

Structure with Course Title

B. Sc. In Botany

Semester – I

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
10032601	Algal Ecology	Major (Core)	2	50	50	0
		Major (Core)	2	50	50	0
		Major (Core)	2	50	50	0
10432611	Herbal Science	OEC	4	100	50	50
10632601	Instrumentation Techniques	VSC S1	2	50	50	0
10732601	Horticulture - I	SEC	2	50	0	50
	AEC link- Click Here	AEC (English) (Any One)	2	50	0	50
10810111	English For Academic Writing - Paper I (For Students of English Medium)					
10810112	English Language and Literature - I (For Students of Non-English medium)					
11051111	Inception of India Knowledge System Link- Click Here	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution Link- Click Here	VEC	2	50	0	50
	CC-Link- Click Here	CC (Any One)	2	50	50	0
11450121	Basics of National Service Scheme					
11450221	National Cadets Corps. (NCC) Studies - I					
11450322	Health and Wellness					
11450421	Performing Arts Exploration					
			22	550	300	250

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester II					
20032611	Botanical Evolution	Major (Core)	2	50	0	50
		Major (Core)	2	50	0	50
		Major (Core)	2	50	0	50
		VSC S2	2	50	50	0
		VSC S3	2	50	50	0
20432611	Biofuels	OEC	4	100	50	50
20732601	Horticulture – II	SEC	2	50	50	0
	AEC Link- Click Here	AEC (English) (Any One)	2	50	0	50
20810111	English For Academic Writing - Paper II (For Students of English Medium)					
20810112	English Language and Literature - II (For Students of Non-English medium)					
20952111	Environment Awareness Link- Click Here	VEC	2	50	0	50
	CC Link- Click Here	CC (Any One)	2	50	50	0
21450121	Volunteerism and National Service Scheme					
21450221	National Cadets Corps. (NCC) Studies - II					
21450323	Yoga Education					
21450421	Fine Art					
			22	550	250	300

Course Syllabus

Semester - I

.1.1 Major (Core)

Course Title	Algal Ecology
Course Credits	2
Course Outcomes	<p>After Completion of this course the learners will be able to,</p> <ol style="list-style-type: none">1. Apply knowledge of algal characteristics, classification, and life-cycles to identify and differentiate various types of algae and their ecological roles.2. Analyze the morphological and reproductive features of specific algae (Nostoc, Oedogonium, Spirogyra, Ectocarpus, and Batrachospermum) to understand their life-cycles and ecological importance.3. Evaluate the ecological and economic significance of Bryophytes and Pteridophytes, considering their roles in ecosystems and their applications in various industries.4. Design cultivation methods for algae such as Spirulina, and propose innovative uses of algal products in food, nutraceuticals, therapeutics, and other industries.
Module 1 (Credit1) – Algae	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify different Types of Algae
	2. Compare Algal Cultivation and Product Development

Content Outline	<ul style="list-style-type: none"> • Algae –Introduction and historical development in algology. • General characteristics and classification of algae, diversity, habitat, thallus organization, pigments, reserve food, flagella types, life-cycle and alternation of generation in Algae. Distribution of Algae. • Morphology and reproduction and life-cycles of Nostoc, Oedogonium, Spirogyra, Ectocarpus and Batrachospermum. • Diatoms and their importance. Blue-green algae- • A general account. Algal blooms and toxins. • Algal cultivation- Cultivation of microalgae- Spirulina; Algalcultivation methods in India. • Algal products- Food and Nutraceuticals, Feed stocks, food colorants; • fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres from algae and uses.
Module 2 (Credit1) – Bryophyte and Pteridophyta	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Identify Bryophytes and Pteridophytes 2. Compare Ecological and Economic Importance of Bryophytes and Pteridophytes
Content Outline	<ul style="list-style-type: none"> • Bryophytes – General characteristics and classification of Bryophytes, diversity- habitat, thallus structure, Gametophytes and sporophytes. Distribution, morphology, anatomy, reproduction and life-cycles of Riccia, Anthoceros, and Funaria. • Ecological and economic importance of Bryophytes. FossilBryophytes. • Pteridophytes- General characteristics and classification; Structure of sporophytes and life-cycles. distribution, morphology, anatomy, reproduction and life-cycles in Psilotum, Selaginella, Equisetum, Pteris. • Heterospory and seed habit. Stelar evolution in Pteridophytes. Affinitiesand evolutionary significance of Pteridophytes. • Ecological and economic importance of Pteridophytes.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Algae

Project: Algal Diversity Study

Description: Students will conduct a field study to identify and document different types of algae in their local environment. They will explore various habitats such as ponds, streams, or coastal areas and collect samples of algae specimens. Using microscopy and identification keys, students will classify the algae into different groups based on their morphological characteristics, pigments, and life-cycle stages. Through this hands-on experience, students will deepen their understanding of algal diversity and ecological roles in different ecosystems.

