DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CHHATRAPATI SAMBHAJINAGAR (M.S.) - 431001

Course Structure and Curriculum

For

B.Sc. Botany (Second Year)

(Semester – III and IV)

(AS PER NEP-2020)

Effective from

Academic Year 2025-26

BOARD OF STUDIES IN BOTANY

Sr. No	Name of BOS member	Designation	
1	Dr. Arvind Dhabe (Chairman), Department of Botany, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar	**Chairmen**	arvinddhabe@gmail.com Mob. No:9923300222/02402403303
2	Dr.Wadikar Madhukar Subhashrao, 4] Department of Botany, R.R.Attal College, Georai, Dist.- Beed.	**BOS Member**	Mob.9712672778 drmswadikar@gmail.com
3	Dr.Ambhore Jalindar Sakharam, Head Dept. of Botany. , Indraraj Arts, Comm. & Science College, Sillod, Chhatrapati Sambhajinagar	**BOS Member**	Mob.9421900118. jalindarambhore@gmail.com
4	Dr. Shaikh Rafiq Isahakhoddin, Miliya College. Beed-431 122.	**BOS Member**	Mob.9423733541 rafeeque. 1567@gmail.com rafeeque. 1567@gmail.com
5	Dr.Abhay Salve, Govt. Institute of Sciencee, Chhatrapati Sambhajinagar	**BOS Member**	**abhaysalve@hotmail.com**
6	Dr.Mogale Umesh Pandurang, R.G.Bagadiya Arts, S.B.Lakhotia Commerce and R.Benjonji Science College, Jalna.	**BOS Member**	upmogle@gmail.com
7	Dr.Patale Shivraj Shankar, Smt. Shantabai Kantila Gandhi Arts, Amolak Science, Pannalal Hiralal Gandhi Commerce College, Kada, Tq-Ashti, Dist. Beed.	**BOS Member**	Mob.9823937501 sspatale@rediffmail.com
8	Dr.Ashfaq M.Khan, Maulana Azad Arts, Science and Commerce College, Chhatrapati Sambhajinagar	**BOS Member**	ashfaqamk@gmail.com **9637777482**
9	Dr. Sopan Tukaram Chavan, Rashtramata Indiara Gandhi College, Jalna.	**BOS Member**	Mob.9423731767. sopanchavan6567@gmail.com
10	Dr.Vasant Pandit Mali, Principal, J.Watumull Sadhubella Girls College, Ulhasnagar-1, Dist. Thane	**BOS Member**	**vasant.mali@rediffmail.com 9321463140**
11	Dr. Rajendra A. Satpute, Director Govt. Institute of Science, Chhatrapati Sambhajinagar.	**BOS Member**	Mob.9404012456. rasatpute@gmail.com
12	Dr.Navnath Gangadhar Kashid, Baburaoji Adaskar Mahavidyalaya Kaij, Dist.Beed.	**BOS Member**	**ngkashid@gmail.com**
13	Dr.Amit Dhanraj Hatti, Sr.Certification Manager, Geo- Fresh, Organic Pvt.Ltd	**BOS Member**	
14	Dr.Kishor Tatyasaheb Veer, Flat No.9/10, Om Apartment, Vidya Nagar, Near Seven Hills, Chhatrapati Sambhajinaga	**BOS Member**	

B. Sc. (Botany) III Semester and IV Semester syllabus has been accepted in the meeting of Board of Studies in Botany held on 17th February, 2025 at H.O.D.s cabin, Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

Following members of BOS in Botany were present:

1. Prof. Arvind S. Dhabe	:	Chairman, (BOS in Botany)	: 17/02/2025
2. Head of the Department	:		: 17/02/2025
3. Prof. M. S. Wadikar	:	Member	:
4. Prof. J. S. Ambhore	:	Member	: 17/02/2025
5. Dr. Shaikh Rafeeque	:	Member	:
6. Prof. Abhay Salve	:	Member	: 17/02/2025
7. Dr. Ashfaque M. Khan	:	Member	: 17/2/25
8. Dr. Chavan S. T.	:	Member	: 17-02-25
9. Prof. Satpute R. A.	:	Member	:

PREFACE

As we stand on the threshold of a new era in education, the dawn of the National Education Policy 2020 illuminates our path toward a holistic, inclusive, and progressive educational landscape. The Bachelor of Science (B. Sc.) curriculum outlined herein reflects the ethos and aspirations of this transformative policy, aiming to equip learners with the knowledge, skills, and values necessary to thrive in the dynamic world of the 21st century.

At its core, the National Education Policy 2020 envisions an educational framework that is learner-centric, multidisciplinary, and geared towards fostering creativity, critical thinking, and innovation. It emphasizes the integration of knowledge across disciplines, breaking down traditional silos to encourage holistic understanding and application of concepts. The Bachelor of Science (B. Sc.) curriculum embodies these principles by offering a diverse array of courses spanning various scientific domains, while also incorporating interdisciplinary studies to nurture well-rounded graduates capable of addressing complex challenges with agility and insight.

Furthermore, the curriculum is designed to promote experiential learning, research, and hands-on exploration, recognizing the importance of practical engagement in deepening understanding and cultivating real-world skills. Through laboratory work, field experiences, internships, and project-based learning opportunities, students will have the chance to apply theoretical knowledge in practical settings, develop problem-solving abilities, and cultivate a spirit of inquiry and discovery.

Integral to the National Education Policy 2020 is the commitment to inclusivity, equity, and access to quality education for all. The Bachelor of Science (B. Sc.) curriculum reflects this commitment by embracing diversity in perspectives, backgrounds, and experiences, and by fostering an inclusive learning environment where every student feels valued, supported, and empowered to succeed.

Moreover, the curriculum emphasizes the cultivation of ethical values, social responsibility, and global citizenship, instilling in students a sense of accountability towards society and the environment. By integrating courses on ethics, sustainability, and social sciences, the Bachelor of Science (B. Sc.) program aims to produce graduates who are not only proficient in their respective fields but also compassionate, ethical leaders committed to making a positive impact on the world.

As we embark on this journey of educational transformation guided by the National Education Policy 2020, the Bachelor of Science (B. Sc.) curriculum stands as a testament to our collective vision of a more equitable, inclusive, and enlightened society. It is our hope that through rigorous academics, innovative pedagogy, and unwavering dedication to excellence, we can inspire the next generation of scientists, scholars, and change-makers to realize their full potential and contribute meaningfully to the advancement of knowledge and the betterment of humanity.

Structure of B. Sc. (Three/Four Years Honours/Honours with Research Degree) Program with Multiple Entry and Exit Options

B. Sc. Second Year: 3rd Semester Subject: Botany

Students will have to select / declare choice of **one major subject** and **one minor subject** from three major options M1, M2 and M3 (which were opted in the first year)

Course Type	Course Code	Examination Code (To be given by respective BoS)	Course Name	Teaching Scheme (Hours/Week)		Credits assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	BOT/DSC/T/200	SAC03012003T	Diversity of Cryptogams - II	2		2		2+2+ 2+2 = 08
	bOT/DSC/T/201	SAC03012013T	Plant Ecology	2		2		
	BOT/DSC/P/226	SAC03012263P	Diversity of Cryptogams - II		4		2	
	BOT/DSC/P/227	SAC03012263P	Plant Ecology		4		2	
Minor Course (Choose any two from pool of courses) It is from different discipline of the same faculty	BOT/Mn/T/200	SCC03012003T	Fundamentals of Soil Science	2		2		2+2 = 04
	BOT/Mn/T/201	SCC03012013T	Organic Farming	2		2		
Generic/ Open Elective (GE/OE) (Choose any one from pool of courses) It should be chosen compulsorily from the faculty other than that of Major)	BOT/ GE/OE/ T/200	SDC03012003T	Fruit Preservation	2		2		02
VSC (Vocational Skill Courses) (Choose any one from BOT/VSC/T/200 & BOT/VSC/T/ 201 and corresponding Practicals	BOT/VSC/T/200	SEC03012003T	Mushroom Cultivation	1		1		1+1 = 02
	BOT/VSC/T/201	SEC03012013T	Biomass Management	1		1		
	BOT/VSC/P/226	SEC03012263P	Mushroom Cultivation		2		1	
	BOT/VSC/P/227	SEC03012273P	Biomass Management		2		1	
AEC/VEC/IKS	SUB/AEC/T/200		English Common for all	2		2		2+2 = 04
	SUB/VEC/T/201		Environmental Studies	2		2		
OJT/FP/CEP/CC/RP	SUB/CC/P/226		Cultural Activities/ NSS/NCC (Common for all)		4		2	02
				15	14	15	07	22

Minor Courses Designed for other Discipline of the same Faculty

- SUB/Mn/T/ 200: Fundamentals of Soil Science (SCC03062003T)
- SUB/Mn/T/ 201: Organic Farming (SCC03062013T)

Generic /Open Elective Courses for other faculty

- SUB/GE/OE/T/200: Fruit Preservation (SDC03062003T)

Detailed Illustration of Courses included in 3rd and 4th semester:

1) **Major** (Core) subject is mandatory.

SUB/DSC/T/200: This is a 2-credit theory course corresponding to Major (core) subject

SUB/DSC/T/201: This is a 2-credit theory course corresponding to Major (core) subject

SUB/DSC/P/226: This is a 2-credit practical course based on SUB/DSC/T/200

SUB/DSC/P/227: This is a 2-credit practical course based on SUB/DSC/T/201

SUB/DSC/T/250: This is a 2-credit theory course corresponding to Major (core) subject

SUB/DSC/T/251: This is a 2-credit theory course corresponding to Major (core) subject

SUB/DSC/P/276: This is a 2-credit practical course based on SUB/DSC/T/250

SUB/DSC/P/277: This is a 2-credit practical course based on SUB/DSC/T/251

2) **Minor: It is from different discipline of the same faculty**

SUB/Mn/T/200: This is a 2-credit theory from different discipline of the same faculty

SUB/Mn/T/201: This is a 2-credit theory from different discipline of the same faculty

SUB/Mn/T/250: This is a 2-credit theory from different discipline of the same faculty

SUB/Mn/T/251: This is a 2-credit theory from different discipline of the same faculty

3) **Generic / Open Elective (GE/OE)**: (Needs to be chosen (any one) from pool of courses available at respective college). **These courses should be chosen compulsorily from faculty other than that of Major.**

SUB/GE/OE/T/200: This is a 2-credit theory course should be chosen compulsorily from faculty other than that of Major.

SUB/GE/OE/T/250: This is a 2-credit theory course should be chosen compulsorily from faculty other than that of Major.

4) **VSC** (Vocational Skill Courses): Choose any one from pool of courses. These courses should be based on Hands on Training corresponding to Major (core) subject.

