

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

SKILL ENHANCEMENT COURSES SEC 4
FERMENTATION TECHNOLOGY

Title of the Course	**FERMENTATION TECHNOLOGY**						
Paper Number	Skill Enhancement 4						
Category	SEC	**Year**	II	**Credits**	2	**Course Code**	
		Semester	IV				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	2	-	-	2			
Pre-requisite	To students to know about the various fermentation technology.						
Learning Objectives							
C1	To appreciate the significance of microbes synthesizing fermented products.						
C2	To gain insights on safety and quality control in large scale production of fermentative products.						
C3	To design and operation of industrial practices in mass production of fermented products.						
C4	To know about the various fermentation technology.						
C5	To learn about the bioproduct recovery.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Enumerate the significance of industrially useful microbes.	K1						
2. Explain the design and operation of industrial practices in mass production of fermented products.	K2						

3. Explain the process of maintenance and preservation of microorganisms.	K3
4. Analyze the various aspects of the fermentation technology and apply for fermentative production.	K4
5. Validate the experimental techniques for microbial production of enzymes: amylase and protease, bio product recover.	K5 & K6

UNIT	CONTENTS
I	Preparation of microbial culture, Preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.
II	Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.
III	Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture.
IV	Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).
V	Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.

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 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. Waites M.J. 2008. Industrial Microbiology: An Introduction, 7th Edition, Blackwell Science, London, UK.
2. Prescott S.C., Dunn C.G., Reed G. 1982. Prescott & Dunn's Industrial Microbiology, 4th Edition, AVI Pub. Co., USA.
3. Reed G. 2004. Prescott & Dunn's industrial microbiology, 4th Edition, AVI Pub. Co., USA.
4. JR Casida L.E. 2015. Industrial Microbiology, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India.
5. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Reference Books	1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. 2016. Principles of Fermentation Technology. Butterworth-Heinemann Press. UK. 2. Peppler, H. J. D. Perlman. 2014. Microbial Technology: Fermentation Technology. Academic Press. 3. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. 2006. CRC Press, USA. 4. Hongzhang Chen. Modern Solid State Fermentation: Theory and Practice. 2013. Springer Press, Germany. 5. John E. Smith. Biotechnology. 2009. Cambridge University Press.UK. 6. Celeste M. Todaro, Henry C. Vogel. 2014. Fermentation and Biochemical Engineering Handbook. William Andrew Press. Norwich, NY. 7. Lancini, G. R. Lorenzetti. 2014. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. Springer publications, Germany.
Web resources	1. https://ebooks.foodtechlearning.xyz/2020/12/principal-of-fermentation-technology-by.html 2. https://www.amazon.in/Principles-Fermentation-Technology-Peter-Stanbury-ebook/dp/B01LMDYFNQ 3. https://www.amazon.in/Principles-Fermentation-Technology-Peter-Stanbury-ebook/dp/B01E3IC73W 4. https://www.pdfdrive.com/principles-of-fermentation-technology-e189052809.html 5. https://www.ebooks.com/en-us/book/2698294/principles-of-fermentation-technology/peter-f-stanbury/

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	2
CO 2	3	3	2	2	1	2	3	2	2	3
CO 3	2	2	3	1	1	1	2	3	1	2
CO 4	3	3	2	1	3	2	1	3	2	1
CO 5	3	3	2	1	2	2	3	3	2	3

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

SKILL ENHANCEMENT COURSES SEC 5

ENVIRONMENTAL IMPACT ANALYSIS

Title of the Course	**ENVIRONMENTAL IMPACT ANALYSIS**						
Paper Number	Skill Enhancement 5						
Category	Elective	**Year**	II	**Credits**	1	**Course Code**	
		Semester	IV				
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	1		-		-	1	
Pre-requisite	To students to know about the environmental impact assessment.						
Learning Objectives							
C1	To understand about the theory and practice of environmental impact assessment.						
C2	To develop skills in identifying and solving problems of environmental concerns.						
C3	Define and classify Environmental Impacts and the terminology.						
C4	Understands the environmental Impact assessment procedure.						
C5	List and describe environmental audits.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Enumerate the fundamental concepts and significance of environmental impact assessment.	K1						
2. Explain the important steps of EIA process.	K2						
3. Interpret the environmental appraisal and procedures in India.	K3						

4. Decipher how to prepare the various documents required by state and federal regulations.	K4
5. Develop their own perspectives on impact assessment and be able to solve problems related to environment.	K5 & K6