Project: Spirulina Cultivation and Product Development

Description: Students will design and implement a cultivation method for Spirulina algae in a controlled environment such as a laboratory or greenhouse. They will research optimal growth conditions for Spirulina cultivation, including nutrient requirements, temperature, light intensity, and pH levels. Students will monitor the growth of Spirulina cultures over time and harvest biomass for product development. They will explore innovative uses of Spirulina products in food, nutraceuticals, therapeutics, and other industries, proposing new applications based on their research findings.

Module 2 – Bryophyte and Pteridophyta

Project: Bryophyte and Pteridophyte Ecology Survey

Description: Students will conduct an ecological survey to study the distribution and ecological roles of Bryophytes and Pteridophytes in different habitats. They will select study sites in diverse ecosystems such as forests, wetlands, or urban areas and collect data on Bryophyte and Pteridophyte diversity, abundance, and habitat preferences. Through field observations and data analysis, students will evaluate the ecological significance of these plant groups in ecosystem functioning, nutrient cycling, and soil stabilization.

Project: Economic Utilization of Bryophytes and Pteridophytes

Description: Students will explore the economic importance of Bryophytes and Pteridophytes by researching their applications in various industries. They will investigate traditional uses of these plant groups in areas such as horticulture, medicine, and landscaping, as well as emerging applications in bioremediation, biofuel production, and green technology. Students will analyze case studies of Bryophyte and Pteridophyte utilization in different regions and propose innovative strategies for sustainable harvesting and commercialization of these plant resources.

References: -

1. Fritsch, F. E. (1935-1945). The Structure and Reproduction of Algae (Vols. I & II). Cambridge University Press.
2. Smith, G. M. (1955). Cryptogamic Botany (Vol. I). Tata McGraw Hill Book Co.
3. Chapman, V. J., & Chapman, D. J. (1973). The Algae (2nd ed.). Edward Arnold.
4. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory Mycology. John Wiley & Sons Inc.

5. Webster, J. (1991). Introduction to Fungi. [Publisher information missing].
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1986). Essentials of Microbiology. [Publisher information missing].
7. Vashishta, B. R., Sinha, A. K., & Singh, V. P. (2002). Botany for Degree Students: Algae (9th rev. ed.). S. Chand & Company Ltd.

1.4 Open Elective Courses/ Generic (OEC)

Course Title	Herbal Science
Course Credits	4
Course Outcomes	<ol style="list-style-type: none"> 1. Analyze different pharmacopoeias (Indian, US, British, WHO), understanding their regulatory frameworks and applications in Herbal Science. 2. Evaluate the active components in herbs, mastering the processes of extraction and their various applications. 3. Investigate the properties, classification, distribution, extraction, biosynthesis, biological roles, and applications of secondary metabolites such as alkaloids and glycosides. 4. Design innovative applications of tannins, phenolic compounds, volatile oils, and resins, utilizing their properties in various herbal science domains.
Module 1 (Credit 1) - Herbal Science	
Learning Outcomes	After learning the module, learners will be able to,
	<ol style="list-style-type: none"> 1. Examine the historical background of Herbal Science, discerning its evolution and relevance in different cultural contexts
	<ol style="list-style-type: none"> 2. Compare the present status and scope of Herbal Science with a focus on Medicinal Botany, Pharmacognosy, Aroma Therapy, and Cosmetology, evaluating their similarities and differences in application and efficacy.
Content Outline	<ul style="list-style-type: none"> • Introduction to Herbal Science: Historical Background, Present Status And Scope With Reference To Medicinal Botany, Pharmacognosy, Aroma Therapy Cosmetology.
Module 2 (Credit 1) - Herbal Pharmacopias	
Learning Outcomes	After learning the module, learners will be able to,
	<ol style="list-style-type: none"> 1. Differentiate between various Pharmacopoeias, including Indian, US, British, and WHO's.
	<ol style="list-style-type: none"> 2. Analyze the regulatory standards and requirements outlined in each Pharmacopoeia for pharmaceutical products