SUB/VSC/T/200: This is a 1 credit theory course-based Hands-on Training corresponding to Major (core) subject.

SUB/VSC/T/201: This is a 1 credit theory course-based Hands-on Training corresponding to Major (core) subject.

SUB/VSC/P/226: This is a 1 credit practical course based on **SUB/VSC/T/200**

SUB/VSC/P/227: This is a 1 credit practical course based on **SUB/VSC/T/201**

5) **SEC** (Skill Enhancement Courses): Choose any one from pool of courses. These courses should be based on Hands on Training corresponding to Major (core) subject.

SUB/SEC/T/250: This is a 1 credit theory course to enhance the technical skills of the students in specific area.

SUB/SEC/T/251: This is a 1 credit theory course to enhance the technical skills of the students in specific area.

SUB/SEC/P/276: This is a 1 credit practical course based on **SUB/SEC/T/250**

SUB/SEC/P/277: This is a 1 credit practical course based on **SUB/SEC/T/251**

6) **AEC** (Ability Enhancement courses): The focus of these courses should be based on linguistic and communication skills.

SUB/AEC/T/200: English

This is a 2-credit theory course based on linguistic proficiency.

SUB/AEC/T/250: Modern Indian Language MIL-2 (Hindi/ Marathi/ Pali & Buddhism/ Sanskrit/ Urdu)

This is a 2-credit theory course based on linguistic proficiency. Students will have to choose one of the above-mentioned languages.

7) **VEC**: Environmental Studies

SUB/VEC/T/201: Environmental Studies

This is 2-credit theory course based on Environmental Studies.

8) **FP-1: Field Project:**

SUB/FP/P/276: This is a 2-credit course, should be corresponding to Major (core) subject

9) **CC** (Curricular Courses): The courses such as Health and wellness, Yoga education, Sports and Fitness, Cultural activities, NSS/NCC, Preforming Arts.

SUB/CC/P/226: Cultural Activity / NSS, NCC

This is a 2-credit practical course based on Co-curricular activities. It will be common for all the faculty

SUB/CC/P/277: Fine/ Applied/ Visual/ Performing Arts

This is a 2-credit practical course based on Co-curricular activities. It will be common for all the faculty

Major (Core) Mandatory DSC-5

BOT/DSC/T/200. (Title of Paper-DIVERSITY OF CRYPTOGAMS –II)

1. Total Credits: 2. Total Contact Hours: 30.

Examination Paper Code SAC03012003T Maximum Marks-50 (CIA-20 , SEE-30**)**

Learning Objectives of the course

i. Provide a thorough knowledge of general characters and classification of Bryophytes and Pteridophytes
ii. Describe Vegetative structure and Life cycle of Marchantia, Anthoceros and Funaria.
iii. Acquire knowledge about general characters and classification of Pteridophytes.
iv. Describe the Vegetative structure and Life cycle of Psilotum, Lycopodium, Equisetum and Marsilea

Course outcomes (COs):

After the successful completion of the module, the learner will be able to

i) Gain knowledge about diversity among the bryophytes and pteridophytes with their general characters
ii) Understand the Classification of bryophytes and pteridophytes based on their structure, reproduction and life cycles
iii) Evaluate the ecological, ethnic, and economic value of bryophytes and pteridophytes.

Module No	Topic /actual content of the syllabus	Contact Hours
I	**Bryophytes** 1. General characters of bryophytes, classification as per G. M. Smith 2. Ecology and economic importance of bryophytes 3. Systematic position, occurrence, thallus structure (external and internal), 4. Reproduction -vegetative, asexual, and sexual (excluding developmental stages) 5. Graphic life cycle and alternation of generations of the following types: a) *Marchantia*, b) *Anthoceros*, c) *Funaria*	10
II	**Pteridophytes** 1. General characters of Pteridophytes, classification as per G. M. Smith 2. Ecology and economic importance of Pteridophytes. 3. Systematic position, occurrence. Morphology, anatomy and reproductive structure of following types: a) *Psilotum* (02), b) *Lycopodium* (02),c) *Equisetum* (02), d) *Marsilea.*	10
III	1. Adaptations of Bryophytes to land habit, 2. Heterospory and seed habit 3. Stelar evolution; 4. Telome theory.	10

Reference Books:-

1. Bendre and Kumar. (2008) Practical Volume 1and 2 Rastogi Publication,Meerut ,2008
2. Bendre, A. M. and Kumar A. (2003). Manual of Practical Botany Vol. II. Rastogi Publications, Meerut.
3. Pandey, B. P. (2014).Modern Practical Botany Vol.I.S.Chand and Company Ltd. Ramnagar, New Delhi.
4. Purohit, S. D., Kundra, G. K. and Singhvi, A. (2013), Practical Botany (part I) Apex

Publishing House, Durga Nursery Road, Udaipur, Rajasthan.
5. Vashishta, P. C. (1997), Vascular Cryptogams. S. Chand & Company Ltd., Ram Nagar, New Delhi.
6. Chopra, R. N. (2005), Biology of bryophytes. New Age International (P) Ltd. New Delhi, India.
7. Gangulee H. C., Kar, A. K. and Santra S. C. (2011). College Botany Vol II. 4th Edition New Central Book Agency.
8. Goffinet B. and Jonathan Shaw, A. (2009), Bryophyte Biology. Cambridge University Press, New York.
9. Parihar, N. S. (2013). An Introduction to Embryophyta. Vol. I Bryophyta, Surjeet Publication, New Delhi.
10. Parihar, N. S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad.
11. Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.
12. Pandey, B. P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi, India.
13. Pandey, B. P. (2014). Modern Practical Botany Vol. II. S. Chand and Company Ltd., New Delhi.
14. Pandey, S. N and Trivedi, P. S. (2015). A text book of Botany Vol.I Vikas publishing House Pvt/ Ltd, New Delhi.
15. Rashid, A. (1998). An Introduction to Bryophyta. Vikas Publishing House, Pvt. Ltd., New Delhi. Watson, E. V. (2015). The structure and life of Bryophytes. Scientific Publication, Jodhpur, India.
16. Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
17. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
18. Vashishta, P.C., Sinha, A.K. and Kumar, A. (2010). Pteridophyta, S Chand and Company Ltd., Ramnagar, New Delhi, India.
19. Santra S.C. and Chatterjee (2005). College Botany Practical Vol. II New Central Book Agency Pvt. Ltd.

----------oooxxxooo-----

Major (Core) Mandatory DSC-6

BOT/DSC/T/201. (Title of Paper- PLANT ECOLOGY)

Total Credits: 2. Total Contact Hours: 30.

Examination Paper Code SAC03012013T Maximum Marks-50 (CIA-20 , SEE-30**)**

Learning Objectives of the course

i. Examine the fundamental principles governing plant-environment interactions across various ecosystems
ii. Analyze spatial and temporal patterns of plant distribution and abundance in relation to biotic and abiotic factors
iii. Evaluate plant physiological responses to environmental stressors and climate change
iv. Apply ecological theories to plant community structure, succession, and dynamics
v. Develop skills in experimental design and data analysis methods specific to plant ecological research

Course outcomes (COs):

After the successful completion of the module, the learner will be able to

i. Interpret complex ecological datasets to explain plant distribution patterns across different spatial scales
ii. Assess how plant functional traits influence community assembly, ecosystem processes, and evolutionary adaptations
iii. Design field-based research protocols to investigate plant-environment relationships
iv. Critically evaluate primary literature in plant ecology and synthesize current understanding of major ecological concepts
v. Predict potential impacts of global environmental change on plant communities and ecosystem functions.

Module No	Topic /actual content of the syllabus	Contact Hours
I	**Plant and environment:** Climatic factors – a) Light as an ecological factor, global radiation and photosynthetically active radiation Temperature as an ecological factor Water as an ecological factor, physicochemical properties of water. **Edaphic factor –** Soil formation -soil profile, physicochemical properties of soil, major soil types of India, soil erosion and soil conservation .	10
II	**Response of plants to water** Morphological, physiological and anatomical response of plants to water – hydrophytes, xerophytes, halophytes and epiphytes **Phytogeography:** Biogeographical regions of India, vegetation types of India	10
III	**Community ecology:** Community characteristics -frequency, density, life forms,biological spectrum **Ecosystem:**structure -biotic and abiotic components, food chain, food web, ecological pyramids, energy flow, biogeochemical cycles-nitrogen and phosphorus.	10

Reference Books

1. **Ernst-Detlef Schulze, Erwin Beck, and Klaus Müller-Hohenstein**- Plant Ecology" (Springer)
2. **Walter Larcher**- Physiological Plant Ecology" (Springer)
3. **Paul A. Keddy**- Plant Ecology: Origins, Processes, Consequences" (Cambridge University Press)
4. **Eddy van der Maarel and Janet Franklin**- Vegetation Ecology" (Wiley-Blackwell)
5. **Peter H. Raven, Ray F. Evert, and Susan E. Eichhorn**- The Biology of Plants" (W.H. Freeman)
6. **Hans Lambers, F. Stuart Chapin III, and Thijs L. Pons** -Plant Physiological Ecology" (Springer)
7. **Jonathan Silvertown and Deborah Charlesworth** -Introduction to Plant Population Biology" (Wiley-Blackwell)
8. **John G. White**- Plant Communities: Processes and Dynamics" (Brooks/Cole)
9. **Jessica Gurevitch, Samuel M. Scheiner, and Gordon A. Fox,** Ecology of Plants" (Sinauer Associates)
10. **Nishanta Rajakaruna, Robert S. Boyd, and Tanner B. Harris,** Plant Ecology and Evolution in Harsh Environments" (Nova Science Publishers)
11. **B.B. Hosetti and A. Kumar** Fundamentals of Ecology and Environment" (New Age International Publishers)
12. **P.D. Sharma**, Ecology and Environment (Rastogi Publications)
13. **J.S. Singh, S.P. Singh, and S.R. Gupta**, Ecology, Environmental Science and Conservation" (S. Chand Publishing)
14. **P.S. Verma and V.K. Agarwal**. Plant Ecology" (S. Chand Publishing)
15. **R.K. Kushwaha,** Fundamentals of Plant Ecology" (Dominant Publishers)
16. **V. Singh**, Economic Botany and Plant Ecology" (Rastogi Publications)
17. **R.F. Dastur,** Plant Ecology and Outlines of Environment Conservation" (Central Book Depot)
18. **P.D. Sharma and M. Sharma** "Ecology and Utilization of Plants" (Rastogi Publications)
19. **S.V.S. Rana** Essentials of Ecology and Environmental Science (PHI Learning)
20. **R.S. Ambasht** A Textbook of Plant Ecology" (CBS Publishers)

Major (Core) Mandatory DSC-7

BOT/DSC/P/226. (Title of Paper-DIVERSITY OF CRYPTOGAMS –II)

Total Credits: 2. Total Contact Hours: 60

Examination Paper Code SAC03012263P. Maximum Marks-50 (CIA-20 , SEE-30)

Learning Objectives of the course

i. To provide practical expertise in identifying and classifying cryptogamic specimens such as bryophytes, pteridophytes, and their allies.
ii. To gain proficiency with making and studying microscopic slides of cryptogamic structures.
iii. To familiarise pupils with the morphological and anatomical characteristics of several cryptogamic groupings.
iv. To provide students the necessary laboratory techniques for collecting, preserving, and documenting cryptogamic specimens.

