Savitribai Phule Pune University, Pune

(Formerly, University of Pune)

Under Graduate Degree Program in Botany (B.Sc. Botany)

(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for

S.Y.B.Sc. Botany (Semester-III and IV)

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

To be implemented from

Academic Year 2025-2026

Framed by

BOARD OF STUDIES IN BOTANY

Savitribai Phule Pune University,
Ganeshkhind, Pune -07.

AIMS AND OBJECTIVES

- To develop employability oriented diversified course content.
- To introduce skill oriented specialized education by introducing in-depth learning concepts.
- To expose students to the process of systematic academic inquiry and exhibiting courtesy to the vast universe of basic and applied knowledge of plants.

PROGRAM OUTCOMES (POS)

According to NEP-2020 criteria, the Under Graduate degree in Botany (S.Y.B.Sc. Botany) program at Savitribai Phule Pune University, Pune's associated colleges, is structured to provide students with advanced field-related knowledge and essential fundamentals. Through a unique combination of required major core courses with in-depth exposure to multidisciplinary minor, elective, and vocational skill courses, among other courses, students will be trained and acquire the fundamental and advanced knowledge essential to the plant sciences industries.

With the knowledge gained in the field of plant sciences, this upgraded curriculum will develop educated, outcome-oriented candidates who are nurtured through discovery and learning, equipped with practice and skills to deal with practical problems, and competent with recent pedagogical trends in education, including E-learning, flipped class, hybrid learning, and experiential learning. These candidates will become responsible citizens, transforming the nation to lead the world in the future.

After successful completion of the Under Graduate (UG) Degree program, the students would be able to:

PO1: Attain thoughtful proficiency in the field of plant sciences.

PO2: Acquire the ability to perform in multidisciplinary domains.

PO3: Attain the ability to exercise intelligence of scientific knowledge for investigation and innovation and nourishment of the world.

PO4: Learn value based ethical practices and principles committed to professional ethics.

PO5: Incorporate 21st century skill oriented self-directed and life-long learning.

PO6: Obtain ability to inculcate the knowledge of plant science in diverse contexts with global perspective.

PO7: Attain maturity to harness the destiny and responds to one's calling.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Recall the diversity, classification, evolution and developmental changes among the plants with reference to lower and higher plant groups and create a knowledge base in understanding the basis of plant diversity, economic values and taxonomy of plants.

PSO2: Understand the advanced concepts of Genetics, Cell biology and Plant Biotechnology of plants and its implementation for the improvement of crop productivity.

PSO3: Acquire and utilize the skills of post-harvest, flower design, fruit processing and dehydration techniques, organic farming and various plant processing technologies for developing the economy to the growing world.

PSO4: Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

PSO5: Inculcate the methodology followed in plant breeding, pharmacognosy, herbal drug technology, plant protection, propagation and improvement.

PSO6: Adapt methods of scientific research in plant improvement program and create entrepreneurships, employment to the society.

PSO7: Analyze the impact of scientific and technological advances on the environment and society and understand the importance of biodiversity conservation, green cover development, carbon sequestration and utilize the knowledge for sustainable development.

PSO8: Explore the knowledge of biotic and abiotic stress tolerance, plant microbe interaction and Integrate pest management for making the revolution in the agriculture.

PSO9: Enrich the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, and enhance communication skill.

PSO10: Apply the fruitful knowledge of plant sciences and plant resources for the sustainable development, betterment of society and environment by recognizing the ethical values.

PSO11: Become competent enough in various analytical and 21st century technical skills related to plant sciences for their exploration.

PSO12: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO13: Employ critical thinking based problem solving and practical skills pertaining to botanical techniques and computational knowledge and apply strategies for environmental conservation.

PSO14: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.

1. Title of the Course: B.Sc. Botany (03 years) / B.Sc. with Honours in Botany (04 years)

Syllabus revised as per National Education Policy (NEP) 2020 for the Colleges Affiliated to Savitribai Phule Pune University, Pune

2. Faculty - Science and Technology

3. To be implemented -For S.Y.B.Sc. (Semester III and Semester IV), from June 2025.

4. Preamble -

Plants are the sole true foundation for all scientific disciplines since they create all kinds of ecosystems and are necessary for all other life forms on Earth to survive. Through both basic and applied research, the study of botany has a significant potential to assist the nation in achieving its sustainable goals. The world's overpopulation is having a concerning effect on the development and productivity of food (particularly plants), in addition to the ever-increasing challenges of environmental contamination brought on by unfavourable climatic changes, global warming, and natural disasters.

Botany is the only supreme foundation of all sciences, because plants, as producers of all kinds of ecosystems, play a critical role in the survival and existence of all other living things on the planet. Botany has tremendous potential for achieving the nation's long-term goals by utilizing it at both the basic and applied levels. In the current scenario, the world's over population, combined with the day-by-day increasing problems of environmental

pollution caused by adverse climatic changes, global warming, and natural calamities, is severely affecting the growth, development, and productivity of produce (particularly plants) to alarming levels.

Higher education in plant sciences should be encouraged for students with backgrounds in the life sciences, with an emphasis on applying the most recent data, expertise, and abilities from both basic and applied branches to develop solutions for sustainable development. In light of this curriculum has been designed to equip students with the knowledge and skills they will need to handle problems pertaining to the needs and worries of both the environment and the human population. In order to accomplish these goals, every effort is made to guarantee high standards of education by implementing numerous strategies to enhance the teaching-learning process, assessment and evaluation methods, and making sure that students are developed holistically in line with the goals and standards of NEP 2020.

The thoughtfully crafted S.Y.B.Sc. Botany curriculum combines a focus on subjects linked to advanced agriculture, the plant-based industry, and pharmaceutical companies with a deep comprehension of the subject's fundamental concepts. This will inspire and attract life science students to seek M.Sc. and Ph.D. degrees in botany in order to become prosperous entrepreneurs, proficient workers, or sophisticated farmers who can address social and environmental issues as a part of sustainable development.

The National Education Policy (NEP-2020), which is being implemented by the Ministry of Higher Education, the Government of India, and the University Grants Commission (UGC), offers opportunities for developing 21st century advanced skills based on the Indian knowledge system through research internships with renowned and esteemed faculty and researchers at their own or other HEIs / research institutes. Additionally, it acknowledges, pinpoints, and nurtures each student's distinct talents in order to support their overall growth and strengthen the country. This will empower Indian youngsters in the field of plant sciences globally and assist the country establish a solid foundation on the global market. Our nation boasts the highest percentage of young people, who, after receiving a top-notch education, have the potential to govern the world in the years to come.

In order to address problems pertaining to plant sciences, such as biodiversity conservation, soil health, plant nutrition, plant wealth and plant-based resource management, interactions between plants and microorganisms, plant pathogens and diseases, and carbon sequestration, the B.Sc. Botany curriculum offers a thorough theoretical and practical knowledge base. In the exploration of plant sciences, students will be able to stand independently and with confidence.

Program Duration and Exit Options

The UG Program lasts for four years or eight semesters.

Student may leave the program after the third year if, he/she would like to receive a three-year undergraduate degree.

If the student decides to withdraw after the first or second year, he/she will receive a UG Certificate or UG Diploma, depending on how many credits he/she is able to complete. Re-entering within three years to finish the degree program is allowed for students who leave with a UG certificate or UG diploma. A student must earn a minimum of 18 credits and a maximum of 26 credits each semester. It is recommended, nevertheless, that student should opt 22 credits per semester. This clause aims to give student the comfort of a flexible

semester-based course load. However, Table 1 lists the minimum number of credits required to be earned in order to be awarded an Undergraduate Certificate/Undergraduate Diploma/Bachelor Degree/Bachelor's Degree with Honors in Botany.

Table1: Type of Awards and Stages of Exit

Sr. No.	Type of Award	Stage of Exit	Mandatory Credits
1.	Undergraduate Certificate in Botany	After successful completion of First year Semesters	44
2.	Undergraduate Diploma in Botany	After successful completion of Second year Semesters	88
3.	Bachelor of Science in Botany	After successful completion of Third year Semesters	132
4.	Bachelor of Science in Botany (Honours)	After successful completion of Fourth yearSemesters	176

5. Eligibility Criteria -

The students who had opted Botany as a subject at FYBSc level and have qualified are eligible for SYBSc Botany Admission. Admissions will be given as per the selection procedure / policies adopted by the college keeping in accordance with the conditions laid down by the Savitribai Phule Pune University, Pune. Reservation and relaxation are as per the State Government rules.

6. Fee Structure – As per the norms of Savitribai Phule Pune University, Pune.

7. Duration of the Course

Certificate Course- 01 year (Completion of 02 Semesters)
Diploma Course- 02 years (Completion of 04 Semesters)
BSc Degree- 03 years (Completion of 06 Semesters)
BSc Degree with Honors- 04 years (Completion of 08 Semesters)

8. No. of semesters – Two semesters per year

9. Medium of instructions and teaching: English

10. Course Implementation Criteria for Theory and Practical:

a. Each semester comprises of 15 weeks (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).

b. One Credit of the Theory is equal to15 clock hours (Teaching 1 hour per week for each credit, 12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.

c. One Credit of Practical = 30 clock hours. (2 Contact hours per credit per week)

One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for journal competition, and Continuous Internal Evaluation of each practical).

d. Practical for each course comprises of 02 Credits = 60 clock hours. Therefore,

- Minimum 12 laboratory sessions of 04 clock hours must be conducted in one

semester.

- In case of short practical, two practicals should be conducted in one session.
- Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

e. Field Project (FP): 02 credits (60 hours including field study, labwork, presentations, assignments etc.)

f. Community Engagement Program (CEP): 02 Credits (60 hours including community engagement activities, labwork, presentations, assignments etc.)

11. Examination Pattern (For each Semester): The examinations will be conducted semester wise for both Theory as well as Practical courses.

- **Theory Paper of 02 Credits -**
  - Internal Exam (15 M) + University Theory Exam (35 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and For University Exam = 02 hours.
- **Practical Paper of 2 Credits -**
  - Internal Exam (15 M) + University Practical Exam (35 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and For University Exam = More than 04 hours.
- **Field Project: 02 credits**

  Student field project should be evaluated for total 50 marks (15 marks for internal and 35 marks for external evaluation). During internal assessment following points should be considered

  1. Appropriateness of the field project
  2. Punctuality of the student
  3. Field work
  4. Field diary
  5. Viva voce

  The criteria for external evaluation should be

  1. Originality and significance of the project, its relevance to the field, and potential impact.
  2. Soundness of methodology, research design, and approach.
  3. Quality, accuracy, and thoroughness of data collection, analysis, and interpretation.
  4. Validity and significance of findings, conclusions, and recommendations.
  5. Clarity, organization, and effectiveness of the project report and presentation.
- **Community Engagement Program (CEP): 02 Credits**

  Student Community Engagement Program (CEP) shall be evaluated for total 50 marks (15 marks for internal and 35 marks for external evaluation). During internal assessment following points shall be considered

  1. Effectiveness of program design and planning.
  2. Student participation and engagement in program activities.
  3. Effectiveness of student communication with community members.
  4. Demonstration of seed technology knowledge and skills.
  5. Maintenance of program records and documentation.

The criteria for external evaluation shall be

1. Clarity, organization, and effectiveness of the report and presentation.
2. Assessment of the program's impact on the local community.
3. Evaluation of student learning outcomes and skills development.
4. Assessment of the program's effectiveness in achieving its objectives.