Content Outline	<ul style="list-style-type: none"> • Pharmacopoeia: <ul style="list-style-type: none"> ○ Indian Pharmacopoeia, ○ US Pharmacopoeia, ○ British Pharmacopoeia and ○ WHO's Pharmacopoeia
Module 3 (Credit 3) - Secondary Metabolites I	
Learning Outcomes	After learning the module, learners will be able to
	1. Examine the historical evolution, classification, properties, and natural distribution of Alkaloids and Glycosides
	2. Investigate extraction techniques, biosynthesis pathways, biological functions, and diverse applications of Alkaloids and Glycosides
Content Outline	<ul style="list-style-type: none"> • Secondary Metabolites I • History, Classification, Properties, Distribution in Nature, Extraction, Biosynthesis, Biological role and applications of Alkaloids and Glycosides.
Module 4 (Credit 4) - Secondary Metabolites II	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze the historical evolution, classification, properties, and natural distribution of Tannins, other Phenolic Compounds, Volatile Oils, and Resins
	2. Investigate extraction methods, biosynthesis pathways, biological functions, and various applications of Tannins, other Phenolic Compounds, Volatile Oils, and Resins
Content Outline	<ul style="list-style-type: none"> • Secondary Metabolites II : <ul style="list-style-type: none"> ○ History, Classification, Properties, Distribution in Nature, Extraction, Biosynthesis, Biological role and Applications of Tannins and other Phenolic Compounds. Volatile oils and resins.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Herbal Science

Project: Herbal Garden Creation

Description: Students will plan and create a herbal garden either on the school premises or in their community. They will research different medicinal herbs, their growing conditions, and uses in Herbal Science. Students will work together to design the layout of the garden, select appropriate herbs to cultivate, and plant them. Throughout the project, they will document the process, including the selection of herbs, soil preparation, planting, and maintenance. The herbal garden will serve as an educational resource for the school or community, providing firsthand experience

with medicinal plants.

Resources Needed: Seeds or seedlings of medicinal herbs, gardening tools, soil, pots or garden beds, water source.

Methodology: Research medicinal herbs suitable for the local climate and growing conditions, plan the layout of the herbal garden, prepare the soil, plant the herbs, and maintain the garden.

Data to be Collected: Documentation of the selection of herbs, planting process, growth observations, and any insights gained from maintaining the herbal garden.

Module 2 - Herbal Pharmacopias

Project: Herbal Medicine Preparation Workshop

Description: Students will organize a workshop to prepare herbal medicines following traditional or standardized methods outlined in different pharmacopoeias. They will research the preparation techniques for specific herbal remedies and gather the necessary ingredients. During the workshop, students will demonstrate the preparation process, including measuring ingredients, mixing, and packaging. Participants will have the opportunity to learn about the medicinal properties of herbs and the cultural significance of herbal remedies. The workshop will provide practical experience in herbal medicine preparation and promote understanding of traditional healing practices.

Resources Needed: Ingredients for herbal remedies, kitchen or laboratory equipment, packaging materials, information on traditional medicine preparation techniques.

Methodology: Research traditional or standardized methods for preparing herbal medicines, gathering ingredients, conduct the workshop, and provide demonstrations.

Data to be Collected: Documentation of the preparation process, participant feedback, and reflections on the cultural and therapeutic aspects of herbal medicine.

Module 3 - Secondary Metabolites I

Project: Extraction and Analysis of Secondary Metabolites

Description: Students will conduct experiments to extract secondary metabolites from medicinal herbs and analyze their properties. They will select herbs rich in secondary metabolites such as alkaloids or glycosides and choose appropriate extraction methods. Students will perform extraction experiments, analyze the extracted compounds using techniques such as chromatography or spectroscopy, and interpret the results. Through hands-on experimentation, students will gain practical experience in extracting and analyzing secondary metabolites, enhancing their understanding of Herbal Science principles.

Resources Needed: Medicinal herbs, extraction solvents, laboratory equipment (such as glassware, centrifuge, chromatography equipment), analytical instruments (such as HPLC, GC-MS), chemicals for analysis.

Methodology: Select herbs for extraction, perform extraction experiments, analyze extracted compounds using chromatography or spectroscopy, and interpret the results.

Data to be Collected: Yield of extracted compounds, chromatographic or spectroscopic data, identification of secondary metabolites, and conclusions drawn from the analysis.