Course outcomes (COs):

i. Identify members of bryophytes and pteridophytes using morphological and anatomical characteristics.
ii. Demonstrate proficiency in preparing temporary and permanent slides of cryptogamic structures.
iii. Compare reproductive structures of different cryptogamic groups and explain their evolutionary significance.
iv. Analyze and interpret the life cycles of representative cryptogamic species.
v. Document and maintain the record of cryptogamic diversity through field collection and laboratory observations.

Expt. No	Title of Experiment	Contact Hours
	Practical through temporary mounting, permanent slides, charts ,models, photograph and audio visuals aids.	
1	Study external features of Gametophyte and sporophyte, Anatomy of *Marchantia* using fresh or preserved specimens	
2	Study external features of Gametophyte and sporophyte, Anatomy of *Anthoceros* using fresh or preserved specimens	
3	Study external features of Gametophyte and sporophyte, Anatomy of *Funaria* using fresh or preserved specimens	
4	Study of the sporophytic structures of the following genera by preparation of temporary and permanent slides: *Psilotum*	
5	Study of the sporophytic structures of the following genera by preparation of temporary and permanent slides: *Lycopodium*	
5	Study of the sporophytic structures of the following genera by preparation of temporary and permanent slides: *Equisetum*	
6	Study of the sporophytic structures of the following genera by preparation of temporary and permanent slides: *Marsilea*	

Major (Core) Mandatory DSC-8

BOT/DSC/P/227. (Title of Paper-Plant Ecology)

Total Credits: 2. Total Contact Hours: 60

Examination Paper Code SAC03012273P. Maximum Marks-50 (CIA-20 , SEE-30)

Learning Objectives of the course

i. Demonstrate field techniques for measuring plant community composition using quadrat sampling, transects, and point-intercept methods.
ii. Apply ecological statistical analyses to quantify species diversity, abundance, and distribution patterns within plant communities.
iii. Conduct experiments investigating plant physiological responses to environmental variables such as light intensity, soil moisture, and nutrient availability.
iv. Interpret plant-environment interactions through analysis of adaptive morphological and physiological traits.
v. Design and execute an independent field-based research project addressing a specific ecological question about plant communities.

Course outcomes (COs):

i. Students will be able to collect, analyze, and interpret quantitative data on plant community structure and diversity using appropriate ecological metrics.
ii. Students will gain proficiency in identifying local flora and understanding their ecological roles within different ecosystem types.
iii. Students will develop technical skills in using field and laboratory equipment essential for plant ecological research (e.g., PAR sensors, soil moisture probes, spectrophotometers).
iv. Students will effectively communicate scientific findings through formal lab reports, data visualization, and presentations that adhere to ecological research standards.
v. Students will evaluate how anthropogenic factors influence plant communities and apply ecological principles to conservation and restoration planning.

Expt. No	Title of Experiment	Contact Hours
	Practical through temporary mounting, permanent slides, charts ,models, photograph and audio visuals aids.	
1	Study of morphological and anatomical adaptations in hydrophytes – *Hydrilla*, *Eichhornia*, *Typha* and *Nymphaea* .	
2	Study of morphological and anatomical adaptations in xerophytes -*Aloe,Nerium, Casuarina.*	
3	Study of morphological adaptations in halophytes -Pneumatophore,Stilt roots	
4	Study of morphological and anatomical adaptations in epiphytes	
5	Study of vegetation by quadrat method	
6	Determination of water holding capacity of different soils	
7	Study of meteorological instruments -Rain gauge, Hygrometer, Barometer	
8	Determination of percent leaf area injury of different infected leaf samples	
9	Estimation of salinity of different water samples	
10	Determination of pH of different soils bypH papers/universal indicator/pH eter.	

SUB/GE/OE/200T: (Title of Paper:- FUNDAMENTALS OF SOIL SCIENCE

Total Credits: 02 Total Contact Hours : 30 Hrs.

Examination Paper Code SCC03012003T Max Marks-50 (CIA-20 , SEE-30)

Learning Objectives of the Course:

i. Understand the fundamental concepts of soil formation and development
ii. Identify and describe physical and chemical properties of soil
iii. Comprehend soil classification systems and their applications
iv. Analyze basic soil fertility concepts and nutrient management principles

Course Outcomes (COs) :

After completion of the course, students will be able to –

i. Explain the processes of soil formation and development
ii. Evaluate physical and chemical properties of soils
iii. Interpret basic soil classification systems
iv. Assess soil fertility status and nutrient requirements
v. Apply soil science principles in agricultural and environmental contexts.

Module No.	Topics / actual contents of the syllabus	Contact Hours
Module -I	**Unit I: Basics of Soil Science** 1. Definition, composition of soil (mineral matter, organic matter, water, and air), and importance of soil 2. Soil formation: Weathering processes (physical, chemical, biological)and factors of soil formation, Functions of soil in ecosystems 3. Soil profile and Soil horizons and their characteristics 4. Physical properties of soil: Texture, structure, density, porosity, color, temperature, and consistency 5. Soil water: Forms, retention, movement, and moisture constants.	(10 Contact Hours)
Module -II	**UNIT II: Unit II: Soil Chemistry and Biology** 1. Soil reaction: pH, buffering, and its role in soil fertility 2. Soil colloids: Types, properties, and significance in nutrient retention . 3. Soil taxonomy , Major soil orders , Soil survey techniques , Soil mapping and interpretation 4. Cation exchange capacity (CEC) and anion exchange capacity (AEC) 5. Soil organic matter: Composition, decomposition, and its impact on soil properties **6.** Soil microbiology: Types of microorganisms, their role in decomposition, nitrogen fixation, and soil health.	(10 Contact Hours

Module-III	**Soil Fertility, Conservation, and Management** 1. Essential plant nutrients: Macronutrients and micronutrients, their roles, and deficiency symptoms 2. Soil fertility and productivity: Factors affecting soil fertility 3. Soil amendments: Lime, gypsum, and organic manures 4. Soil degradation: Causes and types (erosion, salinization, acidification, etc.) 5. Soil conservation techniques: Contour farming, terracing, mulching, and integrated soil fertility management **6.** Sustainable soil management practices, Soil health and quality indicators.	(10 Contact Hours

Reference Books

1. Brady, N.C. and Weil, R.R. (Latest Edition). The Nature and Properties of Soils. Pearson Education.
2. **Boul, S.W., Hole, F.D., & McCracken, R.J.** (2011). *Soil Genesis and Classification*. Wiley.
3. Das, D.K. (Latest Edition). Introductory Soil Science. Kalyani Publishers.
4. Dubey S.K- A textbook of Ecology,Dominant Publishers and Distributors, New Delhi
5. Foth, H.D. (Latest Edition). Fundamentals of Soil Science. John Wiley & Sons.
6. Hudson, N. (Latest Edition). Soil Conservation. B T Batsford Limited.
7. **Indian Society of Soil Science (ISSS)** (2002). *Fundamentals of Soil Science*. New Delhi.
8. **Miller, R.W., & Donahue, R.L.** (1995). *Soils: An Introduction to Soils and Plant Growth*. Prentice Hall.
9. **Piper C.**S., Srish Book Distributors, New Delhi
10. Tan, K.H. (Latest Edition). Principles of Soil Chemistry. CRC Press.
11. White, R.E. (Latest Edition). Principles and Practice of Soil Science. Blackwell Science.
12. **Tisdale, S.L., Nelson, W.L., Beaton, J.D., & Havlin, J.L.** (1993). *Soil Fertility and Fertilizers*. Macmillan.
13. Tandon H.L.S. -Fundamentals of Soil Science. Published by Indian Society of Soil Science, New Delhi.
14. Biswas T.D. and Mukherjee S.K. - A Textbook of Soil Science. Published by Tata McGraw Hill Education
15. Dr. Das D.K. - Soil Science: An Introduction. Published by Kalyani Publishers
16. Sharma V.K. - Fundamentals of Soil. Published by Kalyani Publishers
17. Negi S.S. - Soil Fertility and Nutrient Management. Published by Oxford & IBH Publishing

Reliable Websites and Online Resources:

1. Indian Society of Soil Science (ISSS) - http://www.isss-india.org
2. Indian Council of Agricultural Research (ICAR) - https://icar.gov.in
3. National Bureau of Soil Survey and Land Use Planning - https://www.nbsslup.in
4. Indian Agricultural Research Institute (IARI) - https://www.iari.res.in
5. State Agricultural Universities' websites (various states)
6. USDA Natural Resources Conservation Service Soils Website (soils.usda.gov) - Comprehensive resource with soil surveys and educational materials.