12. Award of Class/Grade: The class / grade for the courses of each semester will be followed as per the norms and conditions laid down by SPPU, Pune.

13. ATKT Rules: As per the norms given by SPPU, Pune.

14. Important Note:

a. There shall be at least a short tour/field visit/industrial visit (1-2 days) per year for all UG students. Tours are the part of curriculum and obligatory to each student, failing which they will not be considered eligible to appear for the practical examination. Under unavoidable circumstances, if the student fails to attend the tour, he/she have to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.

c. The documents to be produced by each student at the time of practical examination (at the end of each Semester) are:

- Submission of practical records (Journals).
- Submission of a Tour / Visit report duly signed by the concerned practical In-charge and Head of the Department.
- Any submissions / assignments, etc. based on the practical course.

15.Question paper pattern for Theory (2 Credit courses)

A student will have to solve the question paper of 35 marks for external exam. The paper setter should set the paper on entire syllabus, including optional questions. As the course is of 2 Credits (30 clock hour lectures), paper setter should allot 2.03 marks per lecture and accordingly, questions should be set for 30 lectures, 61 marks on entire syllabus.

Note: All questions are compulsory.

Time: 2 Hours

Que. 1) Answer any five of the following in one sentence 05 Marks

i.
ii.
iii.
iv.
v.
vi.

Que. 2a) Write any one of the following 06 Marks

i.
ii.

Que. 2b) Write any one of the following 04 Marks

i.
ii.

Que. 3a) Solve any one of the following 06 Marks

i.
ii.

Que. 3b) Solve any one of the following 04 Marks

i.
ii.

Que. 4) Write notes on (Any four) 10 Marks

a.
b.
c.
d.
e.
f.

CREDIT FRAMEWORK FOR S.Y.B.Sc. BOTANY, SEMESTER – III (Level 5.0 / 200)

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical – 1 (V1)			
Major Core Courses – (2T + 1P) x 2C = 6C	BOT-201-MJ	Taxonomy of Angiosperms	**2 C**
	BOT-202-MJ	Plant Physiology and Metabolism	**2 C**
	BOT-203-MJP	Practical Based on BOT-201-MJ & BOT-202-MJ	**2 C**
Major Elective Courses - (0C)	-----	------	**0 C**
Vertical – 2 (V2)			
Minor Courses – (1T + 1P) x2C = 4C (Any one from basket)	BOT-241-MN	Horticulture	**2 C**
	BOT-242-MN	Tissue Culture Technology	
	BOT-243-MN	Seed Technology	
	BOT-244-MNP	Practical Based on BOT-241-MN	**2 C**
	BOT-245-MNP	Practical Based on BOT-242-MN	
	BOT-246-MNP	Practical Based on BOT-243-MN	
Vertical – 3 (V3)			
Generic Elective (GE) / Open Elective (OE) - (1T= 2C)(Any one from basket)	OE-201-BOT-I	Crop Science	**2 C**
	OE-202-BOT-T	Medicinal Botany	
Vertical – 4 (V4)			
Vocational Skill Courses (VSC) – (1T /P = 2C) (Any one from basket)	VSC-221-BOT-P	Phytochemistry	**2C**
	VSC-222-BOT-T	Digital Herbaria	
	VSC-223-BOT-P	Green Cover and Carbon Crediting	
	VSC-224-BOT-P	Plant Ecology and Biodiversity	
SEC – (0C)	------	------	**0 C**
Vertical – 5 (V5)			
IKS – (1T=2C)	IKS-BOT-T	Medicinal Plants in Traditional Systems of Medicine	**2 C**
Ability Enhancement Courses (AEC) – (1T = 2C)	AEC 201 MAR/HIN	Marathi / Hindi	**2C**
VEC – (0C)	-------	-------	**0 C**
Vertical – 6 (V6)			
FP – (2C)	FP-231-BOT	Field Project	**2 C**
Co-curricular Courses (CC) – (1T = 2C)	CC 201 PE, NSS, NCC		**2C**
		Total Credits (V1+V2+V3+V4+V5+V6)	**22C**

CREDIT FRAMEWORK FOR S.Y.B.Sc. BOTANY, SEMESTER – IV (Level 5.0 / 200)

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical – 1 (V1)			
Major Core Courses – (3T + 1P) x 2C = 8C	BOT-251-MJ	Plant Anatomy & Embryology	**2 C**
	BOT-252-MJ	Plant Biotechnology	**2 C**
	BOT-253-MJP	Practical Based on BOT-251-MJ & BOT-252-MJ	**2 C**
Major Elective Courses - (0C)	-----	------	**0 C**
Vertical – 2 (V2)			
Minor Courses – (1T + 1P = 4C) (Any one from basket)	BOT-291-MN	Hybrid Seed Production	**2 C**
	BOT-292-MN	Biological Techniques	
	BOT-293-MN	Herbal Products Technology	
	BOT-294-MNP	Practical based on BOT-291-MN	**2 C**
	BOT-295-MNP	Practical based on BOT-292-MN	
	BOT-296-MNP	Practical based on BOT-293-MN	
Vertical – 3 (V3)			
Generic Elective (GE) / Open Elective (OE) - (1P = 2C)(Any one from basket)	OE-251-BOT-P	Floriculture and Pomoculture	**2 C**
	OE-252-BOT-P	Nursery Techniques	
Vertical – 4 (V4)			
Vocational Skill Courses (VSC) – (1T /P = 2C) (Any one from basket)	VSC-271-BOT-P	Mushroom and SCP Production Technology	**2 C**
	VSC-273-BOT-P	Fermentation Technology	
	VSC-273-BOT-P	Ethnobotany	
Skill Enhancement Courses (SEC) – (1T / 1P = 2C) (Any one from basket)	SEC-251-BOT-P	Applications of Artificial Intelligence in Botany	**2C**
	SEC-252-BOT-P	Value addition to Plant based products	
	SEC-253-BOT-P	Herbal Cosmetics and Nutraceutics	
	SEC-254-BOT-P	Fungal Biotechnology	
Vertical – 5 (V5)			
IKS - (0C)	-----	------	**0 C**
Ability Enhancement Courses (AEC) – (1T = 2C)	AEC 251 MAR / HIN	Marathi / Hindi	**2C**
VEC – (0C)	-------	-------	**0 C**
Vertical – 6 (V6)			
CEP – (2C)	CEP-232-BOT	Community Engagement Programme (CEP)	**2 C**
Co-curricular Courses (CC) – (1T = 2C)	CC 251 PE, NSS, NCC		**2C**
		Total Credits (V1+V2+V3+V4+V5+V6)	**22C**
		Total Credits for SYBSC - Semester III (22C) + Semester IV (22C)	**44C**

Exit Option: **Award of UG Diploma (UG Diploma in Botany) in Major and Minor with 88 Credits and an additional 4 Credits core NSQF course / Internship OR Continue with Major and Minor.**

S.Y.B.Sc. Botany [Semester - III]

Course Category – Major Core Courses (MJ)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Major Core Courses (2T + 1P) x 2C = 6C	BOT-201-MJ	Taxonomy of Angiosperms	2 C
	BOT-202-MJ	Plant Physiology and Metabolism	2 C
	BOT-203-MJP	Practical Based on BOT-201-MJ and BOT-202-MJ	2 C

S.Y.B.Sc. Botany [Semester-III]

Course Category – Major Core Course (MJ)

Course Code – BOT-201-MJ

Course Title: Taxonomy of Angiosperms

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To equip students with the knowledge and skills to identify, classify and name flowering plants.
2. To aware students about plant nomenclature and its importance.
3. To aware students about the traditional and modern systems of classification.
4. To imbibe students about the importance of botanical gardens and conservation.
5. To aware students about the diversity of angiosperms.

COURSE OUTCOMES:

CO 1: Students will be able to identify and classify the plants.
CO 2: Students will learn about the systems of classifications
CO 3: Students will know the contributions made by taxonomists.
CO 4: Students will understand various aspects of Plant Nomenclature.
CO 5: Students will be able to classify the plants based on external morphology.
CO 6: Students will understand the importance of botanical gardens and conservation.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Plant Taxonomy** 1.1 Definition, scope and importance. 1.2 Objectives- Identification, classification and nomenclature. 1.3 Concept of Systematics.	**02**
2	**Contribution of Taxonomists** 2.1 Indian taxonomist - H. Santapau, K. S. Manilal, S. R. Yadav 2.2 Foreign taxonomist - Armen Takhtajan, Arthur Cronquist	**01**
3	**Systems of classification** Broad outline of systems of classification with merits and limitations: 3.1. Artificial system of classification by Carl Linnaeus. 3.2. Natural system of classification by Bentham and Hooker. 3.3. Phylogenetic System of classification by Engler and Prantl.	**05**
4	**Taxonomic literature** 4.1 Flora 4.2 Monograph 4.3 Revisions 4.4 Manuals 4.5 Journals 4.6 Periodicals	**03**

5	**Sources of data for Systematics** 5.1 Morphology 5.2 Anatomy 5.3 Cytology 5.4 Embryology 5.5 Phytochemistry 5.6 Molecular biology	**04**
	CREDIT II	**15**
6	**International Code of Nomenclature (ICN) and Plant nomenclature** 6.1 ICN- Introduction and Principles 6.2 Binomial nomenclature- Definition and concept 6.3 Important principles of ICN: Principle of priority and 6.4 Concept of Typification - Type species and its types – Holotype, Paratype, Isotype, Lectotype and Neotype	**04**
7	**Study of Plant Families** 7.1 Study of families following Bentham & Hooker system with respect to – Systematic position, General morphological characters (vegetative and reproductive), Distinguishing features, Floral formula, Floral diagram and Economic importance of Annonaceae, Myrtaceae, Rubiaceae, Solanaceae, Euphorbiaceae and Amaryllidaceae	**08**
8	**Botanical Gardens** 8.1 Introduction and concept of the botanical garden 8.2 Role of botanical gardens in biodiversity conservation. 8.3 Major Botanical Gardens: 8.3.1 Royal Botanic Garden, Kew, London. 8.3.2 National Botanical Research Institute (NBRI), Lucknow. 8.3.3 A.J.C. Bose Indian Botanic Garden, Kolkata. 8.3.4 Lead Botanical Garden, S.U.K, Maharashtra.	**03**

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S.Y.B.Sc. Botany [Semester - III]

Course Category – Major Core Course (MJ)

Course Code – BOT-202-MJ

Course Title: Plant Physiology and Metabolism

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To understand basic concepts and applications of plant physiology.
2. To study water relations and mechanisms of water uptake and transport in plants.
3. To learn the role and function of essential mineral nutrients in plant growth.
4. To explore the physiological effects of plant growth regulators and transpiration.
5. To understand physiological processes like nitrogen fixation and flowering.