UNIT	CONTENTS
I	Origin and Development Purpose and aim, core values and principles, History of EIA development, Environmental Management Plan, Environmental Impact Statement, Scope of EIA in Project planning and Implementation.
II	EIA Process Components of EIA, EIA Methodology- Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application,
III	Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, Impact on Environmental component: air, noise, water, land, biological, social and environmental factors. EIA Document.
IV	Main participants in EIA Process Role of Project proponent, environmental consultant, PCBs, PCCs, public and IAA. Public participation.
V	Environmental Appraisal and Procedures in India and EIA Methodology, indicators and mitigation, Environmental Audit of different environmental resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation.
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 competitiveexaminations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC /others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

course	
	1 Morris, P. and Therivel, R. 1995. Methods of Environmental Impact Assessment, UCL Press, London. 2. Petts, J. 1999. Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford. 3. Therivel, R. and Partidario, M.R. 1996. The Practice of Strategic Environmental Assessment, Earthscan, London. 4. Vanclay, F. and Bronstein, D.A. 1995. Environmental and Social Impact Assessment, Wiley & Sons, Chichester. 5. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996
Reference Books	1. Kulkarni, V. and Ramachandra, T.V. 2006. Environmental Management, Capital Pub. Co. New Delhi. 2. Petts, J. 2005. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK. 3. Glasson, J. Therivel, R. and Chadwick. 2006. A. Introduction to Environmental Impact Assessment. Routledge, London. 4. Canter, W.L. 1995. Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York. 5. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
Web resources	1. https://www.amazon.in/Environmental-Impact-Assessment-Gajbhiye-Khandeshwar-ebook/dp/B06XTNQ5PW 2. https://www.ikbooks.com/books/book/earth-environmental-sciences/environmental-impact-assessment/9789382332930/ 3. https://www.elsevier.com/books/environmental-impact-assessment/mareddy/978-0-12-811139-0 4. https://link.springer.com/book/10.1007/978-3-030-80942-3 5. https://onlinelibrary.wiley.com/doi/book/10.1002/0471722022

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	2	3	3	2	3	2	3
CO 3	2	2	1	3	1	1	2	3	2	3
CO 4	3	3	3	3	2	2	3	3	3	3
CO 5	3	2	2	3	1	3	3	3	3	3

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

SKILL ENHANCEMENT COURSES SEC 6 –TRAINING FOR COMPETITIVE EXAMINATIONS.

BOTANY FOR COMPETITIVE EXAMINATIONS (2 hours)

Title of the Course	**BOTANY FOR COMPETITIVE EXAMINATIONS**						
Paper Number	Skill Enhancement 6						
Category	SEC	**Year**	III	**Credits**	2	**Course Code**	
		Semester	VI				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		2		1		-	3
Pre-requisite	To develop the students for preparing various competitive examination.						
Learning Objectives							
C1	To develop the student for competitive examination.						
C2	To select the important topics as far as possible, with reference to the examination point of view. It gives a comprehensive account of botany.						
C3	To understand not only the basics of botany and also gives the broader perspective to prepare for the competitive examinations.						
C4	The essays give a detailed account of each aspect of botany to help students preparing for IAS, IFS and state civil services.						
C5	General understanding of plants around us, the different biophysical and biochemical processes that occur within them and their importance to human life.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Identify and define different groups of plants with their taxonomic position Compare the different groups of plants and evaluate their	K1, K2 & K5						

economic importance	
2.List down the general characters of Bryophytes, Pteridophytes and Gymnosperms Classify the types of fossils and recognize the fossil beds of Tamil Nadu Analyse and trace the origin of different plant groups using Geological Time scale	K1,K3 & K5
3.Appreciates the morphology of plant and analyse different modifications of plant organs. Explore the major Herbaria of the world and recognize the importance.	K3 & K5
4.Differentiate Prokaryotic and Eukaryotic cell. Evaluate the significance of cell division. Justify the cause for the sex linked inheritance. Tabulate the different cell organelles with their functions.	K2, K3 & K5

5. Define and appreciates biodiversity. Identify the cause and solve environmental related issues . Design eco friendly approaches to protect earth and generate new conservation strategies.	K1, K5 & K6
	GENERAL STUDIES FOR COMPETITIVE EXAMINATIONS (2 hours) Physical Geography Indian and World Geography Indian and World History International Organizations Everyday Science Awards and Honors Indian Economy Indian Polity