7. Food and Agriculture Organization Soils Portal (fao.org/soils-portal) - Global perspective on soils with extensive resources.
8. Soil Science Society of America (soils.org) - Professional organization with educational resources.
9. European Soil Data Centre (esdac.jrc.ec.europa.eu) - Excellent source for soil data and research
10. International Soil Reference and Information Centre (isric.org) - World Soil Information database

BOT/MN/201 (Title of Paper-ORGANIC FARMING)

Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SCC03012013T Max. Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To provide knowledge about basic concepts and principles related to organic farming.
ii. To study the scope, applications and needs of organic farming.
iii. To develop concepts of conventional farming and organic farming.
iv. To help students understand various organic farming practices in the national and international level.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. The course will address the ethical implications of organic farming, such as fair trade practices, social responsibility, and community involvement.
ii. Gain information about the impact of organic farming and indigenous practices on environment.
iii. Students will learn about marketing organic products, understanding consumer demand, and the economic aspects of organic farming.
iv. Students will gain a thorough understanding of the principles and philosophy behind organic farming, including the importance of sustainability, biodiversity, and ecological balance.
v. Learners will explore the significance of soil health in organic farming and various methods to enhance soil fertility through composting, cover cropping, and crop rotation.

module **No.**	**Content**	**Lectures (1 Hr.)**
I	**Organic Farming Introduction** a) Definition, History, Concept, Need (02) b) Principles, Aims and Objectives (02) c) Various Organic Farming Models (02) d) Organic Farming – Components (02) e) Characteristics of Good Organic Farmer, (02) f) Conventional vs Organic Farming (02) g) Organic Farming- Advantages and Disadvantages . h) Organic farming in World (01) i) Organic farming in India (01)	10
II	**Nutrient Management in Organic Farming** a) Nutrient Management in Organic Farming: Concept b) Organic Manures, Farm Yard Manure . c) Compost Process, Phases, Requirements, d) Microorganisms in composting e) Various Methods of Composting f) Vermicomposting Technology. g) Mulching. h) Green Manures . i) Bio fertilizers	10
III	**Organic Standards and Certification**	10

	a. National and international organic standards b. Organic certification process **Economics and Marketing of Organic Products** c. Cost-benefit analysis of organic farming d. Value addition of organic products e. Marketing strategies for organic produce f. Direct marketing and consumer relationships **Future of Organic Farming** g. Policy support and government schemes h. Research needs and directions i. Innovations in organic farming j. Climate change and organic agriculture	

Reference Books

1. Arun K. Sharma. 2002. A Hand book of organic farming. Agrobios, India. 627p.
2. Balasubramanian, R., Balakishnan, K and Siva Subramanian, K. 2013. Principles and practices of organic farming. Satish Serial Publishing House. 453p
3. Chhonkar, P.K. and Dwivedi, B.S. 2004. Organic farming and its implications on India's food security.Fertil. News 49(11): 15-18,21-28,31&38.
4. Coleman, E. (2018). The New Organic Grower. Chelsea Green Publishing
5. Dushyent Gehlot. 2005. Organic farming- standards, accreditation, certification and inspection. Agrobios, India. 357p.
6. Howard, A. (2010). An Agricultural Testament. Oxford University Press.
7. Lampkin, N. (2002). Organic Farming. Old Pond Publishing.
8. Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p.
9. Palaniappan, S.P and Annadurai, K.1999. Organic farming-Theory and Practice. Scientific publishers, Jodhpur,India. 257p.
10. Tarafdar, J.C., Tripathi, K.P and Mahesh Kumar, 2009. Organic agriculture. Scientific Publishers, India. 369p.

SUB/GE/OE/200T: (Title of Paper:-FRUIT PRESERVATION

Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SDC03012003T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To impart knowledge of basic ideas and processes of fruit preservation
ii. To educate students to several types of preservation methods.
iii. To create understanding about fruit preservation safety measures and quality control.
iv. To help students comprehend the business side of the fruit preservation sector
v. To help them gain hands-on experience with fundamental fruit preservation methods

Course Outcomes (COs) :

After completion of the course, students will be able to –

i. Explain various principles and methods of fruit preservation.
i) Explain various principles and methods of fruit preservation**.**
ii) Identify appropriate preservation techniques for different fruits**.**
iii) Understand quality standards and safety measures
iv) Apply knowledge of packaging and storage requirements
v) Evaluate preserved fruit products for quality parameters

Module No.	Topics / actual contents of the syllabus	Contact Hours
Module -I	1: **Introduction to Fruit Preservation** a. Understanding the fundamentals of fruit preservation b. The significance and scope of fruit preservation. c. Food preservation principles d. Causes of food rotting.	(10 Contact Hours)
	2. Pre-preservation operations **a.** Selection and grading of fruits b. Washing and sanitization c. Blanching and its significance d. Peeling and cutting techniques	
	3. Quality parameters a. Physical and chemical properties of fruits b. Ripening and maturity indices c. Storage conditions and shelf life	
Module -II	**UNIT II: PRESERVATION METHODS AND TECHNOLOGIES**	
	1. Traditional preservation methods a. Drying and dehydration b. Sugar-based preservation (jam, jelly, marmalade) c. Salt-based preservation	(10 Contact Hours)
	2. Modern preservation techniques a. Heat processing and pasteurization b. Cold preservation (refrigeration and freezing) c. Chemical preservation.	
	3. Packaging and storage a. Types of packaging materials b. Storage requirements, c. Quality control during storage	

Module-III	POST HARVEST TECHNOLOGY & ENTREPRENEURSHIP IN FRUIT	
	a. Maturity- Factors responsible for maturity & ripening methods used for delaying ripening. b. Harvest- Time of harvest, harvesting and handling of harvested Fruits c. Small-scale fruit preservation - Types of storage of fruits ,Fruit preservation technology. d. Marketing- grading, packing & transportation. Ways of increasing the market value and shelf life of fruits.. e. Horticultural business, management and Entrepreneurship development Horticulture as a business definition and nature, organization, planning and operation of fruit business.	(10 Contact Hours)

Reference Books

1. Srivastava, R.P. and Kumar, S. (2022). Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co.
2. Fellows, P.J. (2021). Food Processing Technology: Principles and Practice." Woodhead Publishing.
3. Joshi, V.K. (2019). Indigenous Fermented Foods of South Asia.CRC Press.
4. Dauthy, M.E. (2018). Fruit and Vegetable Processing. FAO Agricultural Services Bulletin.
5. Sharma, S.K. (2020). Food Processing and Preservation. New India Publishing Agency.
6. Girdhari Lal, G.S.Siddappa,& G.L.Tandon, Preservation of Fruits and Vegetables , Indian Council of Agricultural Research,
7. Verma, L. R., & Joshi, V. K. (2020). "Indigenous Technologies of Fruit Processing in India." Scientific Publishers India.
8. Mathur, P.B., & Srivastava, H.C."Handbook of Indigenous Methods of Fruit and Vegetable Preservation" (2012) Publisher: CFTRI Press
9. L.R. Verma & V.K. Joshi **"Fruit and Vegetable Preservation: Principles and Practices"** CBS Publishers & Distributors
10. L. R. Verma & V. K. Joshi, **"Postharvest Technology of Fruits and Vegetables"** Indus Publishing.
11. Chakraverty, Mujumdar, Vijaya Raghavan "Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices" Publisher: CRC Press

BOT/VSC/T/200: (Title of Paper:- MUSHROOM CULTIVATION
Total Credits : 01 Total Contact Hours : 15 Hrs
Examination Paper Code SEC03012003T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To make student aware about the mushroom growing techniques,
ii. Appreciation of medicinal and nutritional values,
iii. Economic importance of mushrooms and economical and marketing aspects of mushroom cultivation.

Course Outcomes (COs) :

After completion of the course, students will be able to –

i. Identify various types and categories of mushrooms.
ii. Demonstrate various types of mushroom cultivating technologies.
iii. Value the economic factors associated with mushroom cultivation
iv. Device new methods and strategies to contribute to mushroom production

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.	
II	Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.	
III	Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours), Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins. Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.	

Reference Books: -

1. Swaminathan M. (1990) Food and Nutrition. Bengaluru. The Bangalore Printing and Publishing Co. Ltd.
2. Tewari, Pankaj Kapoor S. C. (1988) Mushroom Cultivation. New Delhi: Mittal Publication
3. Biswas, Subrata, Datta, M., Ngachan S. V. (2012) Mushrooms: A Manual for Cultivation New Delhi: PHI Learning Private Limited.
4. Tripathi, D. P. (2005) Mushroom Cultivation. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.
5. Kannaiyan, S. & Ramasamy, K. (1980) A Handbook of Edible Mushrooms New Delhi: Today & Tomorrow Printers & Publishers 1980.

BOT/VSC/P/226: (Title of Paper:- MUSHROOM CULTIVATION

Total Credits : 01 Total Contact Hours : 30 Hrs

Examination Paper Code SEC03012263P. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. Introduce students to the fundamentals of mushroom cultivation.
ii. Provide hands-on training in mushroom cultivation techniques**.**
iii. Develop skills in identifying edible and non-edible mushrooms **.**
iv. Explore the economic and nutritional significance of mushrooms**.**
v. Encourage sustainable and eco-friendly mushroom production

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Gain practical knowledge of mushroom cultivation techniques **.**
ii. Develop skills in spawn production and maintenance**.**
iii. Differentiate between edible, poisonous, and medicinal mushrooms.
iv. Understand the commercial and entrepreneurial aspects of mushroom farming.
v. Contribute to sustainable agriculture by utilizing organic waste for mushroom cultivation**.**

Experiment	Title of Experiment
	Mushroom Cultivation, Laboratory requirements and layout.
1	Mushroom morphology- L.S. of Basidiocarp, (Button Mushroom) Section through Gills and Mounting of Spores.
2	Preparation of Culture Medium
3	Preparation of Spawn for Oyster Mushroom
4	Cultivation of Oyster Mushroom
5	Mushroom preservation Techniques
6	Visit to relevant farm or Institute

BOT/VSC/T/201: (Title of Paper:- BIOMASS MANAGEMENT

Total Credits : 01 Total Contact Hours : 15 Hrs

Examination Paper Code SEC03012013T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. Biomass resources. Type of biomass and its recalcitrant
ii. Biomass sample preparation, methods of pre-treatments and characterization
iii. Analyzing the biochemical and ultimate properties of biomass
iv. Methods of biomass management and energy conversion process.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Develop knowledge in properties of biomass and energy conversion process.
ii. To be able to understand and perform the various characterization techniques of fuels.
iii. To be able to identify available nonconventional (renewable) energy resources and techniques to utilize them effectively.
iv. The students will be able to set up biomass conversation plant.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**BIOMASS & BIOMASS MANAGEMENT:** 1. Biomass availability, Characteristics of Biomass or organic wastes, Energy Plantation. Waste Biomass /Organic utilization Technology options. Potential, Process and technologies, characteristics of Briquettes and their use 2. Introduction to biomass management, biomass resource assessment management techniques/supply chains etc. 3. Bailing-classification, uses; residue management for surface mulch and soil incorporation 4. Preparation and storage of Silage as animal feed.	10
II	**PROCESSING OF BIOMASS FOR MANAGEMENT:** 1. Processing of paddy straw, densification- Extrusion process, pellets, mills and cubers etc. 2. Paddy Straw choppers and spreaders as an attachment to combine Harvester, 3. Mulch seeder, Paddy Straw Chopper-cum-Loader, Balar for collection of straw; 4. Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, 5. Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.	

III	**BIOMASS CONVERSION TECHNOLOGIES** A. **Thermochemical Conversion** 1. Combustion systems and applications 2. Gasification process and technologies 3. Pyrolysis methods and products B. **Biochemical Conversion** 1. Anaerobic digestion principles 2. Fermentation processes 3. Biogas production and utilization C. **Physical-Chemical Conversion** 1. Extraction methods 2. Mechanical processes **3.** Densification techniques (pelletization, briquetting)	

Reference: -

- Anju Dahiya, "Bioenergy : Biomass to Biofuels", 2014, Academic press, Elsevier Publication.
- Braden Allenby Biomass Management Systems ,
- Capareda S, Introduction to biomass energy conversion, CRC Press. ISBN: 978-1-466-51333-4
- Davis, CA Biomass Resource Assessment California Biomass Collaborative Biological & Agricultural Engineering University of California, 1 Shields Avenue, 95616- 5924
- D. P. Kothari, K.C Singal and Rakesh Ranjan "Renewable Energy Sources And Emerging Technologies", 2011, PHI Learning Private Ltd, New Delhi.
- Erik Dahlquist, "Biomass as Energy Source: Resources, systems and applications", Sustainable Energy Developments series, 2012, CRC Press, Taylor and Francis Group.