Module 4 - Secondary Metabolites II

Project: Formulation of Herbal Products

Description: Students will collaborate to formulate herbal products using secondary metabolites such as tannins, phenolic compounds, volatile oils, and resins. They will research the properties and applications of these compounds in Herbal Science and identify suitable formulations for products such as herbal teas, topical creams, or natural cosmetics. Students will develop prototypes of their products, considering factors such as ingredients, formulation techniques, and packaging. They will present their formulations to a panel for evaluation, focusing on innovation, effectiveness, and market potential.

Resources Needed: Ingredients for herbal formulations, laboratory or kitchen equipment, packaging materials, market research data.

Methodology: Research properties and applications of secondary metabolites, formulate herbal products, develop prototypes, and present formulations to a panel for evaluation.

Data to be Collected: Formulation recipes, prototype samples, feedback from panel evaluation, and reflections on the formulation process.

References:

1. Trivedi, P. C. (2009). Indian Medicinal plants.
2. Bhattacharjee, S. K. (2004). Handbook of Aromatic Plants.
3. Bhattacharjee, S. K. (2004). Handbook of Medicinal and Aromatic Plants.
4. Kapoor, L. D. (2005). Handbook of Ayurvedic Medicinal Plants.
5. Kirtikar, K. R., & Basu, B. D. (2006). Indian Medicinal Plants (Vols. 1-4).
6. Sivarajan, V. V., & Balachandran, I. (1994). Ayurvedic Drugs and Their Plant Sources. Oxford & IBH.
7. Vardhana. (2008). Direct Uses of Medicinal Plants and Their Identification. Sarup and Sons.
8. World Health Organization. (1998). Quality Control Methods for Medicinal Plants Materials.

1.5 Vocational Skill Course (VSC)

Course Title	Instrumentation Techniques
Course Credits	2
Course Outcomes	After Completion of this course, the learner will be able to,
	1. Apply various Chromatographic Techniques, such as TLC, HPTLC, GC, and AffinityChromatography
	2. Analyze the principles, instrumentation, and processes underlying ChromatographicTechniques
	3. Utilize advanced Chromatographic Techniques, including Adsorption Chromatography,Partition Chromatography, and HPLC, for analytical purposes.
	4. Evaluate the principles,instrumentation, and processes associated with ChromatographicTechniques
Module 1 (Credit 1) - Chromatography Techniques I	
Learning Outcomes	After learning the module, learners will be able to,
	1. Understanding Principles of Chromatography
	2. Learn the techniques of Instrumental Analysis
Content Outline	<ul style="list-style-type: none"> • Techniques in Chromatography I Principles, • Instrumentation, processes, • Applications of - TLC, • HPTLC, • Gas- liquid chromatography, GC, • Affinity Chromatography
Module2(Credit1) - Chromatographic Techniques II	
Learning Outcomes	After learning the module, learners will be able to
	1. Learn the Techniques of Chromatography
	2. Learn about the applications of Chromatographic Techniques

Content Outline	<ul style="list-style-type: none"> • Techniques in Chromatography II Principles, Instrumentation, processes • Applications of – Adsorption Chromatography, • Partition Chromatography, • HPLC,
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**Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),
References:**

9. Column Chromatography Optimization: Students optimize column chromatography parameters, such as stationary phase selection, mobile phase composition, and flow rate, to achieve efficient separation of complex mixtures in the laboratory.
10. Sample Analysis with Gas Chromatography: Students analyze volatile compounds in real samples using gas chromatography, focusing on sample preparation, injection techniques, and chromatographic conditions to obtain accurate results.
11. Quantitative HPLC Analysis: Students develop and validate an HPLC method for quantitative analysis of target analytes in pharmaceutical formulations, applying principles of method validation and quality control in the laboratory.
12. TLC Analysis of Medicinal Plants: Students conduct thin-layer chromatography (TLC) analysis of medicinal plant extracts to identify and quantify bioactive compounds, correlating TLC results with biological activity assays.
13. Chiral Separation Experiment: Students perform chiral separation experiments using HPLC or GC columns coated with chiral selectors, investigating enantiomeric resolution and its applications in pharmaceutical analysis.
14. Environmental Analysis using LC-MS: Students analyze environmental samples for trace contaminants using liquid chromatography-mass spectrometry (LC-MS), developing sample extraction and analysis protocols for environmental monitoring.
15. Method Development for Natural Product Analysis: Students develop chromatographic methods for the analysis of natural products, optimizing separation conditions to characterize complex mixtures in herbal extracts or dietary supplements.
16. Impurity Profiling by HPLC: Students conduct impurity profiling studies using HPLC, identifying and quantifying impurities in pharmaceutical formulations to ensure product quality and compliance with regulatory standards.
17. Polymer Characterization with GPC: Students characterize polymers using gel permeation chromatography (GPC), determining molecular weight distribution and polymer composition to study polymer properties and behavior.
18. Food Safety Analysis with LC-UV: Students analyze food samples for contaminants and additives using liquid chromatography with UV detection, applying chromatographic techniques to ensure food safety and quality control.