UNIT	CONTENTS
I	**PLANT WORLD:** Plant science and its branches . Five kingdom classification. Outline of Kingdom plantae General characters and Economic importance of Algae, Fungi and Lichens.
II	**GENERAL CHARACTERS OF PLANT GROUPS:** General characters and Economic importance of Bryophytes, Pteridophytes and Gymnosperms .Palaeobotany- Types of fossils, Geological time scale ,Fossil beds of Tamil Nadu.
III	**PLANT MORPHOLOGY AND TAXONOMY:** Root system and shoot system. Modifications (Pneumatophore, Stilt root, Epiphytic root, Cladode, Phylloclade ,Pitcher and Phyllode) Parts of a flower - Fruits types(Outline) Parthenocarpy- Pollination – types, Seed dispersal – types, Seed Germination types. Taxonomy –definition. Types of classification- Taxonomic hierarchy, ICN, Binomial nomenclature and BSI. Herbarium and Major Herbaria of the world.
IV	**CYTOLOGY AND GENETICS:** Cell –Prokaryotic and Eukaryotic – Cell organelles with functions . DNA and RNA (Basic concepts) -Cell division and its significance -Mitosis and Meiosis (outline) Mendelism – Monohybrid and Dihybrid cross, Sex linked inheritance

V	**ECOLOGY AND BIODIVERSITY:** Ecosystem – abiotic and biotic components. Energy flow in an ecosystem, Aforestation, Deforestation- Chipko movement –-Forest Conservation act- Pollution types and effects- Eutrophication, Global warming ,Ozone depletion, Climate change. Biodiversity and types- Hot spots, Mega diversity countries, Conservation – *ex situ* and *in situ* methods. Endangered plants and Red data Book. Rio -Earth summit. Biodiversity Management Policies - IUCN, UNEP, WWF, ICSU, WCMC.
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 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. Pullaiah, T & D, Varalakshmi Narayana, P, Suresh. 2021. Botany for Competitive Examinations: (Useful for UPSC-Indian Forest Service, Civil Services, PCS, ASRB CSIR - NET, ICAR-NET and Other Competitive Exams.) Astral Cracker. 2. Mitra, S. 2016. Botany for competitive examinations, Academ Publishers. 3. Mohd Akil Shahezad. 2018. M.C.Qs. in Botany, Library Book House. 4. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi. 5. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies Taxonomy: Nair Datta 6. Thieman. 2014. Introduction to Biotechnology 3rd Edition. Pearson Education India.
Reference Books	1. De Robertis and De Robertis. 1990. Cell and Molecular Biology, Saunders College, Philadelphia, USA. 2. Gardner, E.J., Simmons, M.J and Snustad, D. 1991. Principles of Genetics, John Wiley Sons Inc., 8th Edn., New York. 3. Salisbury, F. B.C.W. Ross.1991. Plant Physiology. Wassworth Pub. Co. Belmont.

	4. Sharma, P.D. 2017. Ecology and Environment- Rastogi Publication, Meerut. 5. Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi. 6. Power, C.B and Daginawa, H.F. 2010. General Microbiology : Himalaya Publishing House Pvt Ltd, 7. Rangasamy, G. 2006. Disease of crop plants in India (4th edition). Tata Mc Graw Hill New Delhi. 8. Singh, V., Pande, P.C and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications,Meerut. 9. Bhojwani, S.S. Bhatnagar, S.P and Dantu, P.K. 2015. The Embryology of Angiosperms (6th revised and enlarged edition). Vikas Publishing House, New Delhi.
Web resources	1. https://www.amazon.in/BOTANY-COMPETITIVE-EXAMINATIONS-SUNIT-MITRA/dp/9383420898 2. https://www.amazon.in/Botany-Competitive-Examinations-UPSC-Indian-Competive/dp/B08VWB64BC 3. https://www.ssclatestnews.com/botany-book-pdf-free-download-for-competitive-exams/ 4. https://sscstudy.com/botany-for-competitive-exams-pdf/ 5. https://www.amazon.in/Botany-Entrance-Examination-Anupam-Rajak-ebook/dp/B089S1GLMP

Mapping with Programme Outcomes:

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

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

BOTANY FOR ADVANCED STUDIES (3 hours)

Title of the Course	**BOTANY FOR ADVANCED STUDIES**						
Paper Number	Skill Enhancement						
Category	SEC6	**Year**	III	**Credits**	2	**Course Code**	
		Semester	VI				
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		2		1		-	3
Pre-requisite	To develop the botany students for preparing advanced studies.						
Learning Objectives							
C1	To be familiar with the basic concepts and principles of plant systematics.						
C2	Learn the importance of plant anatomy in plant production systems.						
C3	To expose the students a fundamental of the various techniques used in molecular studies.						
C4	To learn about the physiological processes that underlie plant metabolism.						
C5	To know the energy production and its utilization in plants.						
Course outcomes: On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1.Understand of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data	K1, K2 & K5						
2. Learn the structures, functions and roles of apical *vs* lateral meristems in monocot and	K1,K3 & K5						

dicot plant growth.	
3. Understand the organization of nuclear genome	K3 & K5
4. Understand the various steps involved in the basic functioning of plant growth and the nutritive value of food.	K2, K3 & K5
5. Gain awareness about the various processes involved in the energy production in plants and metabolic pathways.	K1, K5 & K6