Kepner R.A., Bainer Roy & Barger E.L., Principles of Farm Machinery, 3rd Edition.

BOT/VSC/P/227: (Title of Paper:- BIOMASS MANAGEMENT

Total Credits : 01 Total Contact Hours : 30 Hrs

Examination Paper Code SEC03012273P. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To understand the concept of biomass and its significance in sustainable resource management.
ii. To study different sources of biomass including agricultural, industrial, and urban waste.
iii. To learn various biomass conversion techniques such as composting, biogas production, and biofuel generation.
iv. To analyze the impact of biomass utilization on environmental sustainability and energy production.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Gain knowledge about biomass resources and their role in energy production and waste management.
ii. Demonstrate proficiency in biomass conversion techniques like bio-composting, briquetting, and biogas production.
iii. Analyze the environmental benefits and challenges associated with biomass utilization.
iv. Apply scientific principles to design and implement biomass management projects for sustainable development.

Expt. no	Title of Experiment
1	Familiarization with different straw management techniques
2	On-farm and off-farm uses of straw
3	Collection, loading and transport equipment for unbruised loose straw
4	Briquetting machine and preparation of briquettes
5	Straw baler and making of bales in the field
6	Straw/ fodder chopping machines
7	Straw/ mulching & incorporating machinery
8	Machinery requirement for baling forage crops for silage

Structure of B. Sc. (Three/Four Years Honours/Honours with Research Degree) Program with Multiple Entry and Exit Options
B. Sc. Second Year: 4th Semester Subject: Botany

Course Type	Course Code	Course Name	Course	Teaching Scheme (Hours/Week)		Credits assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	BOT/DSC/T/250	SAC03012504T	Gymnosperms and Paleobotany	2		2		2+2+2+2 = 08
	BOT/DSC/T/251	SAC03012514T	Plant Physiology	2		2		
	BOT/DSC/P/276	SAC03012764P	Gymnosperms and Paleobotany		4		2	
	BOT/DSC/P/277	SAC03012774P	Plant Physiology		4		2	
Minor Course (Choose any two from pool of courses). It is from different discipline of the same faculty	BOT/Mn/T/250	SCC03012504T	Medicinal Plants	2		2		2+2 = 04
	BOT/Mn/T/251	SCC03012514T	Landscape Gardening	2		2		
Generic/ Open Elective (GE/OE) (Choose any one from pool of courses) It should be chosen compulsorily from the faculty other than that of Major)	BOT/ GE/OE/ T/250	SDC03012504T	Herbal Cosmetics	2		2		02
SEC (Skill Enhancement Courses) (Choose any one from BOT/SEC/T/250 & BOT/SEC/T/ 251 and corresponding Practicals	BOT/SEC/T/250	SEC03012504T	Herbarium Techniques and Plant Preservation	1		1		1+1 = 02
	BOT/SEC/T/251	SEC03012514T	Vertical Farming	1		1		
	BOT/VSC/P/276	SEC03012764P	Herbarium Techniques and Plant Preservation		2		1	
	BOT/VSC/P/277	SEC03012774P	Vertical Farming		2		1	
AEC/VEC/IKS	SUB/AEC/T/250		Modern Indian Languages (MIL-2) (Choose any one from pool of Language courses)	2		2		02
OJT/FP/CEP/CC/RP	BOT/FP/P/276		Field Project		4		2	2+2 = 04
	SUB/CC/P/277		Fine/ Applied/ Visual/ Performing Arts (Common for all the Faculty)		4		2	
				13	18	13	09	22

Exit Option: Award of UG Diploma in major and minor with 88 credits and an additional 4 credits NSQF course (related to major / minor) / Internship during summer vacation OR Continue with Major and Minor

Minor Courses Designed for other Discipline of the same Faculty

- SUB/Mn/T/ 250: Medicinal Plants (SCC03062504T)
- SUB/Mn/T/ 251: Landscape Gardening (SCC03062514T)

Generic /Open Elective Courses for other faculty

- SUB/GE/OE/T/250: Herbal Cosmetics (SDC03062504T

Major (Core) Mandatory DSC-9

BOT/DSC/T/250 : (Title of Paper:- GYMNOSERMS AND PALEOBOTANY
Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SAC03012504T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To provide students with a comprehensive understanding of Gymnosperm diversity, morphology, anatomy, and reproductive biology.
ii. To explore the evolutionary relationships between Gymnosperms and other plant groups, highlighting their significance as an evolutionary link between lower and higher plants.
iii. To introduce students to the principles and applications of Paleobotany, including fossil plant identification, preservation techniques, and paleoenvironmental reconstruction.
iv. To develop critical thinking skills through comparative analysis of extinct and extant plant groups, with special emphasis on Gymnosperms.
v. To equip students with practical skills in specimen collection, identification, and documentation of Gymnosperm taxa and fossil plant material.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Identify and classify major Gymnosperm groups based on their distinctive morphological, anatomical, and reproductive features.
ii. Explain the evolutionary significance of Gymnosperms and interpret their phylogenetic relationships with other plant groups.
iii. Analyze and describe fossil plant specimens using appropriate terminology and techniques, relating them to extant taxa.
iv. Apply paleobotanical principles to reconstruct past environments and understand plant evolution through geological time.
v. Demonstrate proficiency in laboratory and field techniques related to Gymnosperm and fossil plant studies, including preparation, preservation, and documentation of specimens.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**1.** General characters and economic importance of gymnosperms **2.** Distinction between Gymnosperms and Angiosperms **3.** Outline classification of Gymnosperms ((Stewart 1982), **4.** Evolutionary trends in Gymnosperms alternation of generations. **5.** Geological time scale (brief overview in context of Gymnosperm evolution)	
II	Detailed study of the following genera 1. Study of the habit, habitat, distribution, anatomy, reproduction, and life cycles of *Cycas* and *Pinus* 2, Study of the habit, habitat, distribution, anatomy, reproduction, and life cycles in *Ginkgo* and *Gnetum* Economic importance of Gymnosperms - food, timber, industrial uses, and medicines	5
III	Pleobotany	

	1. Geological Time Scale: Outline of Eras, periods and epochs; Major events in the Geological time scale. 2. Types of Fossilization: Compression, Impression, Incrustation, Petrifaction and Compaction 3. Study of following Fossil forms w. r. t. morphology and structure– 4. Pteridophyta: *Rhynia, Lepidodendron, Stigmaria*, and *Lepidocarpon* 5. Gymnosperms: *Williamsonia* 6. Contribution of Birbal Sahani in Paleobotany	

.----xx-----

Major (Core) Mandatory DSC-10

BOT/DSC/T/250 : (Title of Paper:- PLANT PHYSIOLOGY
Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SAC03012504T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. Understand the fundamental principles of water relations, including water potential, osmosis, and transpiration in plants.
ii. Explain the mechanisms of nutrient uptake, translocation, and utilization, with emphasis on essential macro and micronutrients.
iii. Analyze the biochemical pathways involved in photosynthesis, including light-dependent reactions, Calvin cycle, and photorespiration.
iv. Describe plant hormone functions, signaling pathways, and their roles in growth, development, and stress responses.
v. Examine how plants sense and respond to environmental stresses, including drought, salinity, temperature extremes, and pathogens.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Apply concepts of plant water relations to explain phenomena such as wilting, stomatal regulation, and drought adaptation strategies.
ii. Evaluate plant nutritional status and diagnose nutrient deficiency symptoms based on physiological knowledge.
iii. Interpret experimental data from physiological studies on photosynthesis, respiration, and carbon allocation patterns.
iv. Predict plant growth and developmental responses to various hormonal treatments and environmental conditions.
v. Design strategies to enhance plant productivity and stress tolerance based on physiological principles.

Module No.	Topics / actual contents of the syllabus
I	**Plant water relations:** a.Diffusion, osmosis, plasmolysis and imbibition b.Water absorption and ascent of sap(Transpiration pull theory) c.Transpiration – Definition, types -cuticular, lenticular and stomatal, structure of stomata, mechanism of opening and closing of stomata (starch – sugar hypothesis) **Mineral nutrition:** Macro and microelements: roles and deficiency symptoms of N, P, K, Mg, Ca, Fe, Zn, Bo, Mo.Mineral uptake – passive (ion exchange theory) and active (carrier concept) **Translocation of solutes:** Mass flow hypothesis, protoplasmic streaming theory, Source and sink relationship
II	**Enzymes ::** Chemical nature – holoenzyme ,apoenzyme, prosthetic group, cofactor and coenzyme, properties , nomenclature, classification based on type of reactions, mechanism of enzyme action **Growth**:Definition, Phases of Growth, Sigmoid growth curve.