Reference books:

1. Dean, J. A. (1969). Chemical methods of separation. Van Nostrand Reinhold.
2. Smith, M., & Menemann, S. (1960). Chromatographic and electrophoresis techniques. Interscience.
3. Christian, G. D., Dasgupta, P. K. (Sandy), & Schug, K. A. (2014). Analytical Chemistry (7th ed.). JohnWiley and Sons Inc.
4. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2004). Fundamentals of Analytical Chemistry(8th ed.). Thomson, Brookes/Cole.
5. Harvey, D. (2001). Modern Analytical Chemistry. McGraw Hill.

1.6 Skill Enhancement Courses (SEC)

Course Title	Horticulture - I
Course Credits	2
Course Outcomes	After Completion of this course, the learner will be able to,
	1. Demonstrate the importance and objectives of Horticulture, applying concepts of Pomology, Olericulture, and Landscape Gardening.
	2. Analyze horticultural practices, differentiating between branches such as Apiculture, Sericulture, and Social Forestry
	3. Apply advanced principles of horticultural practices and organic cultivation methods
	4. Operate garden activities proficiently, including soil preparation, irrigation, pruning, and organic farming practices.
Module 1 (Credit 1) - Introduction to Horticulture	
Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate the definition, importance, and objectives of Horticulture, applying concepts of Pomology, Olericulture, and Landscape Gardening
	2. Analyze the branches of Horticulture, including Nurseries, Apiculture, Sericulture, and Social Forestry, illustrating their development and allied contributions
Content Outline	<ul style="list-style-type: none"> • INTRODUCTION TO HORTICULTURE : <ul style="list-style-type: none"> o Definition, importance and objectives of Horticulture, branches of Horticulture, Pomology, Olericulture, Landscape Gardening, Nurseries and development Allied branches – Apiculture and Sericulture, Social Forestry.
Module 2 (Credit 1) - Horticultural Operations	
Learning Outcomes	After learning the module, learners will be able to
	1. Practice site selection, soil preparation, mulching, top-dressing, blanching, sowing, transplanting, tree transplantation, and various irrigation methods
	2. Evaluate Organic Farming's definition, techniques, Indian scenario, and futurescope.

Content Outline	<ul style="list-style-type: none"> • GARDEN OPERATIONS <ul style="list-style-type: none"> ○ Selection of site, Preparation of soils for garden Mulching, top- dressing, blanching Sowing, transplanting, tree transplanting, Irrigation, - Overhead, Surface, Underground Weeding and pruning, - Principles, Objectives and general technique. ○ Organic Farming Definition, Technique, Indian scenario, Future scope
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**Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),
References:**

19. Organic Garden Establishment: Students apply principles learned to establish an organic garden, including site selection, soil preparation, mulching, and planting techniques, fostering hands-on experience in horticultural operations.
20. Horticultural Practices Workshop: Students organize and execute a workshop on horticultural practices, covering topics such as irrigation methods, weeding, pruning, and organic cultivation techniques, enhancing practical skills through hands-on activities in the garden.
21. Pomology Experiment: Students conduct experiments in pomology, focusing on the cultivation and management of fruit-bearing plants, studying factors affecting fruit quality, yield, and storage methods in horticulture.
22. Olericulture Field Study: Students conduct field studies in olericulture, examining the cultivation and management of vegetable crops, assessing factors influencing crop growth, yield, and post- harvest handling techniques in horticultural operations.
23. Landscape Design Project: Students design and implement a landscape project, incorporating principles of landscape gardening to create aesthetically pleasing and functional outdoor spaces, applying knowledge of plant selection, layout, and maintenance.
24. Nursery Management: Students manage a nursery, learning techniques for seedling propagation, transplanting, and nursery maintenance, gaining practical experience in plant propagation and nursery operation.
25. Apiculture Workshop: Students organize a workshop on apiculture, covering beekeeping practices, hive management, honey extraction, and the role of bees in pollination, providing insights into beekeeping as a branch of horticulture.
26. Sericulture Demonstration: Students demonstrate sericulture techniques, including silkworm rearing, silk production, and silk processing, highlighting the economic importance of sericulture in horticultural practices.
27. Social Forestry Campaign: Students organize a social forestry campaign, promoting tree planting and environmental conservation efforts in the community, raising awareness about the benefits of forestry in horticulture and ecosystem restoration.
28. Horticultural Exhibition: Students curate a horticultural exhibition showcasing various aspects of horticulture, including plant diversity, landscaping designs, and

sustainable gardening practices, fostering public engagement and education in horticultural principles and applications