COURSE OUTCOMES:

After successful completion of this course, students will be able to:

CO 1: Explain fundamental principles and scope of plant physiology.
CO 2: Describe water and mineral nutrient dynamics in plant systems.
CO 3: Illustrate mechanisms of water absorption, ascent of sap, and transpiration.
CO 4: Analyze the roles of plant growth regulators in growth and development.
CO 5: Interpret processes like nitrogen fixation, photoperiodism and vernalization.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Plant Physiology** 1.1 Introduction and definition of plant physiology. 1.2 Scope and importance of plant physiology.	**02**
2	**Plant- Water relations** 2.1 Physico-chemical properties of water. 2.2 Membrane permeability. 2.3 Diffusion- definition, concept, and importance of diffusion in plants. 2.4 Osmosis- definition and concept of osmosis; Solution – solute and solvent; Types of solutions- hypotonic, hypertonic and isotonic; Types of osmosis – endosmosis and exosmosis; role of osmosis in plants. 2.5 Concept of osmotic pressure (OP), turgor pressure (TP), wall pressure (WP), Diffusion pressure deficit (DPD). 2.6 Plasmolysis- definition and concept, significance of plasmolysis; deplasmolysis, 2.7 Imbibition- definition and concept, Imbibition Pressure (IP), significance of imbibition.	**06**
3	**Water absorption and Ascent of sap** **3.1 Water Absorption:** 3.1.1 Role of water in plants; 3.1.2 Sources of water - Soil water, gravitational, hygroscopic, and capillary;	**05**

	3.1.3 Concept of water holding capacity (WHC) of soil; 3.1.4 Mechanisms of water absorption: a) Active absorption - osmotic and non-osmotic absorption of water; b) Passive absorption – transpiration pull. **3.2 Ascent of Sap:** 3.2.1 Definition, 3.2.2 Path for ascent of sap, 3.2.3 Theory for ascent of sap: Cohesion - tension theory. **3.3 Factors affecting the rate of water absorption and ascent of sap.**	
4	**Mineral nutrition** 4.1 Introduction and definition. 4.2 Classification of mineral nutrients based on quantity requirements: Macronutrients and Micronutrients. 4.3 Role and deficiency symptoms of essential mineral nutrients.	**02**
	CREDIT II	**15**
5	**Plant Growth Regulators (PGRs)** 5.1 Introduction and definition of PGRs. 5.2 Properties and physiological roles of PGRs - Auxins, Cytokinins, Gibberellins, Ethylene, and Abscisic acid.	**03**
6	**Transpiration** 6.1 Introduction and definition. 6.2 Types of transpiration- cuticular, lenticular and stomatal transpiration. 6.3 Typical structure of stomata. 6.4 Mechanism of opening and closing of stomata - Steward's hypothesis, Active K+ transport mechanism. 6.5 Factors affecting transpiration. 6.6 Anti-transpirants - definition, concept, and role. 6.7 Guttation and Exudation – definition and concept.	**05**
7	**Nitrogen fixation** 7.1 Role of nitrogen in plants. 7.2 Mechanism of nitrogen fixation and role of nitrogenase enzyme. 7.3 Types of nitrogen fixation: Physical and biological nitrogen fixation - symbiotic (BGA and Rhizobium) and non-symbiotic.	**03**
8	**Physiology of Flowering** **8.1 Photoperiodism** 8.1.1 Definition and concept; 8.1.2 Photoperiodic classes - Short Day Plants (SDPs), Long Day Plants (LDPs) and Day Neutral Plants (DNPs); 8.1.3 Photoperiodic induction and role of phytochromes in flowering, 8.1.4 Applications of photoperiodism. **8.2 Vernalization** 8.2.1 Definition and concept, 8.2.2 Mechanism of vernalization 8.2.3 Applications of vernalization.	**04**

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S.Y.B.Sc. Botany [Semester - III]

Course Category – Major Core Course (MJ)

Course Code – BOT-203-MJP

Course Title: Practical Based on BOT-201-MJ and BOT-202-MJ

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To impart hands-on training in taxonomic identification and classification of angiosperms using standard keys and tools.
2. To develop observational and analytical skills in recognizing plant families through floral dissection and morphological features.
3. To enable students to prepare solutions of different concentrations for physiological and biochemical experiments.
4. To understand plant water relations and physiological processes through experiments such as plasmolysis, DPD, and transpiration.
5. To introduce the role of plant growth regulators and their physiological effects on plant development.
6. To encourage field-based learning through botanical excursions and the preparation of a plant checklist.

COURSE OUTCOMES:

CO 1: Students will be able to use taxonomic keys and tools to describe and identify angiospermic plant specimens.

CO 2: Students will gain practical knowledge of dissecting flowers and preparing floral diagrams and floral formulae of selected families.

CO 3: Students will demonstrate competence in solution preparation and understanding of plant-soil interactions (pH, WHC).

CO 4: Students will understand physiological concepts like osmosis, plasmolysis, DPD, and transpiration through experimental setups.

CO 5: Students will analyze the effects of plant growth regulators like auxins and gibberellins on plant growth and development.

CO 6: Students will be capable of preparing a scientific botanical excursion report and identifying wild flora through field visits.

Sr. No.	Title of the Practical	No. of Practical
	Credit I – Practical Based on BOT 201 MJ	
1	Study the characters (key) used to describe angiospermic plants.	**01 P**
2	To study the tools of taxonomy.	**01 P**
3	Prepare a sheet and video of any five dissected flowers studied in theory. (Submission of Youtube Video links on the Departmental Google Drive and submission of sheets).	**01 P**
4	Study of plant families following Bentham & Hooker system with respect to – Systematic position, General morphological characters (vegetative and reproductive), Distinguishing features, Floral formula, Floral diagram: Polypetalae -Annonaceae andMyrtaceae; Gamopetalae -Rubiaceae and Solanaceae; Apetalae -Euphorbiaceae Monocotyledonae -Amaryllidaceae.	**04 P**
	Credit I – Practical Based on BOT 202 MJ	
5	Preparation of solution: Percent (w/v, v/v), Normal, Molar, Molal.	**01 P**
6	Determine water holding capacity (WHC) and pH of soil.	**01 P**
7	Study of plasmolysis in suitable plant material.	**01 P**
8	Determine Diffusion Pressure Deficit (DPD) by using potato tubers.	**01 P**
	Determine rate of transpiration under different conditions of shade, wind and sunlight.	**01 P**
9	Effect of plant growth regulators on plant growth: auxins - root induction; Gibbrelic acid – seed germination.	**01 P**
10	Demonstration Experiments. a. Curling experiment b. Imbibition in seeds c. Biofertilizers – *Azolla*, BGA and *Rhizobium.* d. Anti-transpirants. e. Nutrient Deficiency f. Flowering hormones	**01 P**
11	Botanical Excursion and writing (Preparation of checklist) and submission of botanical excursion report.	**01 P**

S.Y.B.Sc. Botany [Semester - III]
Course Category –Minor Courses (MN)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Minor Courses (1 T + 1P) x 2C = 4 C (Any one Theory and Practical course from basket)	BOT-241-MN	Horticulture	2 C
	BOT-242-MN	Tissue Culture Technology	2 C
	BOT-243-MN	Seed Technology	2 C
	BOT-244-MNP	Practical based on BOT-241-MN	2 C
	BOT-245-MNP	Practical based on BOT-242-MN	2 C
	BOT-246-MNP	Practical based on BOT-243-MN	2 C

S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-241-MN

Course Title: Horticulture

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce students to the basic concepts, scope, and branches of horticulture.
2. To impart knowledge about the morphological features and economic importance of different horticultural plant parts.
3. To provide an understanding of plant propagation methods and the use of propagation structures and growth regulators.
4. To familiarize students with specialized horticultural practices and their application in crop improvement.
5. To develop knowledge about commercial cultivation practices and value addition techniques in horticultural crops.
6. To create awareness about landscaping techniques and the role of national agencies in the development of horticulture in India.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1: Explain the basic principles, branches, and scope of horticulture.

CO2: Identify horticultural crops based on morphological parts and their economic significance.

CO3: Demonstrate understanding of various propagation methods and the role of plant growth regulators and propagation structures.

CO4: Apply special horticultural practices to enhance growth and productivity in selected crops.

CO5: Describe the commercial cultivation techniques and value addition processes of selected horticultural crops.

CO6: Design basic landscape gardens and explain the significance of governmental support in horticulture development.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Horticulture** 1.1 Introduction and Definition 1.2 Branches of Horticulture – Fruits (Pomology), Vegetables (Olericulture), Flowers (Floriculture), Nursery Management, Landscaping, Plantation crops, Spices (Culinary Herbs), Medicinal Plants. 1.3 Importance and scope of horticulture.	**02**
2	**Morphology and importance of horticultural plant parts**	**03**

	2.1 Introduction 2.2 Morphology of horticultural plants with respect to their common name, botanical name, family, parts used and its importance: 2.2.1 Root – carrot 2.2.2 Bulb - onion 2.2.3 Rhizome – turmeric 2.2.4 Stem tuber - potato 2.2.5 Leaf - Cabbage 2.2.6 Flower bud – clove 2.2.7 Flower - rose 2.2.8 fruit - mango 2.2.9 Seed - cashew nut	
3	**Propagation of horticultural plants** 3.1 Introduction and definition of propagation; 3.2 Methods of plant propagation– 3.2.1 Cutting: Stem cutting; 3.2.2 Layering: Air-layering; 3.2.3 Grafting: Cleft and approach grafting; 3.2.4 Budding: T- budding. 3.3 Role of plant growth regulators in horticulture. 3.4 Plant propagation facilities and their applications – 3.4.1 Mist chamber 3.4.2 Humidifiers 3.4.3 Greenhouse 3.4.5 Phytotrons 3.4.6 Cold frames and 3.4.7 Hot beds.	**05**
4	**Special horticultural Practices** 5.1 Introduction, definition, concept and importance of horticultural practices– 4.1.1 Training 4.1.2 Pruning 4.1.3 Girdling 4.1.4 Notching 4.1.5 Bending 4.1.6 Earthing up 4.1.7 Staking 4.1.8 Blanching 4.1.9 Bahar treatment.	**05**
	CREDIT II	**15**
5	**Commercial cultivation of horticultural crops** 5.1 Introduction; 5.2 Commercial value of ***Gerbera*****, Pomegranate** and **Tomato.** 5.3 Commercial cultivation practices of ***Gerbera*****, Pomegranate** and **Tomato** with reference to: center of origin; soil and climatic conditions; varieties; cultivation techniques; irrigation, fertigation	**06**

	and weed management practices; diseases and pest control: harvesting; grading and packaging.	
6	**Value addition to horticultural crops** 6.1 Introduction and concept of value addition 6.2 Processing importance of value-added products of selected horticultural crops: 6.2.1 Rose – gulkand and rose water 6.2.2 Grapes – wine and raisins 6.2.3 Tomato – Sauce and Ketchup	**03**
7	**Landscape gardening** 7.1 Introduction to landscape gardening 7.2 **Landscape gardening components:** Lawns, hedges, pergolas, Pathways, Fountains and topiary. 7.3 **Ornamental plant display techniques:** Moss stick, hanging baskets, Wall planters, bonsai, and terrarium.	**04**
8	**Role of government agenciesin horticulture development** 8.1 National Horticulture Board (NHB) 8.2 Mission for Integrated Development of Horticulture (MIDH) 8.3 National Horticulture Mission (NHM)	**02**

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3. Principles of Horticulture and Fruit Growing: Y. N Kunte, M.P Kawathalkar and K.S
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6. Advances in Horticulture Vol. IV Malhotra Publications : Chadha K. L &Pareek O. P.
7. Post Harvest Technology of Horticultural Crops New Delhi Publications :Sudheer K. P and Indira V.
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13. Ornamental Horticulture" – S. C. Dey (Pointer Publishers).
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15. Plant Propagation: Principles and Practices – Hartmann & Kester (Prentice Hall).
16. Propagation of Horticultural Crops – S. K. Sadhu (New Age International).
17. Nursery Management" – L. C. De (Oxford & IBH).
18. Fruit Science (Fundamentals and Practices)" – V. K. Chattopadhyay (Kalyani Publishers).
19. Advances in Fruit Production" – R. R. Sharma (New India Publishing Agency).
20. A Textbook of Vegetable Crops" – T. S. Rana (Kalyani Publishers.
21. Vegetable Crops" – Bose, Som&Kabir (NayaUdyog).