	Growth regulators: Discovery, stucture, roles and practical applications of Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene
III	**1. Photosynthesis:** Definition, ultra structure of chloroplast, photosynthetic pigments,Light reactions -Hill reaction, red drop and Emerson enhancement effect, two pigment systems (PS I, PS II), photophosphorylation – cyclic and noncyclic, Z-scheme; Dark reactions -C3, C4 and CAM pathways. **2. Respiration:** Definition, Ultra structure of mitochondria, types of respiration, Glycolysis, TCA Cycle, Electron transport system, alcoholic and lactic acid fermentation

Reference Books

1. **Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus- Plant Physiology and Development** (Sinauer Associates/Oxford University Press)
2. **Frank B. Salisbury and Cleon W. Ross- Plant Physiology** (Wadsworth Publishing)
3. **William G. Hopkins and Norman P.A. Hüner** Introduction to Plant Physiology (Wiley)
4. **by Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones -**Biochemistry and Molecular Biology of Plants (Wiley-Blackwell)
5. **Hans Lambers, F. Stuart Chapin III, and Thijs L. Pons -**Plant Physiological Ecology **(Springer)**
6. **Horst Marschner -**Mineral Nutrition of Higher Plants (Academic Press)
7. **Alastair H. Fitter and Robert K.M. Hay-** Environmental Physiology of Plants (Academic Press)
8. **N.K. Fageria, V.C. Baligar, and R.B. Clark- Physiology of Crop Production** (CRC Press)
9. **Robert W. Pearcy, James R. Ehleringer, Harold A. Mooney, and Philip W. Rundel Plant Physiological Ecology: Field Methods and Instrumentation** (Springer)
10. **David W. Lawlor Photosynthesis** (Garland Science).
11. **Dr. V.K. Jain** -Plant Physiology" (S. Chand Publications)
12. **Dr. Verma and Dr. Mohit Verma** Text Book of Plant Physiology" (S. Chand Publications)
13. **Dr. S.N. Pandey and Dr. B.K. Sinha** Plant Physiology" (Vikas Publishing House)
14. **Dr. V. Verma-** Fundamentals of Plant Physiology" (Ane Books)
15. **Dr. Renu Kathpalia and Dr. Sheela Sharma** Plant Physiology" (Rastogi Publications)
16. Dr. **S.K. Verma** Introduction to Plant Physiology" (Narosa Publishing House)
17. **Dr. R.K. Sinha** Modern Plant Physiology" (Narosa Publishing House)

Major (Core) Mandatory DSC-11

BOT/DSC/P/276: (Title of Paper:- GYMNOSPERMS AND PALEOBOTANY

Total Credits : 02 Total Contact Hours : 60 Hrs

Examination Paper Code SAC03012764P. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To provide hands-on experience with various gymnosperm specimens, enabling students to identify and classify major gymnosperm groups based on morphological and anatomical features.
ii. To develop skills in preparing, staining, and examining microscopic slides of gymnosperm reproductive structures and vegetative anatomy.
iii. To familiarize students with fossil plant identification techniques and the study of plant impressions, compressions, petrifactions, and casts.
iv. To enhance understanding of evolutionary relationships between extinct and extant plant groups through comparative analysis of living gymnosperms and fossil specimens.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Identify and classify major gymnosperm taxa (Cycadales, Ginkgoales, Coniferales, Gnetales) based on their vegetative and reproductive structures.
ii. Demonstrate proficiency in preparing and analyzing microscopic sections of gymnosperm tissues and interpreting their anatomical significance.
iii. Apply paleobotanical techniques to identify, describe, and classify fossil plant specimens from different geological eras.
iv. Explain the evolutionary significance of key morphological and anatomical features in gymnosperms and their fossil ancestors.

Expt. no	Title of Experiment
1	**Study of *Cycas*** w. r. t a) Habit, b) Young Leafs c) Bulbils, d) Male Cone, e) Microsporophyll, f) Megasporophyll, g) Pollen grains, h) Mature Seeds.
2	Study Through Permanent Slides: Normal Root (T.S.), Stem (T.S.), Ovule (L.S.)
3	Study Through Hand Section: Coralloid Root (T.S.), Rachis (T.S.), Leaflet (T.S.)
4	**Study of *Pinus*** w. r. t. a) Systematic Position b) External morphology c) Internal morphology i) T. S. of stem ii) T. S. of Needle d) Male cone i) Morphology (Specimen) ii) L. S. of male cone (P. S.) iii) Microsporophyll (Specimen/P. S.) iv) Mounting of pollen grains e) Female cone i) Morphology (Specimen) ii) L. S. of female cone (P. S.) iii) Megasporophyll (Specimen/P. S.) iv) V. S. of mature ovule (P. S.)
5	**Study of *Gnetum*** w. r. t. a) Systematic Position b) External morphology c) Internal morphology: i) T. S. of stem ii) T. S. of leaf iii) Secondary growth in the stem of *G. ula* (P. S.) d) Morphology of male cone (Specimen) e) Female cone i)

	Morphology (Specimen) ii) V. S. of mature ovule (P. S.)
6	**Paleobotany**: - Study of the following with the help of specimens/permanent slides i) *Rhynia* ii) *Lepidodendron*, iii) *Stigmaria* iv) *Lepidocarpon* v) *Williamsonia*

Reference Books: -

1 H. C. Ganguly and A.K. Kar 1999, College Botany. Vol. 2, NCBA
2 Chopra, G. L. (1962). Introduction to Gymnosperms. Asia Pub. House, New Delhi. India
3 S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., E-28, Sector- 8, Noida-201301 (U. P.) India.
4 A. C. Dutta, (1963), Botany for degree students (Revised edition) Oxford University Press, New Delhi 110002, India.
5 Datta, S. C. (1966). Introduction to Gymnosperms. Asia Pub. House, New Delhi, India
6 P. C. Vashishta, (1990), Botany for degree students, gymnosperms, Vol. V, S. Chand and Company Ltd., Ram Nagar, New Delhi- 110 055.
7 S. N. Pandey, S. P. Misra, P. C. Trivedi (2016), A text book of botany, Vol. II (thirteenth Edition), Vikas Publishing House Pvt. Ltd., Noida-201301 (U. P.) India.
8 V. Singh, P. C. Pandey D. K. Jain, 2016 Text Book of Botany, Rastogi Publications, GangotriShivaji Road, Meerut, 250002.
9 Biswas C, Johri B.M (1997). Pentoxylales. In: The Gymnosperms. Springer, Berilin, Heidelberg. • Osborn J M, Taylor T N, Crane P R (1991).
10 Singh V P. (2006). Gymnosperm (naked seeds plant): structure and development. Sarup& sons.
11 S. P. Bhatnagar and Alok Moita, 1996, Gymnosperms. New age international publications, New Delhi.
12 Vashishta P. C., 1996, Gymnosperms. S. Chand & Company Ltd. New Delhi.
13 Kumar A. 2006, Botany for Degree Students Gymnosperm. S. Chand Company Ltd. New Delhi.
14 Sporne, K. R. (1967). Morphology of Gymnosperms. Hutchinson university library London, U. K.
15 Delevoryas, T. (1962). Morphology and Evolution of fossil plants. Holt Reihart &Winston, New York.
16 Mishra, S. R. (2010). Text Book of Paleobotany. Discovery Publication House Pvt. Ltd
17 https://en.wikipedia.org/wiki/Ginkgo_biloba
18 https://www.britannica.com/plant/Gnetum

Major (Core) Mandatory DSC-12

BOT/DSC/T/277 : (Title of Paper:- PLANT PHYOSIOLOGY
Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SAC03012774T Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. Demonstrate proficiency in experimental techniques for measuring plant physiological processes such as photosynthesis, respiration, and transpiration.
ii. Apply analytical methods to quantify plant hormones, metabolites, and nutrients in plant tissues.
iii. Design and conduct experiments to investigate plant responses to environmental stressors (drought, salinity, temperature).
iv. Interpret experimental data using statistical analysis and scientific reasoning to draw valid conclusions about plant physiological processes.
v. Develop technical skills in using laboratory equipment specific to plant physiology research, including spectrophotometers, gas analyzers, and microscopy techniques.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Students will be able to independently design, execute, and troubleshoot experiments related to key plant physiological processes.
ii. Students will demonstrate competence in data collection, analysis, and presentation of results in scientific report format.
iii. Students will explain the physiological mechanisms underlying plant growth, development, and adaptation to changing environmental conditions.
iv. Students will critically evaluate scientific literature in plant physiology and apply this knowledge to their own experimental work.
v. Students will collaborate effectively in teams to conduct complex experiments and communicate findings through oral presentations and written reports.

Expt. Name	Name of Experiment
1	Osmosis by egg membrane and potato osmoscope.
2	Plasmolysis in *Tradescantia* leaves
3	Effect of different conc. of organic solvents on membrane permeability
4	Determination of water potential of any tuber
5	Detection of mineral elements in plant ash.
6	Digestion of starch by amylase
7	Detection of enzyme activity : oxidase, peroxidase, catalase and dehydrogenase
8	Separation of chloroplast pigments by paper chromatography
9	Demonstration of Hill reaction
10	Effect of different intensities of light on photosynthesis
11	Effect of different colors of light on photosynthesis
12	Fermentation by Kuhnes fermentation vessel
13	Isolation of starch
14	Isolation of pectin
15	Estimation of total and reducing sugars in fruit juice by Fehling solution.
16	Separation of amino acids by paper chromatography
17	Effect of IAA and Gibberellins on seed germination

BOT/MN/T/250: (Title of Paper:- MEDICINAL LANTS

Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SCC03012504T . Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To enrich the knowledge of students regarding classification of drugs.
ii. To train the students regarding identification, active principles, properties and uses of Medicinal plants
iii. To train the students regarding utilization of these medicinal plants in their common diseases and disorders.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Classify the drug plants
ii. Identify the medicinal plants, know the active principles, properties and uses of medicinal plants.
iii. Utilize the medicinal plants as home remedy against the common diseases and disorders.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**1. Classification of Drug Plants based on** a) Organ of plants and b) Properties 2. **Morphology, Phytochemistry, properties and uses of Root Drugs**: a)Ashwagandha- *Withania somnifera,* b) Shatavari- *Asparagus racemosus*, c) Safed Musli – *Chlorophytum borivilianum* **3. Morphology, Phytochemistry, properties and uses of: Rhizome Drugs:** a) Ginger – *Zingiber officinale*, b) Turmeric – *Curcuma longa* c) Vacha – *Acorus calamus* **4. Morphology, Phytochemistry, properties and uses of Bark Drugs:** a) Arjun – *Terminalia arjuna*, b) Varun – *Crateva adansonii* c) Acacia – *Acacia nilotica*, d) Neem – *Azadirachta indica* **5. Morphology, Phytochemistry, properties and uses of Leaf Drugs:** a) Adulsa – *Justicea adhatoda*, b) Kumari – *Aloe vera* c) Kalanchoe – *Bryophyllum pinnatum,* d) Tridex – *Tridex procumbens*	10
II	**1. Morphology, Phytochemistry, properties and uses of Wood drugs:** a) Sandle – *Santalum album,* b) Bija – *Pterocarpus marsupium* c) Red Sandle wood – *Pterocarpus santalinus* **2. Morphology, Phytochemistry, properties and uses of Fruit Drugs:** a) Indian goose berry – *Phyllanthus emblica,* b) Belliric myrobalan – *Terminalia bellirica* c) Chebulic myrobalan – *Terminalia chebula* d) Wood apple – *Aegle marmelos* **3. Morphology, Phytochemistry, properties and uses of Seed Drugs**: a) Almond – *Prunus amygdalus,* b) Marking nut – *Semecarpus anacardium,* c) Cashew – *Anacardium occidentale* d) Jyotishmati – *Celastrus paniculatus* **4. Morphology, Phytochemistry, properties and uses of Flower Drugs:** a) Clove – *Syzygium aromaticum,* b) Saffron – *Crocus sativus* **5. Morphology, Phytochemistry, properties and uses of Entire Plant Drugs**:	10

	a) Holy Basil – *Ocimum tenuiflorum*, b) Mahabhringraj – *Eclipta alba*, c) Amruta – *Tinospora cordifolia.*	
III	**Conservation, Cultivation And Commercial Aspects** 1. **Conservation Strategies** a. Threats to medicinal plant biodiversity b. In-situ and ex-situ conservation methods c. Role of botanical gardens and germplasm banks 2. **Cultivation and Propagation** a. Agronomic practices for important medicinal plants b. Organic cultivation methods c. Propagation techniques (conventional and biotechnological) d. Good Agricultural and Collection Practices (GACP) 3. **Processing and Quality Control** a. Post-harvest technologies b. Storage and processing methods c. Quality control parameters and standardization d. Good Manufacturing Practices (GMP) 4. **Commercial and Regulatory Aspects** a. Global trade in medicinal plants b. Intellectual property rights and traditional knowledge c. Regulatory frameworks and certification **d.** Sustainable utilization and ethical sourcing.	