References Books:

1. Chadha K L (2002). Handbook of Horticulture ICAR
2. Peter K V (2008). (Ed.) Basics of Horticulture New India Publication agency
3. Bose T K., Maiti R G., Duha R S and Das P (1999). Floriculture and Landscaping, NayaPrakash
4. Sudheer K P and Indira V (2007) Post harvest technology of Horticultural crops, NewIndia Publication agencies
5. Nambisan KMP (1992) Design elements of Landscape gardening Oxford and IBH
6. Arora J S (1999). Introduction to ornamental horticulture Kalyani Publishers, Ludhiana

Semester - II

.2.1 Major (Core)

Course Title	Botanical Evolution
Course Credits	2
Course Outcomes	After Completion of this course the learners will be able to
	1. Identify Gymnosperms and assess their evolutionary and economic significance.
	2. Analyze plant evolution across geological time scales and comprehend modern plant diversity.
	3. Apply radiocarbon dating and investigate fossil taxa, enhancing their understanding of Earth's past.
	4. Design effective experiments to study Gymnosperms and paleobotanical research, contributing significantly to plant evolution and biodiversity.
Module1(Credit1)- Gymnosperms	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify Gymnosperms
	2. Compare Evolutionary and Economic Importance of Gymnosperms
Content Outline	<ul style="list-style-type: none">• Gymnosperms- General characteristics. Distribution and classification of Gymnosperms.• Study of the habitat, distribution, habit, anatomy, reproduction and life-cycles in Cycas, Pinus and Gnetum• Affinities and evolutionary significance of Gymnosperms. Economic importance of Gymnosperms - food, timber, industrial uses and medicines.
Module2(Credit1)- Paleobotany	
Learning Outcomes	After learning the module, learners will be able to
	1. Describe Evolution of Plants
	2. Compare Geological Time Scale and Paleobotany

Content Outline	<ul style="list-style-type: none"> • Origin and evolution of Plants: Origin and evolution of plants through Geological Time scale. • Paleobotany- Paleobotanical records, plant fossils, Preservation of plant fossils -impressions, compressions, petrification's, moulds and casts, pith casts. • Radiocarbon dating. • Fossil taxa- Rhynia, Lepidodendron ,Lyginopteri Exploration of fossil fuels. • Birbal Sahni Institute of Paleosciences.
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

No Internal Assignments.

Reference Books

1. Fritsch, F. E. (1935-1945). The Structure and Reproduction of Algae (Vols. I & II). Cambridge University Press.
2. Smith, G. M. (1955). Cryptogamic Botany (Vol. I). Tata McGraw Hill Book Co.
3. Chapman, V. J., & Chapman, D. J. (1973). The Algae (2nd ed.). Edward Arnold.
4. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory Mycology. John Wiley & Sons Inc.
5. Webster, J. (1991). Introduction to Fungi. [Publisher information missing].
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1986). Essentials of Microbiology. [Publisher information missing].
7. Vashishta, B. R., Sinha, A. K., & Singh, V. P. (2002). Botany for Degree Students: Algae (9th rev. ed.). S. Chand & Company Ltd.

.2.6 Open Elective Courses/ Generic (OEC)

Course Title	Biofuels
Course Credits	4
Course Outcomes	After Completion of this course the learner will be able to
	1. Demonstrate an understanding of the definition, scope, and importance of Biofuels, analyzing their relevance to climate change and environmental issues, and evaluating public awareness.
	2. Calculate the potential impact of various biofuel feedstocks on production, applying knowledge of agricultural, farm, forestry, and organic wastes
	3. Identify different plant species yielding biodiesel and practice seed harvesting, processing, and oil extraction techniques for biofuel production.
	4. Design innovative production technology processes for biofuels (biodiesel, ethanol, and biogas) and evaluate their effectiveness in meeting energy demands
Module 1 (Credit 1) - Biofuels	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze the introduction, definition, scope, and importance of biofuels concerning climate change and environmental issues.
	2. Investigate the historical development of biofuels, including the advantages, disadvantages, and the progression through first to fourth generations
Content Outline	<ul style="list-style-type: none"> • Introduction, Definition, scope and Importance of Bio-fuel with respect to climate change and environmental issues. • Public awareness. • Biofuels scenario in India and world. • History of Biofuels. • Advantages and disadvantages of biofuels. • Developmental generation of biofuels: first, second, third and fourth generation of biofuels and present status.
Module 2 (Credit 1) - Biofuel Feed Stock	
Learning Outcomes	After learning the module, learners will be able to
	1. Classify various biofuel feedstocks, including agricultural, farm, forestry, and organic wastes from residential, institutional, and industrial sources