22. Floriculture in India" – G. S. Randhawa & A. Mukhopadhyay (Allied Publishers).
23. Post-Harvest Technology of Horticultural Crops" – K. P. Sudhakar Rao (Agrotech Publishing).
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26. Fundamentals of Horticulture. – Jitendra Singh (Kalyani Publishers).

S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-242-MN

Course Title: Tissue Culture Technology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce fundamental concepts and terminology of plant tissue culture (PTC).
2. To understand the layout, equipment, and materials required for a PTC laboratory.
3. To learn aseptic techniques and sterilization methods essential for in vitro cultures.
4. To study the composition, preparation, and role of various culture media in PTC.
5. To explore the stages, applications, and protocols of micropropagation and organogenesis.
6. To examine advanced PTC techniques such as callus, suspension, protoplast, and cryopreservation for plant improvement and conservation.

COURSE OUTCOMES (COs):

After successful completion of the course, students will be able to:

CO1: Describe the fundamental concepts and terminologies related to plant tissue culture.

CO2: Demonstrate knowledge of laboratory setup, infrastructure, and equipment required for PTC.

CO3: Apply aseptic and sterilization techniques for media and culture handling.

CO4: Explain and differentiate between various types of PTC techniques and their applications.

CO5: Analyze the significance of germplasm conservation and cryopreservation methods.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I – Basics of Plant Tissue Culture Technology	**15**
1	**Introduction to Plant Tissue Culture** 1.1. Introduction and brief history of PTC. 1.2. Definitions and Concepts: 1.2.1. Plant tissue culture, *In vitro* culture, cellular totipotency, differentiation, dedifferentiation, and re-differentiation. 1.2.2. *In vitro* culture, *in vivo* culture, plantlet, seedling, and micropropagation. 1.2.3. Aseptic condition, sterilization, contamination, decontamination. 1.2.4. Mother/stock plant, virus-free plant, explant, callus, cell suspension, and protoplast. 1.2.5. Inoculation, incubation, sub-culturing, hardening, and acclimatization. 1.2.6. Normality, molarity, molality and percentage solutions – weight by volume (w/v) and volume-by-volume (v/v), hard water, distilled water, alkaline, acidic and neutral solutions.	**04**

	1.2.7. Nutrient medium, macronutrients, micronutrients, carbon/energy source, organic supplements, plant growth regulator (PGR), gelling agent, pH, stock solution, and working solution. 1.2.8. Organogenesis – rhizogenesis, callogenesis, caulogenesis, somatic embryogenesis, haploid culture, somatic hybridization, cybridization, artificial / synthetic seeds, somaclonal variations, clonal propagation.	
2	**Laboratory Setup and Requirements in PTC** 2.1. Layout and design of plant tissue culture lab: Stock room, Washing and sterilization area, Media preparation room, Inoculation / transfer room (Aseptic chamber), Culture / Incubation room, Hardening / greenhouse area. 2.2. Basic requirements in PTC: 2.2.1. Chemicals: Detergents / disinfectants, Surfactants, Double distilled water, Inorganic macro and micronutrients, organic supplements (vitamins, amino acids, etc.), gelling agents, carbon / energy sources, other additives, plant growth regulators: Auxins, cytokinins, gibberellins - its types and role in PTC. 2.2.2. Glassware and plastic ware: for measuring, storage, and culture; standards of glassware / plastic ware used in PTC. 2.2.3. Equipment/Instruments: Glass distillation unit, Hot air oven, Autoclave, Laminar Air Flow, pH meter, Hot plate magnetic stirrer, Microwave oven, Culture racks, Air conditioner (A.C.), Digital rotary Incubator, Air pressure modules. 2.2.4. Miscellaneous	**04**
3	**Aseptic / Sterilization Techniques** 3.1. Introduction, definition and concept. 3.2. Methods of sterilization: 3.2.1. Physical methods: dry heat sterilization (Hot air oven), steam/moist/wet heat sterilization (Autoclave), UV Irradiation (Laminar Air Flow), Ultrafilter sterilization (Membrane filters). 3.2.2. Chemical methods: Fumigation, disinfection, surface sterilization.	**03**
4	**Plant Tissue Culture Media** 4.1. Introduction, definition and concept of medium. 4.2. Role of essential nutrients in plant growth and development. 4.3. Types of culture media: MS, B5, White's and Nitsch medium. 4.4. Composition of MS nutrient culture media – macronutrients (Major stock), micronutrients (minor stock), organic supplements (vitamins and amino acids), carbon/energy source, plant growth regulators, other additives, pH, gelling agent. 4.5. Media preparation: concept of stock and working solutions preparation for media and PGRs, standard operating protocol (SOP) of media preparation; media sterilization.	**04**
	CREDIT II – Applied Plant Tissue Culture Technology	**15**
5	**Micropropagation** 5.1. Introduction, definition and concept of micropropagation.	**05**

	5.2. Stages of micropropagation: Stage I: Mother plant selection; Stage II: Initiation / establishment; Stage III: Multiplication; Stage IV: Rooting; Stage V: Hardening and acclimatization. 5.3. Organogenesis: definition, concept, types –caulogenesis (shoot formation) and rhizogenesis (root formation); production of virus free plants using meristem tip culture. 5.4. Commercial micropropagation of Banana and Pomegranate. 5.5. Advantages and limitations of micropropagation.	
6	**Applied Plant Tissue Culture Techniques** 6.1. Callus culture: definition, stages – induction, proliferation and morphogenesis (direct and indirect organogenesis); Types of callus based on a) Texture - compact and friable; b) Origin – organogenic and non-organogenic, c) Morphogenic potential – embryogenic and non-embryogenic, d) Color – white, green, brown; Growth measurement parameters – fresh and dry weight; Importance of callus culture. 6.2. Cell Suspension culture: types – batch and continuous culture; role in secondary metabolite production. 6.3. Somatic embryogenesis: definition, process, structure, stages of somatic embryos, factors affecting somatic embryogenesis; artificial / synthetic seed production. 6.4. Protoplast culture and fusion: methods of protoplast isolation – mechanical and enzymatic; viability test – FDA (fluorescein Diacetate staining) and Evans Blue staining; Protoplast fusion: PEG and electric shock; Somatic hybridization and cybridization; applications of protoplast culture. 6.5. Haploid culture: Anther and pollen culture – development of homozygous lines (double haploids); Embryo and ovule culture – embryo rescue.	**08**
7	**Cryopreservation and Germplasm conservation** 7.1. Cryopreservation: definition, techniques – slow freezing, vitrification, sub-zero non-freezing storage and preservation in dry state; steps involved in cryopreservation; applications. 7.2. Germplasm conservation: definition, *in situ* and *ex situ* conservation.	**02**

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2. Bhojwani, S. S., &Dantu, P. K. (2013). Plant tissue culture: An introductory text (2nd ed.). Springer.
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-243-MN

Course Title: Seed Technology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To understand the basic difference between monocot and Dicot seed.
2. To understand the basic parameters of good quality seed.
3. To understand the process of release of a new variety.
4. To gain the knowledge regarding steps in seed production and marketing.
5. To learn seed testing and processing techniques.
6. To know seed storage constraints, pathogens and pest affecting the same.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Acquainted with the basic difference between monocot and Dicot seed.
CO2: Understand the basic parameters of good quality seed.
CO3: Understand the process of release of a new variety.
CO4: Gain the knowledge regarding steps in seed production and marketing.
CO5: Apply seed testing and processing techniques.
CO6: Get aware regarding seed storage constraints, pathogens and pest affecting the same.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction to Seed** **1.1 Seed:** 1.1.1 Definition, structure and importance; 1.1.2 Difference between seed and grain; 1.1.3 Types of seed based on: a) Structure (Monocot and Dicot) and b) Life Span (Recalcitrant and Orthodox). **1.2 Characters of good quality seed:** 1.2.1 Germination percentage 1.2.2 Genetic purity 1.2.3 Physical purity 1.2.4 Moisture percentage 1.2.5 Seed health 1.2.6 Seed vigor	**05**
2	**Seed Technology** 2.1 Introduction and definition of seed technology 2.2 History of seed technology in India 2.3 Scope and importance of seed technology 2.4 Major seed industries in Maharashtra 2.5 Government Organizations and Seed Agencies in India - 2.5.1 International Seed Testing Association (ISTA) 2.5.2 National Seed Corporation (NSC)	**04**

	2.5.3 State Seed Corporation (SSC) 2.5.4 Central Seed Committee (CSC) 2.5.5 Central Seed Certification Board (CSCB) 2.5.6 Seed Certification Agency (SCA) 2.5.7 Seed Testing Laboratory (STL)	
3	**Release of new Variety** 3.1 Introduction 3.2 Evaluation 3.2.1 Station trials 3.2.2 Multi-location trials 3.2.3 Disease and insect pest 3.2.4 Quality test 3.3 Identification of entries for release 3.4 Release of a variety	**02**
4	**Seed Production** 4.1 Seed pre-sowing steps: Location and season; land requirement and preparation; seed source; isolation distance. 4.2 Methods of seed sowing: Hand broad casting; Dibbling; Drilling and Transplanting. 4.3 Cultivation practices: Irrigation, cultural practices, plant protection, weed management, roughing, harvesting, and threshing.	**04**
	Credit-II	
5	**Seed Testing and Certification** **5.1 Seed testing:** 5.1.1 Definition and importance of seed testing; 5.1.2 Methods of seed testing–a) Physical purity analysis ,b) Moisture testing, c) Germination testing, and d) Seed vigor testing; 5.1.3 Reporting the results; 5.1.5 Storage of guard samples. **5.2 Seed Certification:** 5.2.1 Definition and objectives; 5.2.2 Classes of seed: a) Nucleus Seed, b) Breeder Seed, c)Foundation Seed and d) Certified Seed; 5.2.3 Phases of seed certification; 5.2.4 Procedure of seed certification.	**05**
6	**Seed Processing and Storage** **6.1 Seed Processing:** 6.1.1 Introduction, definition and concept of seed processing 6.1.2 Various steps in seed processing: • Receiving of seed lot • Conditioning • Seed Drying • Seed Cleaning • Seed grading 6.1.3 Methods of seed treatment: Disinfection and disinfestation 6.1.4 Seed treating equipment's **6.2 Seed Storage:** 6.2.1 Definition and need of seed storage. 6.2.2 Stages of seed storage. 6.2.3 Containers and packing material. 6.2.4 Factors affecting seed storage. 6.2.5 Methods of controlling seed damage during storage.	**06**
7	**Seed Pathology and Entomology**	**02**

	7.1. Introduction, definition and concept 7.2. Difference between seed borne and storage fungi with example 7.3 Insects as vectors of plant diseases	
8	**Seed Marketing** 8.1 Introduction 8.2 Major components of seed marketing 8.3 Role of different organizations in seed marketing	**02**

References:

1. Handbook of Agriculture- *Indian Council of Agricultural Research, New Delhi.*
2. Experimental Seed Science and Technology -Umarani*et.al.* 2006., *Agrobios, Jodhpur.*
3. Seed Technology- Agrawal, 2005. *Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.*
4. Seed Technology-Harpal Singh Tomar.
5. Seed Technology-B. S. Dahiya and K. N. Rai, Kalyani Publishers, New Delhi.
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-244-MNP

Course Title: Practical based on BOT-241-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To study the morphology and economic importance of selected plant parts used in horticulture.
2. To impart knowledge and practical skills in using common horticultural tools and techniques.
3. To demonstrate and practice special horticultural methods such as pruning, training, girdling, and bending.
4. To provide hands-on training in vegetative propagation techniques including cutting, layering, grafting, and budding.
5. To develop skills in value-added product preparation (e.g., rose water, wine, sauces) and ornamental plant arrangements like bonsai and terrariums.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Identify and describe the morphology of various plant parts of horticultural importance (root, stem, leaf, flower, fruit, seed).