UNIT	CONTENTS
I	**MOLECULAR GENETICS** (i) Molecular Biology of gene expression: Brief overview of the Central Dogma and Teminism. Transcription in prokaryotes and eukaryotes. Types and structure of RNA polymerase, Different types of RNA, Regulatory sequences and transcription factors involved. Mechanism: Initiation, elongation and termination. Split genes and RNA splicing in eukaryotes. Translation in prokaryotes and eukaryotes. Salient features, exceptions, tRNA-suppressor mutations. Mechanism of translation: Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy. Molecular mechanism of mutation, cancer biology, human cytogentics (ii) Molecular mechanism of Gene Regulation: Regulation in prokaryotes, Regulation in Eukaryotes, Epigenetic mechanisms: methylation and transcriptional inactivation, cosuppression through transcriptional silencing, genome imprinting. RNA processing->alternative splicing, RNA stability, RNA interference. Translational regulation: Gene amplification, mating type interconversion. Genomics: Structural genomics, Genetic and physical mapping (RFLP), microsatellite maps, cytogenetic maps, physical maps, positional cloning, chromosome walks and jumps, Genome sequencing, genome databases, human genome sequencing project. Functional genomics. transcriptome, proteome and

	metabolome, Microarrays and gene-chips. Comparative genomics. Functional and evolutionary relationships prokaryotes, organelles and eukaryotes, orthologues and paralogues. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing.
II	**ADVANCED TRENDS IN SYSTEMATICS** **(i) Basic concepts of:** a. Morphology - History, general morphology, types of data, methods of gathering data, b. Anatomy - History, general anatomy, types of data, methods of gathering data, c. Embryology – History, types of data, methods of gathering data; d. Palynology: History, general palynological characters, types of data, methods of gathering data; e. Cytology and Cytogenetics: History, general cytological and cytogenetic characters, types of data, methods of gathering data; f. Ecology, History, general ecology, types of data, methods of gathering data (At least two examples from each section should be studied to substantiate the taxonomic significance) **(ii) Chemotaxonomy:** a. History, general chemical and chemotaxonomic characters, types of data, methods of gathering data. b. Identification of the major classes of the pharmaceutically important secondary metabolites from natural sources 8 (phenolics, steroids, terpenoids glycosides and alkaloids). c. Applications: Phytochemicals in cosmetics, aromatherapy, disease prevention, biotechnology in the production of phytochemicals. Phytochemical databases (iii) Molecular trends in Biosystematics a. Molecules and genomes in plant systematics, techniques used in molecular taxonomy, molecular systematics in crop evolution b. Serology in relation to plant taxonomy- Methods, role of serology in taxonomy. c. Cladistics and Phenetics (iv) Molecular trends in Reproductive Biology: (i) Apomixis – Types, cytogenetic basis and induction of apomixes, applications.) Biochemistry and genetics of incompatibility, methods to overcome incompatibility, pollen viability tests, molecular basis of incompatibility) Sterility – Male sterility, CMS, GMS, CGMS, temperature sensitive and photosensitive male sterility, transgenic male sterility, female sterility and zygotic sterility.
	PLANT PHYSIOLOGY (i) Modern concepts Photosynthesis – Environmental and agricultural relevance; Respiration – Biochemical control of respiration (ii) Photomorphogenesis Phytochrome genes and their expression, control of photo-morphogenic responses. Dose-response relations in photomorphogenesis, light induced chloroplast differentiation, effect of photoreceptors.

III	(iii) Biological clock: Circadian rhythms, rhythm responses to environment, clock mechanism (iv) Photoperiodism General principles , florigen concept (v) Plant growth and development Patterns of growth and differentiation; Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model in Arabidopsis flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorphogenesis.
IV	**PLANT PHYSIOLOGY** **(i)** Enzymes: General account: Importance and properties of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, Mechanism of enzyme action role of enzyme in chemical action, various factors affecting the enzyme activity.Molecular genetics in plant physiology, Environmental plant physiology, Stress physiology .
V	**ECONOMC BOTANY** Economic importance of Cereals, Tuber Crops, Fibre yielding plants, Plantation Crops, Sugar yielding plants, Narcotics, Vegetables, Oil yielding plants, Pulses and Beverages
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 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. Sharma, O.P. 2017. Plant Taxonomy. (II Edition).The McGraw Hill Companies. 2. Maheshwari, P. 1963. Recent Advances in Embryology of Angiosperms. Intl. Soc. Plant Morphologists, New Delhi. 3. Sharma, P.C. 2017. Text Book of Plant Anatomy. Arjun Publishing House, New Delhi.