Suggested Reading:

1. Daniel M. 2006, Medicinal Plants: Chemistry and Properties, Science Publisher, Enfield
2. Namrita Lall,2017, Medicinal Plants for Holestic Health and Well-being, Elsevier Science
3. Joshi M. C. 2019, Handbook of Indian Medicinal Plants, Scientific Publisher Jodhpur
4. Dhar Priti and Durga Nath Dhar, 2019, Medicinal Plants of India, World Scientific Publisher, Singapore.
5. Trivedi P. C. 2006, Medicinal Plants Traditional uses, I K International Pvt. Ltd. New Delhi
6. Shahid Akbar, 2020, Handbook of 200 Medicinal Plants, Springer
7. Rajapati Narayan Das, S. S. Purohit, Arun K. Sharma and Tarun Kumar, 2010, A Handbookof Medicinal Plants, A complete source book, Agribios India, Jodhpur.
8. Shivrajan V. V. and Indira Balchandran, 1994, Ayurvedic Drugs and Their Plant Sources, Oxford and IBH ublishing Co. Pvt. Ltd. New Delhi.
9. Amsar Private Limited, 1998, Natural Plant roducts, A Practical Guide, Amsar Private Limited, Indore.
10. Desai Waman Ganesh, 1927, Aushadhi Sangrah, Hindusthanatil Aushadhi Vanaspatinchi Olakh, tyanche Gundharm va Upyog, Rajesh rakashan, Pune

BOT/MN/T/251: (Title of Paper:- LANDSCAE GARDENING

Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SCC03012514T. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

The program is aimed to teach students the basic knowledge required to develop entrepreneurship skills in the development of Landscaping and Gardening.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Describe and differentiate between the types of Gardens.
ii. Practice different methods for propagation of plants.
iii. Execute several nursery and gardening operations.
iv. Assess growing conditions of different horticultural plants, their general requirements and understand their role in landscaping.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Early history, principles and elements of Landscape design, gardening, designing landscapes, basic style, formal – informal, Prospect of landscaping, Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens. Colour wheel.	10
II	Garden plant components- lawn, arches and pergolas, edges and hedges, arboretum, shrubbery, fernery, palmatum, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpetbeds, bamboo groves. Non-plant components. Special types of gardens-vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, temple garden, sacred groves. Management of light, humidity, watering, maintenance of pot plants and indoor plants.	10
III	Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates. Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, water scaping, xeriscaping, hardscaping. Principles and Elements of Landscape Designs, Garden Elements And Designs, Propagation of Ornamental plants. Graphics And Symbols in Landscape Gardening Tools and Implements used in Land Scape Design, Layout of different styles of Gardens, Layout of Special types of Gardens, Layout of Rock Garden and Gravel Garden, Roof Gardening, Paved Garden, Landscaping of Places of Public Importance, Gardening of Public Places, Desinging of Greenhouses, Conservatory And Lathe House.	10

Suggested Readings:

6. Ahern J. Greenways as a planning strategy. Landscape and Urban Planning. 1995; 33.1: 131–155.

7. Andersson E. Urban Landscapes and Sustainable Cities. Ecology and Society. 2006; 11.1: 34. [Internet]. Available from: http://www.ecologyandsociety.org/vol11/iss1/art34/ [accessed: 2016-01-14]

8. Anonymous (2008). Green roofs for healthy cities: Introduction to green walls technology. http://www.greenscreen.com/Resources/download_it/IntroductionGreenWalls.pdf.2. Anonymous (2013). Retrieved from http://wwwgreenology.sg/2011/11/benefits-of-vertical-greening-a-discussion.3.

9. Dikey Bahçeler ve Kent Ekolojisi, Türk Bilimsel Derlemeler Dergisi, 6(1): 1308-0040.5.

10. Farina A. Principles and Methods of Landscape Ecology. 2nd ed. Dordrecht, Netherlands: Springer. 2006. 412p.

11. Gaston K.J., Warren P.H., Thompson K., Smith R.M. Urban domestic gardens (IV): the extent of the resource and its associated features. Biodiversity and Conservation. 2005; 14: 3327–3349.

12. Gonchar, J. (2009). Vertical and verdant, living wall systems sprout on two buildings, in Paris and Vancouver, Architectural Record, McGrew HillConstruction.http://archrecord.construction.com/features/digital/archives/0702dignews-1.asp.

13. Howard E. Garden Cities of To-Morrow. London: S. Sonnenschein & Co., Ltd. 1902. 195p.

14. Johnston, J. and Newton, J. (2004). Building Green "A guide to using plants on roofs, walls and pavements", Greater London Authority. London.

15. Selman P. Planning at the Landscape Scale. Oxon: Routledge. 2006. 225p.

16. Sharp, R. (2007). "6 Things You Need to Know About Green Walls", Building Design and Construction, BD & C News, Retrieved fromhttp://www.bdcnetwork.com/article/CA6459410.html.

17. Thompson, J. W. and Sorving, K. (2000). Sustainable Landscape Construction, AGuide to Green Building Outdoors. Island Press, Washington D.C.

18. Wolf, K. L. (2002). Retail and Urban Nature: Creating a Consumer Habitat", at the People/Plant Symposium, Amsterdam.http://www.plantsinbuildings.com/whyplants.php?PHPSESSID=e653e7b957ce5bc2b6f.

19. Wong, N. H.; Tan, A. Y.; Tan, P. Y.; Chiang, K. and Wong, N. C. (2010). AcousticsEvolution of Vertical Greenery Systems for Building Walls. Building andEnvironment, 45.

20. Yeh, Y. P. (2012). Green Wall Creative Solution in Response to the Urban HeatIsland Effect. Report of National Chung-Hsing University. *(PDF) Vertical Garden : New form of gardening*. Available from: https://www.researchgate.net/publication/384056070_Vertical_Garden_New_form_of_gardening

BOT/GE/OE/T/250: (Title of Paper:- HERBAL COSMETICS

Total Credits : 02 Total Contact Hours : 30 Hrs

Examination Paper Code SCC03012504T. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To enrich the knowledge of students regarding Indian Herbs used as Cosmetics
ii. To train the students regarding identification, active principles, properties and uses of Indian Herbs used as Cosmetics
iii. To train the students regarding preparation and utilization of these Herbal Home Cosmetics

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Know the Indian Herbs used as Cosmetics
ii. Identify the Indian Herbs; know their active principles, properties and uses.
iii. Prepare and utilize the Herbal Home Cosmetics.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Introduction to Herbal Cosmetics** 1. History and Evolution of Herbal Cosmetics 2. Advantages of Herbal Cosmetics over Synthetic Cosmetics 3. Basic Principles of Cosmetic Formulation 4. Classification of Herbal Cosmetic Products 5. Important Medicinal Plants Used in Cosmetics 6. Extraction Methods for Cosmetic Ingredients 7. Introduction to Ayurvedic Cosmetics	
II	Definition of Cosmetics, Classification of Cosmetics, Cosmetics for Skin: Botany, Phytochemistry, properties and usage of following herbs: a. Turmeric – *Curcuma longa* L. b. Spiked Ginger Lily – *Hedychium spicatum* Sm. c. Kachur – *Curcuma zedoaria* (Christm.) Roscoe, d. Mango ginger – *Curcuma amara* Roxb. e. Nutmeg – *Myristica fragrance* Houtt. f. Nut grass – *Cyperus rotundus* L. g. Sandle wood – *Santalum album* L. h. Red Sandle – *Pterocarpus santalinus* L. f. i. Orange peel – *Citrus* x *sinensis* (L.) Osbeck j. Arjun bark – *Terminalia arjuna* Wt. & Arn. k. Kumari – *Aloe vera* Mill. l. Neem – *Azadirachta Indica* A. Juss m. Cucumber – *Cucumis sativus* L. n. Rose – *Rosa indica* L. o. Lotus – *Nelumbo nucifera* Gaertn.	
II	Cosmetics for Hair: Botany, Phytochemistry, properties and usage of following herbs: a. Shikakai – *Acacia concinna* Wall.	

	b. Indian goose berry – *Phyllanthus emblica* L. c. China rose – *Hibiscus x rosa-sinensis* L. d. Mahabhringraj – Eclipta prostrata (L.) L. e. Henna – *Lawsonia inermis* L. e) Jatamansi – *Nardostachys jatamansi* (D. Don) DC f) Banyan tree – *Ficus benghalensis* L. g) Dodder – *Cuscuta reflexa* Roxb. h) Soap nut – *Sapindus emarginatus* Vahl i) Bramhi – Bacopa monnieri (L.) Wettst.	

Suggested Readings:

1. Sharma Gaurav Kumar, Jayesh Gadiya and Meenakshi Dhanwat, 2018, A text book of Cosmetic Formulations, Research Gate. https://www.researchgate.net/publication/325023106_Textbook_of_Cosmetic_Formulations
2. Tanstia – FNF Service Centre, 2011 Project Profile on Herbal Cosmetics, July 2011. http://www.efaidnbmnnnibpcajpcglclefindmkaj/https://www.moice.gov.bt/wp-content/uploads/2020/07/Herbal-Cosmetics.pdf
3. Sharma Niraj Kumar, Vaibhav Tripathi, Md. Rageeb Md. Usman and Deenanath Zade, 2020, A Tet Book of Herbal Cosmetics, PV Books,

   https://www.researchgate.net/publication/348590631_A_TEXT_BOOK_OF_HERBAL_COSMETICS/link/6007ba2692851c13fe23ae17/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19
4. Panda Hemadri, 2021, Herbal Cosmetics Handbook (Formulae, Manufactring Processes with Machinery and Equipment details) 5 th revised edition, Asia Pacific Business Press New Delhi.
5. Suresh Babu S., 2005, Home made Herbal Cosmetics, Pustak Mahal Delhi, India https://openlibrary.org/books/OL13132256M/Home_Made_Herbal_Cosmetics
6. Vimaladevi M., 2018, Text Book oh Herbal Cosmetics, CBS Distributors and Publisher, New Delhi.
7. Burlando Bruno, Luisella Verotta, Laura Cornara and Elisa Bottini- Massa, 2010, Herbal Principles in Cosmetics- Properties and Mechanisms of Action, CRC Press, Taylor & Francis Group.