CO2: Efficiently handle and utilize horticultural tools and perform key horticultural practices such as pruning, earthing up, and staking.

CO3: Apply vegetative propagation techniques (cutting, layering, grafting, budding) for plant multiplication in both ornamental and fruit plants.

CO4: Prepare and present value-added horticultural products and ornamental structures like gulkand, rose water, moss sticks, bonsai, and terrariums.

CO5: Demonstrate knowledge of horticultural industries through field visits and compile structured reports based on nursery, orchard, or floriculture market observations.

Sr. No.	Title of the Practical	No. of Practical
1	Study of morphology of root – carrot; bulb - onion; rhizome – turmeric; stem tuber - potato; leaf - Cabbage; flower bud – clove; flower - Rose; fruit - mango; seed - cashew nut.	01 P
2	To study the horticultural tools.	01 P
3	Demonstration of special horticultural practices - Training, Pruning, Girdling, Notching, Bending, Earthing up, Staking, and Blanching.	01 P
4	Study of plant propagation by Cutting (stem and leaf) and Layering (air and soil).	01 P
5	Study of plant propagation by grafting (simple approach and stone) and Budding (I, T and patch).	02 P
6	Preparation of gulkand and rose water.	01 P
7	Demonstration on laboratory preparation of grape wine.	01 P

8	Preparation of tomato sauce and ketchup.	**02 P**
9	Preparation of moss-stick, hanging baskets, potted plants and wall planters.	**01 P**
10	Demonstration on bonsai and terrarium.	**01 P**
11	Preparation of plant growth regulator solutions and its applications for vegetative propagation.	**01 P**
12	Submission of potted plant, Hanging Basket, Moss stick, Wall planters and Bonsai.	**01 P**
13	Visit to Nursery / orchard / floriculture industry / floricultural market and report writing.	**01 P**

References:

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S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-245-MNP

Course Title: Practical based on BOT-242-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. Understand the layout and sterilization techniques used in a Plant Tissue Culture (PTC) laboratory through ICT tools.
2. Learn the principles and applications of key instruments and equipment used in PTC.
3. Perform accurate laboratory calculations for preparing stock solutions and MS media.
4. Execute media preparation, sterilization, and inoculation techniques for organogenesis and callogenesis.
5. Demonstrate micropropagation, subculturing, and hardening procedures for commercially important plants.

COURSE OUTCOMES (COs):

After successful completion of the course, students will be able to:

CO1: Demonstrate knowledge of the layout and aseptic techniques required for setting up and maintaining a plant tissue culture laboratory.

CO2: Explain the working principles, applications, and handling of key instruments and glassware used in plant tissue culture.

CO3: Prepare and sterilize nutrient media and plant growth regulator stock solutions for various in vitro culture processes.

CO4: Perform surface sterilization, inoculation, callus induction, shoot and root proliferation, and micropropagation techniques for important crops.

CO5: Carry out in vitro rooting, sub-culturing, hardening, acclimatization of plantlets, and prepare a technical report based on lab visit.

Sr. No.	Title of the Practical	No. of Practical
1	To study the basic layout of a typical Plant Tissue Culture Laboratory and various sterilization methods used in PTC using ICT tools.	01 P
2	To study the principle, working and applications of instruments / equipment / glassware used in PTC laboratory: Autoclave, Hot Air Oven, pH Meter, One pan Digital Balance, Hot plate Magnetic stirrer, Laminar Air Flow, Refrigerator, Micropipettes, Air Conditioner, Culture Racks, Digital Temperature controlled rotary shaker.	01 P
3	Basics of laboratory mathematics, calculations for solution preparation.	01 P
4	To perform the procedure of stocks solution preparation for various components of MS basal media and plant growth regulators (PGRs).	01 P
5	Preparation and sterilization of MS media supplemented with plant growth regulators (Auxins and cytokinin) for organogenesis (shoot and root formation) and callogenesis (callus production).	02 P

6	Surface sterilization and inoculation of leaf / apical meristem / nodal sector for organogenesis and callogenesis.	**02 P**
7	To study the steps involved in sub culturing of proliferated shoots and roots on freshly prepared nutrient media.	**01 P**
8	To study the procedure involved in hardening of rooted plantlets and its acclimatization.	**01 P**
9	Micropropagation of commercially important plants – Banana / Gerbera / Strawberry / Pomegranate.	**03 P**
10	Initiation of cell suspension culture and its growth measurement.	**01 P**
11	Visit to the plant tissue culture laboratory and preparation of visit report.	**01 P**

References:

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2. De, K. K. (2001). An introduction to plant tissue culture. New Central Book Agency (P) Ltd.
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8. Trigiano, R. N., & Gray, D. J. (2011). Plant tissue culture, development, and biotechnology. CRC Press.
9. Smith, R. H. (2013). Plant tissue culture: Techniques and experiments (3rd ed.). Academic Press.
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Minor Course (MN)

Course Code – BOT-246-MNP

Course Title: Practical based on BOT-243-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To study the structure and types of monocot and dicot seeds using crop examples.
2. To understand different types and methods of seed germination and their testing techniques.
3. To learn seed quality assessment techniques such as purity, moisture content, and seed vigor.
4. To explore various seed sowing methods, irrigation systems, and seed storage practices.
5. To identify common seed/grain pests and recognize seed-borne disease symptoms.
6. To provide practical exposure through field visits to seed industries or research centers.

COURSE OUTCOMES (COs):

After successful completion of the course, students will be able to:

CO1: Differentiate monocot and dicot seed structures with suitable examples.
CO2: Gain hands-on experience in seed germination testing and purity analysis.
CO3: Acquire skills to analyze seed moisture and seed vigor using physical methods.
CO4: Understand and demonstrate various seed sowing and irrigation techniques.
CO5: Identify storage containers, seed tags, pests, and seed diseases effectively.
CO6: Develop practical insights into seed processing and quality control through industrial visits.

Sr. No.	Title of the Practical	No. of Practical
1	To study monocot seed structure w.r.t wheat and maize.	01 P
2	To study dicot seed structure w.r.t chickpea and Cotton/Sunflower.	01 P
3	To study different types of seed germination- Epigeal, Hypogeal and Viviparous.	01 P
4	To study different methods for testing percent seed germination-Soil, Sand and Paper.	02 P
5	To study technique of physical purity analysis with suitable example.	01 P
6	To analyze moisture percent with suitable technique-Hot Air Oven/Digital Moisture meter/Universal Moisture meter.	01 P
7	To analyze seed vigor using physical method-Seed Size, Seed Density and Seed Soundness	01 P
8	To study different methods of seed sowing with suitable examples	01 P
9	To understand seed tags- breeder, foundation, certified and truthful	01 P
10	To know different storage containers and packing material	01 P
11	To study any two store grain pest with suitable example	01 P
12	To study visual examination of dry seeds for diseased symptoms	01 P

13	Demonstration of various irrigation methods- Flood, Drip, Sprinkler, micro-sprinklers, Rain gun, Subsurface	**01 P**
14	Visit to any Seed Industry/Research Centre/Processing Plant	**01 P**

References:

1. Agrawal, P. K. (1995). Seed technology. Oxford & IBH Publishing Co. Pvt. Ltd.
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5. Kochhar, S. L. (2016). Economic botany in the tropics (4th ed.). Macmillan Publishers India.
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7. National Seeds Corporation. (2010). Manual on storage and handling of seeds. NSC Publication.
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S.Y.B.Sc. Botany [Semester - III]

Course Category –Generic Elective (GE) / Open Elective (OE)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Generic Elective (GE) / Open Elective (OE) –(1T = 2C) (Any one from basket)	OE-201-BOT-T	Crop Science	2 C
	OE-202-BOT-T	Medicinal Botany	2 C

S.Y.B.Sc. Botany [Semester - III]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code –OE -201-BOT-T

Course Title: Crop Science

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce the fundamental concepts, history, and branches of crop science.
2. To familiarize students with the classification and examples of major crop groups in India.
3. To understand the climatic, edaphic, and genetic factors influencing crop growth and productivity.
4. To study the agronomic practices and crop management techniques for major cereals, pulses, oilseeds, and fiber crops.
5. To impart knowledge of cultivation, care, and post-harvest handling of major fruit, industrial, sugar, spice, and condiment crops.
6. To explore the role of crop science in sustainable agriculture, food security, and rural development.

COURSE OUTCOMES:

CO 1: Define crop science and explain its historical development and branches.
CO 2: Identify and classify different types of crops based on their usage and characteristics.
CO 3: Describe the influence of soil, climate, and water on crop growth and yield.
CO 4: Demonstrate knowledge of field practices, varietal selection, and input management in major food and fiber crops.
CO 5: Apply agronomic knowledge to the cultivation and management of fruits, spices, sugar, and industrial crops.
CO 6: Evaluate the significance of crop science in enhancing crop productivity and supporting sustainable agriculture.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Crop Science** 1.1 Introduction, definition and history of crop science. 1.2 Branches of crop science. 1.3 Scope and importance of Crop science.	**02**
2	**Classification of crops** 2.1 Cereals – Rice, Wheat, Sorghum, Maize, Bajra, Ragi 2.2 Pulses – Pigeon pea, Moong bean, Chickpea, Black gram, Red lentils (Massor dal) 2.3 Fiber crops – Cotton, Jute, Hemp and Silk 2.4 Oilseeds – Groundnut, Soybean, Sunflower, Safflower, Mustard, Sesamum, and Niger 2.5 Cash crops – Sugarcane, Cotton, Tobacco, Tea, 2.6 Fruit crops – Tomato, Mango, Banana, Grapes, Citrus, Guava, Pomegranate, Drumstick	**05**