	4. Jain, V.K. 2017. Plant Physiology, S.Chand & Company Ltd. New Delhi. 5. Lincoln, T, Eduardo, Z, Ian Max, M, and Angus, M. 2018. Fundamentals of Plant Physiology. Sinauer Associates Inc., US. 6. Becker, W.M., Kleinsmith L.J. & Hardin J. 2005. The World of the Cell (6th edition). Benjamin/Cummings Pub. Co. New York. 7. Brooker, R. J. 1999. Genetics Analysis and Principles. Addison Wesley Longman Inc., New York. 8. Bruce, A. et. al. 2002. Molecular Biology of the Cell. Garland Publishing. New York.
Reference books	1. Mabberley, J.D. 2014. Mebberley's Plant-Book: A portable dictionary of plants, their classification and uses, 3rd ed. Cambridge University Press, Cambridge, U.K. 1021pp. 2. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi. 3. Bhojwani, S.S. and Soh, W.Y. 2013. Current trends in the embryology of angiosperms. Springer Science & Business Media, Germany. 4. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Blackwell Publishing, Malden, USA. 5. Steward, F.C. 2012. Plant Physiology Academic Press, US. 6. Hopkins, W.G and Huner, N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A. 7. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi. 8. Anthony J . F. G .2000. An Introduction to Genetic Analysis. W. H.Freeman &Co. New York. 9. Hartl, .D.L & Jones E. W. 2000. Genetic analysis of Genes and Genomes Jones and Bartlett Pub, Boston. 10. Klug .S.W. & Cummings, M.R. 2003. Concepts of Genetics . Pearson Education Pvt. Ltd., Singapore. Kreezer et al . 2001. Recombinant DNA and Biotechnology. American Society for Cell Biology, New York. 11. Lodish Harvey. 1999. Molecular Cell Biology. W.H. Freeman &Co.New York. 12. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cumming, San Francisco. 13. Snustad, D. P. & Simmons M.J. 2003.Principles of Genetics. JohnHailey & Sons Inc. U.S.A. 14. Mabberley, J.D. 2014. Mebberley's Plant-Book: A portable dictionary of plants, their classification and uses, 3rd ed. Cambridge University Press, Cambridge, U.K. 1021pp. 15. Pandey.B.P. 1999. Economic Botany. S. Chand Limited, New Delhi. 16. Bhojwani, S.S. and Soh, W.Y. 2013. Current trends in the embryology of angiosperms. Springer Science & Business Media, Germany. 17. Cutler, D. F., Botha, T and Stevenson, D.W. 2008. Plant Anatomy:

	An Applied Approach. Blackwell Publishing, Malden, USA. 18. Steward, F.C. 2012. Plant Physiology Academic Press, US. 19. Hopkins, W.G and Huner, N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A. 20. Noggle G.R and G.J. Fritz. 2002. Introductory Plant Physiology. Prentice Hall of India, New Delhi. 21. Anthony J . F. G .2000. An Introduction to Genetic Analysis. W. H. Freeman &Co. New York. 22. Hartl, .D.L & Jones E. W. 2000. Genetic analysis of Genes and Genomes Jones and Bartlett Pub, Boston. 23. Klug .S.W. & Cummings, M.R. 2003. Concepts of Genetics . Pearson Education Pvt. Ltd., Singapore. Kreezer et al . 2001. Recombinant DNA and Biotechnology. American Society for Cell Biology, New York. 24. Lodish Harvey. 1999. Molecular Cell Biology. W.H. Freeman &Co. New York. 25. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd edition). Pearson/Benjamin Cumming, San Francisco. 26. Snustad, D. P. & Simmons M.J. 2003.Principles of Genetics. JohnHailey & Sons Inc. U.S.A.
Web resources	1. http:// www.ornl.gov. 2. http:// ash. gene. ncl. ac .nk.. 3. http://tor. cshl. org. http:www. gdb. org. 4. http: //www. neg r. org. 5. http: // www. genetics. wustl. edu. 6. http: // genome. imb- jena. dc.