	2. Investigate the significance of algal biofuels in the context of sustainable energy production
Content Outline	<ul style="list-style-type: none"> • Biofuel feed stocks: • Agricultural waste, farm waste, forestry waste, organic wastes from the residential, institutional and industrial waste and its importance. • (Biomass- plant, animal and microbial based waste). • Algal biofuel.
Module 3 (Credit 1) - Biodiesel species Biofuel Feed Stock	
Learning Outcomes	After learning the module, learners will be able to
	1. Classify biodiesel species such as Pongamia pinnata, Simarouba gluca, Jatrophacurcas, Azadirachta indica, Madhuca indica, and Calophyllum inophyllum.
	2. Practice seed harvesting, processing, oil extraction, and characterization techniques specific to each biodiesel species
Course Content	<ul style="list-style-type: none"> • Biodiesel species: • Pongamia pinnata, Simarouba gluca, Jatropha curcas, Azadirachta india, Madhuca indica and Callophyllum innophyllum Seed harvesting, processing, oil extraction, and characterization
Module 4 (Credit 1) - Bioethanol	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze the introduction and production technology of biodiesel, bioethanol, biogas, and biohydrogen, including quality analysis techniques.
	2. Evaluate biofuel sustainability and policies in India, and interpret biofuel production statistics to assess their impact on the energy sector
Course Outcomes	<ul style="list-style-type: none"> • Introduction to biodiesel, bioethanol, biogas and bio hydrogen. Production technology of biofuels (Biodiesel, ethanol and biogas). Quality analysis of biodiesel, bioethanol and biogas • Biofuel sustainability; Biofuel Policy in India. Biofuel production statistics.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Biofuels

Project: Public Awareness Campaign on Biofuels

Description: Students will design a public awareness campaign on biofuels to educate their local community about the importance and benefits of biofuels in mitigating climate change and addressing environmental issues. They will create informative posters, pamphlets, and digital content highlighting the definition, scope, advantages, and disadvantages of biofuels. Through outreach events and social media platforms, students will disseminate information on the history and developmental generations of biofuels, emphasizing their relevance in the context of sustainable energy solutions. This project will not only enhance students' understanding of biofuels but also empower them to communicate scientific concepts effectively to the public.

Module 2 - Biofuel Feedstock

Project: Feasibility Study of Algal Biofuels

Description: Students will conduct a feasibility study on the production of algal biofuels as a sustainable energy source. They will research different species of algae suitable for biofuel production and assess their growth characteristics, lipid content, and potential yield. Using basic laboratory equipment and techniques, students will culture algae samples under controlled conditions and monitor their growth over time. Through experimentation, students will determine the feasibility of algal biofuel production and explore its potential as a renewable energy solution. This project encourages hands-on experimentation and critical thinking skills in evaluating alternative biofuel feedstocks.

Module 3 - Biodiesel Species as Biofuel Feedstock

Project: Seed-to-Fuel Biodiesel Production

Description: Students will engage in a hands-on project to produce biodiesel from selected biodiesel species, such as *Pongamia pinnata* or *Jatropha curcas*. They will start by collecting seeds of the chosen species and then proceed to harvest, process, and extract oil from the seeds using simple techniques that can be conducted in a school laboratory or at home. After obtaining the biodiesel, students will characterize its properties and assess its quality using standard analytical methods. Through this practical project, students will gain valuable experience in biodiesel production and deepen their understanding of the entire seed-to-fuel process.

Module 4 - Bioethanol

Project: Bioethanol Production and Quality Analysis

Description: Students will design and conduct experiments to produce bioethanol from renewable feedstocks such as sugarcane or maize. They will ferment the feedstock to produce ethanol and then distill and purify the ethanol using basic laboratory equipment. Students will analyze the quality of the bioethanol using standard analytical techniques to assess its purity, alcohol content, and suitability for use as a

fuel. Additionally, students will research and evaluate biofuel sustainability policies in India to understand the regulatory framework governing bioethanol production. This project provides hands-on experience in bioethanol production and quality analysis while fostering an understanding of biofuel sustainability and policy considerations.