BOT/SEC/T/250: (Title of Paper:- HERBARIUM TECHNIQUES AND PLANT PRESERVATION

Total Credits : 01 Total Contact Hours :15 Hrs.

Examination Paper Code SDC03012504T. Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. To give training to the students regarding preservation of plant specimens for Cytological, Anatomical, Molecular, physiological, phytochemical analysis and Micro-propagation through tissue culture techniques.
ii. To train the students regarding preservation of plant specimens of all plant groups.
iii. To train students to prepare Herbarium specimens

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Preserve the plant specimens for all biological studies.
ii. Preserve the plant specimens belonging to different plant groups
iii. Prepare Herbarium specimens and can deposit in resosible Herbaria.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Need and importance of plant preservation, Collection of Specimens, Recording data: a) Preservation for Cytological studies, b) Preservation for Anatomical studies, c) Preservation for Molecular studies, d) Preservation for Physiological studies, e) Preservation for Phytochemical studies, f) Tissue culture	05
II	Wet preservation of the plant belonging to Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.Preservative and Fixative chemicals. Temporary and Permanent preservation	05
III	Herbarium techniques: Definition of Herbarium, Standard size of Sheet, Collection, Pressing, Drying, Poisoning, Mounting, Labelling and Deposition at responsible Herbaria.	05

Reference Books

1. Nina Davies, Clare Drinkell, Timothy Utteridge. 2023, The Herbarium Handbook, ISBN 9781842467695. Kew Publishing, Royal Botanic Garden, Kew, England.
2. Naik, V. N. 1989, Taxonomy of Angiosperms, Tata MacGraw Hill, New Delhi
3. Jain S. K. and R. R. Rao, 2016, A Handbook of Field and Herbarium methods, Todays and Tomorrows Printers and Publishers, New Delhi.
4. Inam Akhtar, Seema Sahay, Afroza Akhtar, 2016, Experiments in lant Physiology, Biochemistry and Ecology, Jaya Publishing House, Delhi
5. Jensen WilliaA Tm A., 2015, Botanical Histochemistry, Agri Horti Press, New Delhi.
6. Bendre Ashok M. and Ashok Kumar, 2018, A Text Book of Practical Botany, Rastogi Publications, MeerutPapdiwal P. B.,1980, Laboratory Techniques, Marathwada University, Aurangabad.

BOT/SEC/P/276: (Title of Paper:- HERBARIUM TECHNIQUES AND PLANT PRESERVATION

Total Credits : 01 **Total Contact Hours : 30 Hrs**

Examination Paper Code SDC03012764T. **Maximum Marks-50 (CIA-20 and SEE-30)**

Learning Objectives of the Course:

i. To know the methods of collecting, pressing, drying, and preserving plant specimens for herbarium preparation.
ii. To understand the importance of herbarium and plant preservation in botanical studies, research, and biodiversity conservation.
iii. Develop skills in proper labeling, cataloging, and scientific documentation of preserved plant specimens.
iv. Study various techniques of plant preservation, including wet preservation, embedding, and resin preservation.
v. To gain hands-on experience in preparing a small herbarium collection and learning the principles of plant taxonomy through preserved specimens.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Students will be able to systematically collect and preserve plant specimens using standard herbarium techniques.
ii. Develop expertise in proper identification, labeling, and documentation of herbarium specimens.
iii. Understand the role of herbaria in botanical research, ecological studies, and biodiversity conservation.
iv. Skilled in different plant preservation techniques, including dry and wet preservation methods.
v. Prepare a well-organized herbarium and contribute to plant taxonomy and conservation efforts.

Expt.No	Title of Experiment
1	Preservation of Plant materials for Cytological studies
2	Preservation of Plant materials for Anatomical studies.
3	Preservation of Plant materials for Cytological studies
4	Preservation of Plant materials for Molecular studies
5	Preservation of Plant materials for Physiological studies.
6	Preservation of Plant materials for Phytochemical analysis
7	Collection of plant materials for Tissue culture
8	Wet preservation of the plant belonging to different plant groups
9	Preparation and use of Preservative and Fixative chemicals.
10	Preparation and deposition of Herbarium specimens

BOT/SEC/T/251 : (Title of Paper:- VERTICAL FARMING

Total Credits : 01 **Total Contact Hours : 15 Hrs.**

Examination Paper Code SDC03012514T . Maximum Marks-50 (CIA-20 and SEE-30)

Learning Objectives of the Course:

i. The students must know the advancement in the field of vertical farming.
ii. The students will acquire the skill of establishment and maintenance of vertical farming system.

Course Outcomes (COs) :

After completion of the course, students will be able to.

i. Identify various components required for ornamental garden development.
ii. Perform various skills related to establishment and maintenance of an ornamental garden.
iii. Demonstrate skills of making developing a lawn and bonsai.
iv. Make landscape design using CAD software etc

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**VERTICAL FARMING:** Introduction of Vertical farming, history, Important features of vertical farming, Hydroponic, Aeroponics, Aquaponics, Vertical farming- types, green facade, living/green wall-modular green wall, vegetated mat wall Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plant. Challenges in Vertical farming	05
II	**MODERN CONCEPTS**:- Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops	05
III	**WASTE MANAGEMENT**:- Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes-solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.	05

Reference Books:

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47-53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on periurban agriculture: A case study. Environmental Pollution, 126 (3): 323-329.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.
4. Ali F. And Srivastava C. (2017). Futuristic Urbanism-An overview of vertical farming and urban agriculture for future cities in India. International Journal of Advanced Research in Science, Engineering and Technology,4 (4), April 2017.
5. Banerjee C. (2014). Up and Away! The Economics of Vertical Farming. Journal of

Agricultural Studies, 2(1):40-60

6. Despommier D. and Carter M. (2011). The Vertical Farm: Feeding the World in the 21st Century. UK: Picador. https://interestingengineering.com/13-vertical-farming-innovations-that-could revolutionize-agriculture. https://medium.com/@anishad_45562/vertical-farming-in-india-misguided-dream-or a-much-needed-reality-d993a2a0dc29.
7. Hota S., Stobdon T. and Chaurasia O. P. (2018). Aeroponics and inflatable greenhouse in trans-Himalaya: Challenges and future perspective. New Age Protected Cultivation, ISPC, New Delhi: 4(2)18-20.
8. Jain R. and Janakiram T. (2016). Vertical gardening: a new concept of modern era. In:Commercial Horticulture, © 2016, Editors, N.L. Patel, S.L. Chawla and T.R. Ahlawat,New India Publishing Agency, New Delhi, India.
9. Jankiram T. and Bhaskar S. (2018). Recent advances in protected cultivation in China. New Age Protected Cultivation, ISPC, New Delhi: 4(2):25-30.
10. Kheir Al-Kodmany 2018. The Vertical Farm: A Review of Developments and Implications for the Vertical City. MDPI, February 2018:1-36(www.mdpi.com/journal/buildings).
11. Kojai T., Niu G., Takagaki M. (ed). (2015). Plant factory an indoor vertical farming system for efficient quality food production. Academic Press, 432p.
12. Pant T.; Agarwal A.; Bhoj A.S.; Joshi R.P.; Om Prakash and Dwivedi S.K.(2018). Vegetable cultivation under hydroponics in Himalayas- challenges and opportunities. Defence Life Science J., 3 (2):111-115
13. https://www.sciencedirect.Com/science/article/pii/S0269749103002458#aep-section-id24.
14. https://vertical-farming.net/ https://www.thebalancesmb.com/what-you-should-know-about-vertical farming-4144786.

BOT/SEC/P/277: (Title of Paper:- VERTICAL FARMING

Total Credits : 01 **Total Contact Hours : 30 Hrs**

Examination Paper Code SEC03012764P **Maximum Marks-50 (CIA-20 and SEE-30)**

Learning Objectives of the Course:

i. To introduce principles and technologies of vertical farming as a sustainable agriculture method
ii. To develop hands-on skills in designing and maintaining vertical farming systems
iii. To analyze the environmental and economic impacts of vertical farming compared to conventional agriculture
iv. To explore innovative crop selection and growing techniques specific to vertical farming environments
v. To evaluate the potential of vertical farming in addressing food security challenges in urban settings.

Course Outcomes (COs) :

After completion of the course, students will be able to

i. Design and construct functional small-scale vertical farming systems using appropriate technologies
ii. Demonstrate proficiency in managing hydroponic, aeroponic, and aquaponic growing systems
iii. Apply principles of controlled environment agriculture to optimize plant growth and yield
iv. Monitor and maintain optimal growing conditions including lighting, irrigation, and nutrient delivery.

Expt. No	Title of Experiment
1	Identification and description of various plants grown in ornamental gardens.
2	Tools, implements and containers used in ornamental gardening.
3	Planning, designing and establishment of garden features viz. lawn, hedge and edge, rockery etc.,
4	Demonstration of types and styles of gardens using photos or videos.
5	Planning, designing and establishment of water garden, carpet bedding, shade garden, roof garden.
6	Preparation of land for lawn and planting.
7	Exposure to CAD (Computer Aided Designing)
8	Demonstration of bonsai making.
9	Preparation and deposition of Herbarium specimens
10	Study and creation of terrariums, vertical garden.

Structure / Pattern of 30 Marks Theory Course

- The SEE of the theory course shall have two parts (10 + 20 = 30 Marks).
- **Part A** shall consist of 5 questions having 2 marks each (multiple choice questions / fill in the blanks / answer in sentence) as compulsory questions, and it should cover the entire course curriculum (10 Marks).
- **Part B** shall consist of 6 questions (5 marks for each question) (02 questions from each of 03 units / covering the entire syllabus), and students shall have to attempt any 04 questions out of 06 (20 Marks).
- Wherever possible, 20 to 30% weightage can be given to problems/numerical, wherein the use of a non-programmable scientific calculator may be allowed.
- The number of sub-questions (with the allotment of marks) in a question may be decided by the examiner.

PRACTICALS

Candidate shall submit the following at the time of practical exam.

1. Certified laboratory record book.
2. Field note book / Tour report.
3. Collection of specimens from algae and fungi.

In addition to number of practicals prescribed above, the students are required to undertake field excursions to the places of botanical interest and industrial places under the guidance of teacher. Collection of rare flowering and non flowering plants should be avoided during excursion. There shall be frequent study tours in local areas. T.A. and D.A. be paid to the teachers, peons and field collectors as per university rules. The record book is to be signed periodically by teacher in charge and certified by the Head of Department at the end of the term. Candidate should not be allowed to appear for practical examination without a certified record book or a certificate from the Head of Department.