	2.7 Medicinal and Aromatic crop plants – 2.7.1 Aromatic crop Plants: Lavender, Basil, Jasmine, Mint, Vanilla, Geranium, Rose, Lemongrass and Citronella. 2.7.2 Medicinal crop plants - Aloe vera, Turmeric, Ginger, Curry leaf, Tulsi.	
3	**Factors required for Crop Growth** 3.1. Introduction 3.2. Climatic zones of India 3.3 Crop seasons: 3.3.1 Kharif season (monsoon crops) 3.3.2 Rabi season (Winter crops) 3.3.3 Zaid season (short summer crops) 3.4 Edaphic (soil) factors: 3.4.1 Types of soil - sandy, loamy, clayey, black, red soils, etc. 3.4.2 Physical and chemical properties of soil for crop growth 3.4.3 Soil water holding (retention) capacity and its effect on crop growth and yield 3.4.4 Effect of soil pH, salinity and alkalinity on crop production 3.4.5 Soil nutrients availability 3.5 Climatic Factors: 3.5.1 Temperature: impact on crop growth, flowering, fruiting, harvesting. 3.5.2 Rainfall: water supply and its role in crop growth 3.5.3 Humidity 3.5.4 Wind velocity 3.6 Impact of water quality and irrigation practices on crop production 3.7 Impact of genetic traits, variety and cultivars on crop production 3.8 Effect of advanced agricultural technology on crop growth	**08**
	CREDIT II	**15**
4	**Major Cereals, Pulses, Oilseeds, and Fiber crops of India** Study of following crops with reference to origin and distribution; season and climatic conditions, soil / edaphic factors; varieties, hybrids and cultivars; cultural practices: land preparation, sowing time, methods and plantation techniques, seed / plant material rate and spacing, intercropping practices; irrigation schedule and types; Intercultural and weeding practices; nutrient and fertilizer management; disease and pest management; harvesting; yield and storage methods: 4.1 Cereals: Wheat and Maize 4.2 Pulses: Pigeon Pea and Chickpea, 4.3 Oilseeds: Groundnut, and Soybean 4.4 Fiber: Cotton	**08**
5	**Major Fruit, Sugar, Industrial, Spices and condiments crops of India** Study of following crops with reference to origin and distribution; season and climatic conditions, soil / edaphic factors; varieties, hybrids and cultivars; cultural practices: land preparation, sowing time, methods and plantation techniques, seed / plant material rate and spacing, intercropping practices; irrigation schedule and types; Intercultural and weeding practices; nutrient and fertilizer management; disease and pest management; harvesting; yield and storage methods:	**07**

	5.1 Fruit crops: Pomegranate and Guava 5.2 Sugar and starch crops: Sugarcane and Sweet potato 5.3 Industrial/commercial crops: Coconut 5.4 Spices and condiments: Chilli and Turmeric	

References:

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3. ICAR. (2006). Handbook of agriculture (6th ed.). Indian Council of Agricultural Research.
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8. Kumar, R. (2017). A textbook of field crops production. New India Publishing Agency.
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code –OE-201-BOT-T

Course Title: Crop Science (पिकशास्त्र)

[No. of Credits: 2 C] (मराठीत अभ्यासक्रम) [No. of Lectures: 30 L]

उद्दिष्टे (OBJECTIVES):

१. पिकशास्त्राचे मूलभूत संकल्पना, इतिहास आणि शाखा यांची ओळख करून देणे.
२. भारतातील प्रमुख पिकांच्या वर्गीकरण आणि उदाहरणांची माहिती देणे.
३. पिकांच्या वाढीवर व उत्पादनक्षमतेवर प्रभाव टाकणाऱ्या हवामानिक, मृदात्मक व आनुवंशिक घटकांचे समज प्राप्त करणे.
४. प्रमुख धान्य, कडधान्य, तेलबियां व तंतू पिकांकरिता कृषिसंवर्धन व व्यवस्थापन तंत्रांचा अभ्यास करणे.
५. प्रमुख फळबाग, औद्योगिक, साखर, मसाला व सुगंधी पिकांच्या लागवड, निगा व पश्चात प्रक्रिया यांचे ज्ञान प्रदान करणे.
६. शाश्वत शेती, अन्नसुरक्षा व ग्रामीण विकासामध्ये पिकशास्त्राच्या भूमिकेचा अभ्यास करणे.

COURSE OUTCOMES (COs):

CO1: पिकशास्त्राची व्याख्या, इतिहास व शाखांचे स्पष्टीकरण करता येणे.
CO2: विविध पिकांचे उपयोग व वैशिष्ट्यांनुसार वर्गीकरण करता येणे.
CO3: मृदा, हवामान व जलविषयक घटकांचा पिकांच्या वाढीवर व उत्पादनावर होणारा प्रभाव समजावता येणे.
CO4: अन्नधान्य व तंतूपिकांमध्ये शेती पद्धती, जातींची निवड व इनपुट व्यवस्थापनाचे ज्ञान दाखवता येणे.
CO5: फळे, मसाले, साखर व औद्योगिक पिकांची लागवड व व्यवस्थापनाचे ज्ञान वापरता येणे.
CO6: उत्पादनक्षमतेत वाढ व शाश्वत शेतीसाठी पिकशास्त्राचे महत्त्व विश्लेषित करता येणे.

अ. क्र.	विषय	तास
	क्रेडीट–१	**१५**
१.	**पिकशास्त्राची ओळख** १.१ पिकशास्त्राची व्याख्या, इतिहास १.२ पिकशास्त्राच्या शाखा १.३ पिकशास्त्राचे महत्त्व व व्याप्ती	०२
२.	**पिकांचे वर्गीकरण** २.१ धान्ये – भात, गहू, ज्वारी, मका, बाजरी, नाचणी २.२ कडधान्ये – तुर, मूग, हरभरा, उडीद, मसूर २.३ तंतूपिके – कापूस, जूट, भांग, रेशीम २.४ तेलबिया – शेंगदाणा, सोयाबीन, सूर्यफूल, करडई, मोहरी, तीळ, खुरासणी २.५ नगदी पिके – ऊस, कापूस, तंबाखू, चहा २.६ फळपिके – टोमॅटो, आंबा, केळी, द्राक्ष, संत्रा, पेरू, डाळिंब, शेवगा २.७ औषधी व सुगंधी वनस्पती - सुगंधी वनस्पती: लॅव्हेंडर, जाई, पुदिना, व्हॅनिला, जिरॅनियम, गुलाब, लेमन गवतव सिट्रोनेला औषधी वनस्पती: कोरफड (अ लोवेरा), हळद, आले, कडीपत्ता, तुळस	०५
३.	**पिकांच्या वाढीसाठी आवश्यक घटक**	०८

	३.१ ओळख ३.२ भारतातील हवामान विभागणी ३.३ पिकांचे हंगाम: खरीप, रब्बी व जायद ३.४ मृदाशास्त्रीय घटक: ३.४.१ मृदेचे प्रकार: वालुकामय, गाळयुक्त, चिकण, काळी, तांबडी इ. ३.४.२ मृदेचे भौतिक व रासायनिक गुणधर्म ३.४.३ मृदेची जलधारण क्षमता व उत्पादनावर परिणाम ३.४.४ सामू (pH), क्षारता व अल्कलिनतेचा परिणाम ३.४.५ पोषक तत्वांची उपलब्धता ३.५ हवामान घटक: ३.५.१ तापमान, ३.५.२ पर्जन्यमान, ३.५.३ आर्द्रता, ३.५.४ वाऱ्याचा वेग ३.६ पाणी गुणवत्ता व सिंचन पद्धतींचा प्रभाव ३.७ आनुवंशिक गुणधर्म, जाती व वाण यांचा परिणाम ३.८ आधुनिक कृषी तंत्रज्ञानाचा प्रभाव	
	क्रेडीट-२	
४.	**प्रमुख धान्य, कडधान्य, तेलबिया व तंतूपिके** मूळ व वितरण; हंगाम व हवामान; मृदाघटक; जाती, वाण व संकरीत वाण; शेती पद्धती – जमीन तयार करणे, पेरणी, बियाण्याचे प्रमाण व अंतर, आंतरपीक पद्धती; सिंचन वेळापत्रक; तणनियंत्रण; पोषण व्यवस्थापन; रोग व कीड नियंत्रण; काढणी, उत्पादन व साठवण यामुद्यांवर आधारित खालील पिकांचा सविस्तर अभ्यास: ४.१ धान्ये: गहू आणि मका ४.२ कडधान्ये: तुर आणि हरभरा ४.३ तेलबिया: शेंगदाणा आणि सोयाबीन ४.४ तंतूपिके: कापूस	०८
५.	**प्रमुख फळे, साखर, औद्योगिक, मसाले व स्वादपिके** मूळ व वितरण; हंगाम व हवामान; मृदाघटक; जाती, वाण व संकरीत वाण; शेती पद्धती – जमीन तयार करणे, पेरणी, बियाण्याचे प्रमाण व अंतर, आंतरपीक पद्धती; सिंचन वेळापत्रक;तणनियंत्रण;पोषण व्यवस्थापन; रोग व कीड नियंत्रण; काढणी, उत्पादन व साठवण या मुद्यांवर आधारित खालील पिकांचा सविस्तर अभ्यास: ५.१ फळपिके: डाळिंब आणि पेरू ५.२ साखर व स्टार्च पिके: ऊस आणि रताळे ५.३ औद्योगिक पिके: नारळ ५.४ मसाले व स्वादपिके: मिरची आणि हळद	०५

संदर्भ ग्रंथ वपुस्तके:

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2. Das, N. R. (2015). Introduction to crop science. Scientific Publishers.
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code – OE-202-BOT-T

Course Title: Medicinal Botany

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To acquire scientific and traditional knowledge of medicinal plants.
2. To understand the fundamental philosophy of various traditional medicinal systems of India.
3. To develop skills in preparing household products from medicinal plants.
4. To learn techniques for the cultivation and conservation of medicinal plants.
5. To gain information about entrepreneurial opportunities and government schemes in the field of medicinal plants.

COURSE OUTCOMES (COs):

CO1: Students will acquire theoretical and scientific knowledge about the definition, historical background, classification of medicinal plants, and the chemical constituents involved in drug formulation.

CO2: Students will understand the philosophy, uses of medicinal plants, and comparative aspects of traditional Indian medicinal systems such as Ayurveda, Unani, Siddha, Naturopathy, and Homeopathy.

CO3: Students will learn the methods of preparing household Ayurvedic products (such as hair oil, Triphala powder, face pack, shampoo, etc.) and will be able to use them safely.

CO4: Students will gain knowledge about the organic cultivation of medicinal plants, biological protection, and conservation techniques (In-situ and Ex-situ), and will develop awareness about the conservation of local biodiversity.