References:

1. The Biodiesel Handbook (2005). Jurgen Krahl, Jon Harlan Van Gerpen. AOCS Press.
2. Bioenergy and Biofuels (2017). Ozcan Konur. CRC Press, Taylor & Francis's group.
3. <https://mnre.gov.in/biofuels>

.2.7 Skill Enhancement Courses (SEC)

Course Title	Horticulture - II
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Exhibit knowledge of horticultural products and greenhouse technology.
	2. Demonstrate understanding of floriculture and its economic aspects
	3. Apply commercial production techniques to various horticultural crops
	4. Analyze different types of horticultural produce, considering post-harvest management and specific crop requirements
Module1(Credit1) - Horticultural Products	
Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate knowledge of high-tech horticultural production and greenhouse technology.
	2. Analyze the significance of floriculture, encompassing soil and climate requirements, cultivation practices, and greenhouse economics for crops such as Gerbera, Carnation, Roses, and Orchids
Content Outline	<ul style="list-style-type: none"> • HORTICULTURE PRODUCE <ul style="list-style-type: none"> ○ High -tech Horticultural production ○ Green house technology- Meaning, types, layout & construction, irrigation systems. Care & attention. Hardening of plants. Space gardens. ○ Floriculture – Scope & importance, ○ soil and climatic requirement and cultivation practices ○ Economics of green house production of Gerbera, Carnation, Roses, Orchids. Propagation techniques, packing and marketing
Module2(Credit1) - Commercial Production	
Learning Outcomes	After learning the module, learners will be able to
	1. Investigate the cultivation methods and commercial aspects of spices and condiments, particularly chili peppers

	2. Evaluate the cultivation practices and economic significance of medicinal plants like Aloe vera and Stevia rebaudiana (Madura), as well as aromatic plants such as Citronella and Patchouli.
Content Outline	<ul style="list-style-type: none"> • HORTICULTURE PRODUCTION <ul style="list-style-type: none"> ○ Commercial production of the following – in relation to propagation, post plantation care, harvesting, ○ Post harvest management & varieties. Tubers- potato ○ Vegetables- Tomato ○ Fruits- Mango, Grapes & Coconut Products like coco peat/ Coir etc. ○ Spices/condiments- chilly ○ Medicinal plants- Aloe vera, Stevia rebaudiana (Madura) ○ Aromatic plant- Citronella, Patchouli

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Horticultural Products

Project: Mini Indoor Herb Garden Workshop

Description: Each student will organize a mini indoor herb garden workshop for their community. They will gather materials such as small pots, potting soil, herb seeds, and basic gardening tools. During the workshop, students will guide participants through the process of planting herb seeds, providing instructions on soil preparation, seed planting depth, and watering techniques. They will also discuss essential care tips for maintaining healthy herb plants, including sunlight requirements and pest management. Through hands-on experience, participants will learn how to start their indoor herb garden and gain practical knowledge of horticultural practices in a controlled environment.

Module 2 - Commercial Production

Project: Spice Blend Making Workshop

Description: Each student will host a spice blend making workshop to showcase the cultivation and culinary potential of spices. They will collect a variety of dried spices such as chili peppers, turmeric, cumin, and coriander from local markets or farms. During the workshop, students will educate participants about the origin and cultivation of each spice, highlighting their unique flavors and health benefits. Participants will then have the opportunity to create their custom spice blends using mortar and pestle or spice grinders, experimenting with different flavor combinations. By actively engaging in the spice blending process, participants will develop an appreciation for spice cultivation and culinary arts while enjoying hands-on learning.

The Internal evaluation should comprise the Unit tests, and continuous Internal evaluation emphasizing practical, Projects, activities, presentations, seminars, workshops, products, assignments and reports

References:

4. Chadha K L (2002). Handbook of Horticulture ICAR

5. Peter K V (2008). (Ed.) Basics of Horticulture New India Publication agency
6. Bose T K., Maiti R G., Duha R S and Das P (1999). Floriculture and Landscaping, NayaPrakash
7. Sudheer K P and Indira V (2007) Post harvest technology of Horticultural crops, NewIndia Publication agencies
8. Nambisan KMP (1992) Design elements of Landscape gardening Oxford and IBH Arora J.S.(1999). Introduction to ornamental horticulture Kalyani Publishers, Ludhiana