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	2
CO 2	3	3	2	2	3	3	2	3	3	2
CO 3	2	2	3	2	1	2	1	3	2	1
CO 4	3	3	3	3	3	2	3	3	2	3
CO 5	3	3	2	3	2	2	2	2	2	2

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

FOUNDATION COURSE FOR BOTANY

BASICS OF BOTANY

Title of the Course	**BASICS OF BOTANY**						
Paper Number	Foundation Course						
Category	Foundation course	**Year**	I	**Credits**	2	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		2	-		-	2	
Pre-requisite	To recall the students about the basic aspects of botany.						
Learning Objectives							
C1	To learn about the classification, distinguishing traits, geographic distribution, and reproductive cycle of algae, fungi, lichens, and bryophytes.						
C2	To understand the biodiversity by describing and explaining the morphology and reproductive processes of algae, fungi, bryophytes and microorganisms.						
C3	To investigate the classification, distinctive traits, distribution and reproduction and life history of the various classes and major types of Pteridophytes and Gymnosperms.						
C4	Enable to learn various cell structures and functions of prokaryotes and eukaryotes and understand the salient features and functions of cellular organelles.						
C5	Understanding of laws of inheritance, genetic basis of loci and alleles.						
Course outcomes On completion of this course, the students will be able to: CO	**Programme Outcomes**						
1. Increase the awareness and appreciation of human friendly algae and their economic importance.	K1						
2.Develop an understanding of microbes	K2						

and fungi and appreciate their adaptive strategies	
3.Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.	K3
4.Compare the structure and function of cells and explain the development of cells.	K4
5.Understand the core concepts and fundamentals of plant biotechnology and genetic engineering.	K5

UNIT	CONTENTS
I	**BIODIVERSITY** Systematics : Two Kingdom and Five Kingdom systems - Salient features of various Plant Groups : Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms- Viruses - Bacteria.
II	**CELL BIOLOGY** Cell as the basic unit of life - Prokaryotic and Eukaryotic Cell (Plant Cell) - Light Microscope and Electron Microscope Ultra Structure of Prokaryotic and Eukaryotic Cells - Cell Wall - Cell Membrane Plastids, Ribosomes.
III	**PLANT MORPHOLOGY** Structure and Modification of Root, Stem and Leaf - Structure and Types of Inflorescences - Structure and Types of Flowers, Fruits and Seeds.
IV	**GENETICS** Concept of Heredity and Variation - Mendel's Laws of Inheritance.

V	**PLANT PHYSIOLOGY** Cell as a Physiological Unit : Water relations -Absorption and movement : Diffusion, Osmosis, Plasmolysis, Imbibition -Permeability, Water Potential - Transpiration - Movement - Mineral Nutrition
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 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. Singh, V., Pande, P.C and Jain, D.K. 2021. A Text Book of Botany. Rastogi Publications,Meerut. 2. Bhatnagar, S.P and Alok Moitra. 2020. Gymnosperms, New Age International (P) Ltd., Publishers, Bengaluru. 3. Sharma, O.P. 2017. Bryophyta, MacMillan India Ltd. Delhi. 4. Lee, R.E. 2008. Phycology, IV Edition, Cambridge University Press, New Delhi. 5. Pandey B.P. 1986, Text Book of Botany (College Botany) Vol I and II, S.Chand and Co. New Delhi. 6. Rao, K., Krishnamurthy, K.V and Rao, G.S. 1979. Ancillary Botany,S. Viswanathan Pvt. Ltd., Madras.
Reference books	1. Parihar, N.S. 2012. An introduction to Embryophyta –Pteridophytes - Surjeet Publications, Delhi. 2. Alexopoulos, C.J. 2013. Introduction to Mycology. Willey Eastern Pvt. Ltd. 3. Vashishta, P.C. 2014. Botany for Degree Students Gymnosperms. Chand & Company Ltd, Delhi. 4. Coulter, M. Jhon, 2014. Morphology of Gymnosperms. Surjeet Publications, Delhi. 6. Vashishta, P.C. 2014. Botany for Degree Students Algae. 2014. Chand & Company Ltd, Delhi. 7. Parihar, N.S. 2013. An introduction to Embryophyta –Bryophytes -, Surjeet Publications, Delhi.
Web Resources	1.https://www.kobo.com/us/en/ebook/the-algae-world

	2. http://www.freebookcentre.net/biology-books-download/Fungi-(PDF-15P).html 3. http://scitec.uwichill.edu.bb/bcs/bl14apl/bryo1.htm 4. https://www.toppr.com/guides/biology/plant-kingdom/pteridophytes/ 5.https://arboretum.harvard.edu/wp-content/uploads/2013-70-4-beyond-pine-cones-an-introduction-to-gymnosperms.pdf 6. https://www.us.elsevierhealth.com/medicine/cell-biology 7. https://www.us.elsevierhealth.com/medicine/genetics 8. https://www.kobo.com/us/en/ebook/plant-biotechnology-1