CO5: Students will explore the commercial potential of medicinal plants, local and global markets, startup opportunities, and government schemes, thus paving the way toward entrepreneurship.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction to Medicinal Botany** 1.1 Definition of Medicinal Plants; Uses of medicinal plants in drug formulation; Relationship between medicinal plants, food, health, and nutrition. 1.2 Importance and History –Use of medicinal plants in ancient India (Rigveda, Atharvaveda, Charaka Samhita); India's contribution to global traditional medicinal systems; Need for medicinal plants in modern times. 1.3 Chemical Constituents in Medicinal Plants –Primary and secondary metabolites; Major groups of constituents: alkaloids, glycosides, terpenoids, flavonoids, tannins, phenolic compounds, resins, and latex. 1.4 Scientific Terminology and External Morphology of Medicinal Plants – Scientific nomenclature (Binomial nomenclature); Identification features of medicinal plants (habit, habitat, morphology); Medicinal	**03**

	parts: roots, stems, leaves, fruits, seeds, bark, flowers; Rules for preparing herbarium and field notebooks.	
2	**Traditional Medicine Systems** 2.1 Ayurveda – Definition, sources, and philosophy; Tridosha theory (Vata, Pitta, Kapha); Concepts of Dhatu, Mala, Agni; Description of medicinal plants (Dravya Guna Vigyan). 2.2 Homeopathy – Principle of 'Similia Similibus Curentur'; Use of medicinal plants in dilution; Important medicinal plants and their specific uses. 2.3 Yoga and Naturopathy – Concept of Pancha mahabhutas; Use of medicinal plants in diet therapy; Medicinal components in fruits, vegetables, green juices, etc. 2.4 Siddha System – Origin in Tamil tradition; Combination of medicinal plants and minerals; Medicinal formulations for rejuvenation (Kayakalpa). 2.5 Unani Medicine – Humoral theory (Blood, Phlegm, Yellow bile, Black bile); Use of medicinal plants based on cold/hot properties. 2.6 Other Traditional Systems – Folk medicine, tribal medicinal systems; Traditional Chinese Medicine (TCM).	**06**
3	**Ayurveda** 3.1 Introduction –Origin of Ayurveda and its place in the Vedic era; Major texts: Charaka Samhita, Sushruta Samhita; Modern revival and development. 3.2 Pancha mahabhutas and Tridosha –Five elements: Earth, Water, Fire, Air, Ether; Properties and balance of Vata, Pitta, and Kapha. 3.3 Panchakarma and Body Detoxification –Five therapies: Vamana, Virechana, Basti, Nasya, Raktamokshan; Use of medicinal plants in Panchakarma. 3.4 Diet and Health –Satvik, Rajasik, Tamasik diet; Medicinal plant-based diets for health promotion. 3.5 Importance and Methods of Fasting –Intermittent fasting, medicated water therapy, fruit diet. 3.6 Kitchen Ayurveda –Medicinal components in the kitchen: turmeric, cumin, cinnamon; Kitchen-based herbal formulations. 3.7 Seasons and Ayurveda –Seasonal regimen (Ritucharya) and daily regimen (Dinacharya); Season-specific use of medicinal plants.	**06**
	Credit-II	**15**
4	**Medicinal Plants and Health** 4.1 Impact on Human Health and Treatment of Diseases –Preventive applications; Common ailments: cold, fever, indigestion, skin diseases; Lifestyle diseases: diabetes, hypertension, arthritis. 4.2 Dosage and Methods of Use –Doses based on plant parts: decoction, powder, extract; Precautions in internal/external applications. 4.3 Adulterant Plants and Identification –Morphological/chemical identification of look-alike species; Ways to procure unadulterated medicinal plants.	**03**
5	**Preparation and Use of Homemade Ayurvedic Products** 5.1 Hair Oil – Preparation using Bhringraj, Amla, Brahmi. 5.2 Ubtan (Herbal Body Pack) –Ingredients: Turmeric, Sandalwood, Kasturi. 5.3 Herbal Balm – Using honey, vaseline, and medicinal oils. 5.4 Soap – Herbal soaps using plant extracts and glycerin. 5.5 Shampoo – Using Shikakai, Reetha, Bhringraj.	**05**

	5.6 Face Pack – With MultaniMitti (Fuller's Earth), cucumber, rose water. 5.7 Triphala Powder – Made from Haritaki, Bibhitaki, Amla. 5.8 Tooth Powder – With Babool, clove, cinnamon. 5.9 Ginger Jam – Prepared using ginger extract, jaggery/sugar, and ghee. 5.10 ShatavariKalpa – Made from Shatavari root, sugar, and Vanshlochan.	
6	**Cultivation and Conservation of Medicinal Plants** Medicinal plants in demand by pharmaceutical industries and rare/threatened due to overuse. 6.1 Cultivation of Medicinal Plants – 6.1.1 Selection of Suitable Plants: Species selection based on local climate and soil; priority to indigenous and local species. 6.1.2 Cultivation Requirements: Climate, rainfall, sunlight, soil type and management, irrigation techniques, water conservation. 6.1.3 Cultivation Methods: Nursery management, sowing time and spacing, use of organic farming. 6.1.4 Pest and Disease Management: Biological pest control, eco-friendly plant protection measures. 6.2 Conservation of Medicinal Plants – 6.2.1 Definition and Importance of Conservation. 6.2.2 Conservation Strategies – a) In-situ conservation: Biodiversity parks, sacred groves. b) Ex-situ conservation: Medicinal plant gardens, seed banks, tissue culture, gene banks. c) Community participation: Conservation through local involvement, documentation of traditional knowledge.	**05**
7	**Medicinal Plant Business and Opportunities** 7.1 Business Opportunities –Medicinal plant farming; herbal product manufacturing; export of medicinal plants. 7.2 Startup and Entrepreneurial Opportunities –Creation of "Plant-based wellness brands"; online sale of herbal products. 7.3 Government Schemes and Support –Information on National Medicinal Plants Board (NMPB) schemes; Grants under MSME, Startup India, Skill India, etc.	**02**

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6. Cultivation and Utilization of Medicinal Plants – By C.K. Atal and B.M. Kapoor (RRL Jammu) (Cultivation, selection of species, irrigation, and commercial aspects).
7. Cultivation of Medicinal and Aromatic Plants – S.K. Patil.
8. Current Status of Herbal Drugs in India: An Overview – Vaidya, A. D. B. &Devasagayam, T. P. A. (2007). Journal of Clinical Biochemistry and Nutrition, 41(1), 1–11.
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19. Herbal Drug Industry – By R.D. Chaudhary (Herbal products and startups, production process and certifications).
20. Home Herbal – By Penelope Ody (Home-made herbal remedies and products).
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28. Medicinal Plants: Conservation and Cultivation – By A.N. Shukla (In-situ and ex-situ conservation, seed banks, tissue culture).
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31. Pharmacognosy – By Trease and Evans (Secondary metabolites and chemical constituents of medicinal plants).
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S.Y.B.Sc. Botany [Semester - III]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code –OE-202-BOT-T

Course Title: Medicinal Botany (औषधी वनस्पतीशास्त्र)

[No. of Credits: 2 C] (मराठीत अभ्यासक्रम) [No. of Lectures: 30 L]

उद्दिष्टे(OBJECTIVES):

१. औषधीवनस्पतींचेशास्त्रीयवपारंपरिकज्ञानप्राप्तकरणे.
२. भारताच्या विविध पारंपरिक औषधी चिकित्सा प्रणालींचे मूलभूत तत्त्वज्ञान समजून घेणे.
३. औषधी वनस्पतींपासून तयार होणाऱ्या घरगुती उत्पादने बनविण्याचे कौशल्य आत्मसात करणे.
४. औषधी वनस्पतींच्या लागवडी व संवर्धनाचे तंत्रज्ञान जाणून घेणे.
५. औषधी वनस्पती क्षेत्रातील व्यवसायिक संधी व शासकीय योजनांची माहिती मिळवणे.

COURSE OUTCOMES (COs):

CO1: विद्यार्थ्यांना औषधी वनस्पतींची व्याख्या, ऐतिहासिक पार्श्वभूमी, वर्गीकरण व औषध निर्मितीतील रासायनिक घटक यांचे सैद्धांतिक व शास्त्रीय ज्ञान प्राप्त होईल.
CO2: विद्यार्थी भारतातील पारंपरिक औषधी पद्धती (जसे आयुर्वेद, युनानी, सिद्ध, निसर्गोपचार, होमिओपॅथी इ.) यांचे तत्वज्ञान, औषधी वनस्पतींचा उपयोग व तुलना आत्मसात करतील.
CO3: विद्यार्थी घरगुती आयुर्वेदिक उत्पादने (जसे केश तेल, त्रिफळा चूर्ण, फेस पॅक, शाम्पू इ.) तयार करण्याच्या पद्धती शिकून त्यांचा सुरक्षित वापर करू शकतील.
CO4: विद्यार्थ्यांना औषधी वनस्पतींची सेंद्रिय लागवड, जैविक संरक्षण, व संवर्धनाचे तंत्र (In-situ व Ex-situ) यांची माहिती मिळेल आणि स्थानिक जैवविविधतेचे संरक्षण करण्याची जाणीव निर्माण होईल.
CO5: विद्यार्थी औषधी वनस्पतींच्या व्यवसायिक शक्यता, स्थानिक व जागतिक बाजारपेठ, स्टार्टअप संधी व शासकीय योजना यांचा अभ्यास करून उद्योजकतेकडे वाटचाल करतील.

अ. क्र.	विषय	तास
	क्रेडीट – १	**१५**
१.	**औषधी वनस्पतीशास्त्राचा परिचय** १.१ औषधी वनस्पती व्याख्या; औषधी वनस्पती आणि औषधनिर्मितीतील उपयोग; औषधी वनस्पती व अन्न, आरोग्य, आणि पोषण यांचा संबंध. १.२ महत्व व इतिहास - प्राचीन भारतातील औषधी वनस्पतींचा उपयोग (ऋग्वेद, अथर्ववेद, चरक-संहिता); जगातील पारंपरिक औषधी पद्धतींमध्ये भारताचे स्थान; आधुनिक काळातील औषधी वनस्पतींची गरज. १.३ औषधी वनस्पतींमधील रासायनिक घटक - प्राथमिक व द्वितीयक चयापचय उत्पादने; मुख्य घटक गट: अल्कलॉईड्स, ग्लायकोसाइड्स, टेरपिनॉईड्स, फ्लॅव्होनॉईड्स, टॅनीन्स, फिनॉलिक संयुगे, रेझिन्स व लेटेक्स. १.४ औषधी वनस्पतींसाठी शास्त्रीय संज्ञा व त्यांचा बाह्य रचनेचा अभ्यास - औषधी वनस्पतींची शास्त्रीय नामकरण पद्धती (Binomial nomenclature); औषधी वनस्पती ओळखण्याची वैशिष्ट्ये (habit, habitat, morphology); औषधी भाग: मुळे, खोड, पाने, फळे, बिया, साल, फुले; हर्बेरियम आणि फील्ड नोटबुक तयार करण्याचे नियम .	०३
२.	**पारंपारिक औषधी पद्धती**	०६