Mapping with Programme Outcomes:

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

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

MODEL QUESTION PAPER

B. Sc., Botany Degree Examination

((For Students Admitted from the Academic Year 2023 – 2024 onwards under CBCS Pattern)

CORE COURSE – III. MAJOR PRACTICAL I

(Covering the core courses I &II)

(ALGAE, FUNGI, LICHENS, BACTERIA, VIRUSES)

Time : 3 hrs. **Maximum: 60 Marks**

Practical: 50 Marks

Record : 10 Marks

1. Cut transverse section of A and B. Stain and mount in glycerin. Identify giving reason. Draw diagrams. Leave the slides for valuation. (7X2=14)
2. Stain the material C and interfere its Gram stain. (6X1=6)
3. Draw diagrams and write notes of interest on D, E, F, and G. (4X4=16)
4. Name the genus, group and morphology of given part of H and I. (Diagrams not Necessary) (3X2=6)
5. Identify the disease, causative and write notes on the symptoms of the disease material in J. Draw diagram. (4X1=4)
6. Identify and write notes on economic importance of K, and L. (2X2=4)

Key

1. A/ B - Algae/ Fungi
(Preperation-2, Identification -1, Diagram -2, Reason -2) (7X2=14)

2.C - Bacteria
(Procedure-2, Identification with reason-1, preparation-2) (6X1=6)

3.D/E/F/B - Algae/ Fungi/ Lichens-vegetative/ reproductive(Permanent slide only)/ Bacteria/viruses-electron micrograph photograph(any four)
(Identification -1, Diagram -1 , Reason -2) (4X4=16)

4. H/I - Algae/Fungi
(Genus 1, Group 1, Morphology 1) (3X2=6)

5.J – Fungal/Bacterial/Viral disease Herbarium/photograph
(Name of the disease-1, Causative-1, symptoms-1,Diagram-1) (4X1=4)

6. K/L-Algae/Fungi/Bacteria/Lichen economic importance (any two)
(identification 1, importance 1) (2X2=6)

MODEL QUESTION PAPER

B. Sc., Botany Degree Examination

((For Students Admitted from the Academic Year 2023 – 2024 onwards under CBCS Pattern)

CORE COURSE – VI.

MAJOR PRACTICAL II

(Covering the core courses III and IV)

(BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS, PALEOBOTANY AND EVOLUTION)

Time : 3 hrs. **Maximum: 60 Marks**

Practical: 50 Marks

Record : 10 Marks

1. Cut transverse section of A, B and C. Stain and mount in glycerin. Identify giving reason. Draw diagrams. Leave the slides for valuation. (7X3=21)
2. Make suitable micro-preparation of D,E. Stain and mount in glycerin. Identify giving reason. Draw diagrams. Leave the slides for valuation. (4X2=8)
3. Draw diagrams and write notes of interest on F, G,H and I. (3X4=12)
4. Name the genus, group and morphology of given part of J,K and L. (Diagrams not Necessary) (3X3=9)

Key

1. A/B/C - Bryophytes/Pteridophytes/Gymnosperms
   (Preperation-2, Identification -1, Diagram -2, Reason -2) (7X3=21)
2. D/E-Reproductive structures of Bryophytes/Pteridophytes/Gymnosperms(any 2) (4X2=8)
3. F/G/H/I - Bryophytes/Pteridophytes/Gymnosperms vegetative/ reproductive(Permanent slide only) /Fossil permanent slides or micorphotograph(each 1)
   (Identification -1, Diagram -1 , Reason -1) (3X4=12)
4. J/K- Bryophytes/Pteridophytes/Gymnosperms(each 1)
   (Genus 1, Group 1, Morphology 1) (3X3=9)

MODEL QUESTION PAPER

B. Sc., Botany Degree Examination

((For Students Admitted from the Academic Year 2023 – 2024 onwards under CBCS Pattern)

CORE COURSE – X

MAJOR PRACTICAL III

(Covering the core courses VII ,VIII&IX)

(MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS; PLANT ANATOMY AND EMBYROLOGY; CELL BIOLOGY, GENETICS, AND PLANT BREEDING)

Time: 3 hrs. **Maximum: 60 Marks**

Practical : 45 Marks

Record: 10 Marks

Herbarium: 5 Marks

1. Refer A and B, to their respective families. Point out the characters on which the identification is based at each level. (Diagrams not necessary) (2X4=8)
2. Describe C in Technical terms. Draw diagrams of the floral parts only. Construct the floral Diagram. Give the floral formula (1X4=4)
3. Cut transverse section of D Stain and mount in glycerin. Identify giving reason. Draw diagrams. Leave the slides for valuation. (1X6=6)
4. Dissect and mount any one of the stages of the given material E. (Diagram and notes not necessary) (1X4=4)
5. Make acetocarmine preparation of F(Squash) any one stage. Draw diagram. (1X4=4)
6. Construct the chromosome map with the data provided G (1X5=5)
7. Solve the given genetic problem H and I (2X4=8)
8. Spot at sight J,K and L (3X2=6)

Key

1. A&B-Family from polypetalae/gamopetalae/monochlamydae/ monocots(any 2) (identification=1, steps for Bentham and Hooker key=3) (2X4=8)
2. C-(any one above mentioned group other than given in A &B) (Technical description=2, floral diagram=1, floral formula=1) (1X4=4)
3. D=Dicot/Monocot- root, stem or leaf (any one) (identification=1, slide=2, diagram and description with reason=3) (1X6=6)
4. E= Embryo – dicot – Tridax – (submission=2, Diagram=2) (1X4=4)
5. F=Onion root tip (preparation =3 marks , diagram -1 marks) (1X4=4)
6. G=Chromosome map-three point test cross (Step wise parent, single cross, double cross, gene sequence,result-5) (1X5=5)
7. H,I= Genetic problems - 2X4 = 8 (2X4=8)
8. J,K,L= Anatomy slide/Cell biology slide or photograph/plant breeding (each one) (Diagram and notes=2) (3X2=6)

MODEL QUESTION PAPER

B. Sc., Botany Degree Examination

((For Students Admitted from the Academic Year 2023 – 2024onwards under CBCS Pattern)

CORE COURSE – X

MAJOR PRACTICAL IV

(Covering the core courses XI, XII &XIII)

(PLANT ECOLOGY & PHYTOGEOGRAPHY, PLANT BIOTECHNOLOGY & MOLECULAR BIOLOGY, PLANT PHYSIOLOGY & BIOCHEMISTRY)

Time: 3 hrs. **Maximum: 60 Marks**

Practical : 50 Marks

Record: 10 Marks.

1. Based on morphological and anatomical characters, assign, A and B to their respective probable habitats. Draw suitable diagrams. Submit slides for valuation. (2X8=16)
2. Outline the procedure, apparatus and materials required for investigating the physiological Problem C assigned. Set up the experiment. Tabulate the data obtained and report the Results. Leave the set up for valuation. (1X16=16)
3. Identify the biochemical entities present in material D. (1X6=6)
4. Spot at sight-E,F,G & H (4x3=12)

Key

1. A &B- Ecology material –preparation -2 marks , identification -1 mark ,Diagram-2 reason -3 marks (2X8=16)

2.- C-(experiment selected by student from the lot)Physiology - Materials – 2 marks, Procedure-4, Setup – 4 marks, Spot Viva- strictly pertained to the concerned physiology experiment- 2 marks-Result - 4marks (1X16=16)

5. 3.D- biochemical test for carbohydrate, proteins and lipids (Procedure-4 marks, Result-2) (1X6=6)

4. E.F.G.H-Phytogeography maps/Biotechnology/Molecular Biology/Physiology(Demonstration) (4x3=12)

MODEL QUESTION PAPER

(For Students Admitted from the Academic Year 2023 – 2024 onwards under CBCS Pattern)

B.Sc., BOTANY ALLIED PRACTICAL

Time : 3 hrs. **Maximum: 60 Marks**

Practical : 50 Marks

Record : 10 Marks

1. Refer A&B to their families giving reasons (Diagrams not necessary) (2X5=10)
2. Identify the plant, family and morphology of the parts used for C, D, E,F and G. (3X5=15)
3. Cut transverse section of H & I. Stain and mount in Glycerin. Identify giving reasons. Draw diagrams. Submit the slides for valuation. (2X5=10)
4. Write critical notes on J, K, L, M, N, O. Draw diagrams. (2X6=12)
5. Physiology Experiment P (1X3=3)

Key

1. For A and B - Any 2 plants prescribed in the syllabus.
   Reasons 3, Identification -2 2 x 5=10
2. For C, D, E, F and G - any 5 specimens given in the practical syllabus. 5X3=15

For H and I – Slide -2 Identification -1 Reasons – 2 2 x 5=10

4. Notes 1, Diagram 1 for J, K, L, M, N, O 2 x 6=12
5. Physiology Experiment P 1X3= 3