	२.१ आयुर्वेद - परिभाषा, स्रोत व तत्वज्ञान; त्रिदोष सिद्धांत (वात, पित्त, कफ); धातु, मल, अग्नि संकल्पना; औषधी वनस्पतींचे वर्णन (द्रव्य गुण विज्ञान) २.२ होमिओपॅथी - 'Similia Similibus Curentur' तत्व; औषधी वनस्पतींचा डायल्यूशनमध्ये वापर; प्रमुख औषधी वनस्पती व त्याचे लक्षणीय उपयोग २.३ योग व निसर्गोपचार - पंचतत्त्व संकल्पना; औषधी वनस्पतींचा आहारोपचारात उपयोग; फळे, भाज्या, ग्रीन जूस इ. मधील औषधी घटक २.४ सिध्द चिकित्सा - मूळ तमिळ औषधी प्रणाली; औषधी वनस्पती आणि खनिज यांचे मिश्रण; कायाकल्पासाठी औषधी संयुगे २.५ युनानी चिकित्सा – हुमोरल थिअरी (Blood, Phlegm, Yellow bile, Black bile); औषधी वनस्पतींचा थंड/उष्ण गुणधर्मानुसार उपयोग २.६ इतर पारंपारिक औषधी पद्धती - लोकचिकित्सा, आदिवासी औषधी पद्धती; चीनची पारंपरिक चिकित्सा प्रणाली (TCM)	
३.	**आयुर्वेद** ३.१ परिचय: आयुर्वेदाचा उगम व वैदिक काळातील स्थान, इतिहास - प्रमुख ग्रंथ: चरक संहिता, सुश्रुत संहिता; विकास: आधुनिक काळातील पुनरुत्थान ३.२ पंचमहाभूत - पृथ्वी, जल, अग्नि, वायू, आकाश आणि त्रिदोष - वात, पित्त, कफाचे गुणधर्म व संतुलन ३.३ पंचकर्म व शरीर शुद्धी - वमन, विरेचन, बस्ती, नस्य, रक्तमोक्षण; औषधी वनस्पतींचा पंचकर्मात उपयोग ३.४ आहार आणि आरोग्य - सात्विक, राजसिक, तामसिक आहार; आरोग्य वृद्धीसाठी औषधी वनस्पतीयुक्त आहार. ३.५ उपवासाचे महत्व व पद्धती - आंतर उपवास, औषधी जलपान, फळाहार ३.६ किचन आयुर्वेद - स्वयंपाकघरातील औषधी घटक: हळद, जिरे, दालचिनी; किचन औषधी फॉर्म्युलेशन ३.७ सन आणि आयुर्वेद - ऋतूचर्या व दिनचर्या; ऋतुनुसार औषधी वनस्पतींचा वापर	०६
	क्रेडीट - २	
४.	**औषधी वनस्पती आणि आरोग्य** ४.१ औषधी वनस्पतींचा मानवी आरोग्यावर होणारा परिणाम आणि विविध रोगांवर उपचार - रोगप्रतिबंधक उपयोग; सामान्य रोग: सर्दी, ताप, अपचन, त्वचारोग इ.; जीवनशैलीविषयक आजार: मधुमेह, रक्तदाब, संधिवात ४.२ औषधी वनस्पतींची मात्रा व घेण्याच्या पद्धती - वनस्पती भागानुसार डोस: क्वाथ, चूर्ण, अर्क; अंतर्गत/बाह्य उपयोगाची काळजी ४.३ औषधीसाठी वापरात येणाऱ्या भेसळ वनस्पती व ओळख - समदर्शी वनस्पती व त्यांच्या भौतिक/रासायनिक ओळख पद्धती; भेसळमुक्त वनस्पती मिळवण्याचे मार्ग	०३
५.	**घरगुती आयुर्वेदिक प्रोडक्ट्स बनवण्याच्या पद्धती व उपयोग** ५.१ केश तेल - भृंगराज, आवळा, ब्राह्मीपासून तयार करण्याची पद्धत ५.२ उटणे - हरिद्रा, चंदन, कस्तुरी मंजन ५.३ लीप बाम - मध, वासेलिन, औषधी तेल ५.४ साबण - वनस्पती अर्क व ग्लिसरीनयुक्त हर्बल साबण ५.५ शाम्पू - शिकेकाई, रिठा, भृंगराज वापरून ५.६ फेस पॅक - मुलतानी माती, काकडी, गुलाबजल ५.७ त्रिफळा चूर्ण - हिरडा, बेहडा, आवळा ५.८ दंतमंजन - बबूल, लवंग, दालचिनी ५.९ आलेपाक - आल्याचा अर्क, गुळ / साखर, तूप ५.१० शतावरी कल्प - शतावरी मूळ, साखर, वंशलोचन	०५

६.	**औषधी वनस्पतींची लागवड आणि संवर्धन** औषधी कंपन्यांमध्ये मागणी असलेल्या तसेच दुर्मिळ व अतिवापरामुळे नष्ट होत चाललेल्या विविध वनस्पतींसंबंधी - ६.१ औषधी वनस्पतींची लागवड – ६.१.१ योग्य वनस्पतींची निवड: स्थानिक हवामान व मातीप्रमाणे प्रजातींची निवड, देशी व स्थानिक औषधी वनस्पतींचे प्राधान्य; ६.१.२ लागवडीसाठी आवश्यक अटी: हवामान, पर्जन्यमान, सूर्यप्रकाश, मृदा प्रकार व त्याचे व्यवस्थापन, सिंचन पद्धती व जलसंधारण; ६.१.३ लागवडीच्या पद्धती: रोपवाटिका व्यवस्थापन, बी व रोप पेरणीची वेळ व अंतर, सेंद्रिय शेतीचा वापर; ६.१.४ कीड व रोग व्यवस्थापन: जैविक कीड नियंत्रण, वनस्पती संरक्षणाचे पर्यावरणपूरक उपाय ६.२ औषधी वनस्पतींचे संवर्धन – ६.२.१ व्याख्या व संवर्धनाचे महत्व; ६.२.२ संवर्धनाचे उपाय – अ) नैसर्गिक अधिवासात (*In-situ*) संवर्धन: जैवविविधता उद्यान, देवराई क्षेत्रांचे संरक्षण; ब) नैसर्गिक अधिवासाबाहेर (*Ex-situ*) संवर्धन: औषधी वनस्पती उद्यान, बियाणे बँक, ऊती संवर्धन, जीवाणुशेती (जिनबँक); क) स्थानिक समुदायाचा सहभाग: लोकसहभागातून संवर्धन, पारंपरिक ज्ञानाचे दस्तऐवजीकरण	०५
७.	**औषधी वनस्पतींचा व्यवसाय व संधी** ७.१ व्यवसायाच्या संधी - औषधी वनस्पती शेती; हर्बल प्रोडक्ट उत्पादन; औषधी वनस्पती निर्यात ७.२ स्टार्टअप व उद्योजक संधी - "वनस्पती आधारित वेलनेस ब्रँड" निर्मिती; ऑनलाईन हर्बल उत्पादन विक्री ७.३ शासन योजना व सहकार्य - NMPB (National Medicinal Plants Board) योजनेची माहिती; MSME, Startup India, Skill India इ. मधून अनुदान	०२

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7. द्रव्य गुण विज्ञान- जवळगेकर –देशपांडे
8. औषधी बाण-पदे शास्त्री
9. औषधी व सुगंधी वनस्पती लागवड –एस. के पाटील
10. औषधी वनस्पती ओळखण्याच्या पद्धती- मेहता पुब्लिकेशन
11. हर दिन हर घर आयुर्वेद-श्रीरामपूर आयुर्वेद आसोसिएशन
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S.Y.B.Sc. Botany [Semester - III]

Course Category –Vocational Skill Courses (VSC)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Vocational Skill Courses (VSC) - (1T/P = 2C) (Any one from basket)	VSC-221-BOT- P	Phytochemistry	2 C
	VSC-222-BOT- T	Digital Herbaria	2 C
	VSC-223-BOT- P	Green Cover and Carbon Crediting	2 C
	VSC-224-BOT- P	Plant Ecology and Biodiversity	2 C

S. Y. B. Sc. Botany [Semester - III]

Course Category – Vocational Skill Courses (VSC)

Course Code – VSC-221-BOT - P

Course Title: Phytochemistry

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To develop skills in the preparation of plant extracts using different extraction techniques.
2. To perform qualitative tests for primary and secondary plant metabolites.
3. To carry out quantitative estimation of phytochemicals using standard protocols.
4. To identify common adulterants in herbal products through simple detection tests.
5. To familiarize students with industrial processes in herbal and nutraceutical production.

COURSE OUTCOMES:

CO1: Students will be able to prepare plant extracts using hot, cold, and maceration methods.
CO2: Students will identify proteins, carbohydrates, lipids, phenols, tannins, flavonoids, glycosides, terpenoids, and alkaloids in plant samples.
CO3: Students will quantify carbohydrates, ascorbic acid, and lycopene from selected plant sources.
CO4: Students will detect adulteration in common household spices and food items.
CO5: Students will gain practical exposure to herbal extraction and processing in industrial settings.

Sr. No.	Title of the Practical	No. of Practical
1	Preparation of reagents and standard solutions used in the phytochemical studies.	01 P
2	Study of qualitative tests for proteins, carbohydrates, and lipids extracted phenols, tannins, and flavonoids (from tea / amala / coffee), glycosides (sorghum / almonds), Terpenoids (Soybean, Groundnut) and alkaloids (tobacco) from any suitable plant material.	02 P
3	Demonstration of Hot and cold extraction.	01 P
4	Preparation of plant extract using water and alcohol solvent by maceration technique.	01 P
5	Quantitative Estimation of Total Phenolic Content Using Folin–Ciocalteu Reagent.	01 P
6	Quantitative estimation of carbohydrates from any suitable plant sample using anthrone reagent.	01 P
7	Quantitative estimation of ascorbic acid from chilli / amla.	01 P
8	Extraction and Thin Layer Chromatographic (TLC) Separation of Alkaloids from *Tobacco* or *Datura.*	01 P
9	Extraction and analysis of lycopene from Tomato using acetone and petroleum ether.	01 P

10	Preparation of *Triphala Churna* using suitable material and its qualitative phytochemical analysis with respect to polyphenols, tannins, ascorbic acid, and flavonoids.	**01 P**
11	Determination of Total Anthocyanins in Flower Petals or Fruits Using pH Differential Method.	**01 P**
12	Extraction and UV-Visible Spectrophotometric Quantification of Curcumin from Turmeric Powder.	**01 P**
13	Evaluation of Antimicrobial Activity of Ethanolic Plant Extracts Using Disc Diffusion Method.	**01 P**
14	Visit to medicinal plant extraction Unit / Nutraceutical industry / Herbal / Ayurvedic Industry and submission of visit report.	**01 P**

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S.Y.B.Sc. Botany [Semester - III]

Course Category –Vocational Skill Courses (VSC)

Course Code - VSC-222-BOT-T

Course Title: Digital Herbaria

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce the concept and significance of traditional and digital herbaria.
2. To develop skills in plant specimen collection, labeling, and documentation.
3. To train students in digitization techniques and image processing of herbarium specimens.
4. To familiarize students with herbarium data management systems and GIS tools.
5. To enable application of digital herbarium data in taxonomic and ecological research.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Understand the scope and importance of digital herbaria in biodiversity conservation.
CO2: Demonstrate proper methods of field collection and documentation of plant specimens.
CO3: Digitize herbarium specimens using appropriate imaging and metadata standards.
CO4: Manage herbarium data using software tools and apply GIS for mapping distributions.
CO5: Use digital herbarium data for plant identification and ecological analysis.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Digital Herbaria** 1.1 Introduction 1.2 Definition and concept 1.3 Scope and applications	**02**
2	**Introduction to Herbarium Collections** 2.1 Overview of traditional herbarium practices 2.2 Role of herbaria in biodiversity research 2.3 Importance of digitalization in preserving biodiversity	**03**
3	**Principles of Botanical Data Collection** 3.1 Plant specimen collection techniques 3.2 Proper labeling and documentation 3.3 Fieldwork and ethical considerations 3.4 Introduction to taxonomic identification	**03**
4	**Digitization of Herbarium Specimens** 4.1 Basics of plant specimen imaging - photography and scanning 4.2 Introduction to metadata - taxonomic, geographic, ecological data 4.3 Handling and preserving physical specimens for digitization 4.4 Digital preservation standards and practices	**07**
	Credit-II	
5	**Image Processing and Annotation** 5.1 Editing and enhancing herbarium specimen images 5.2 software tools for digital annotation (e.g., Adobe Photoshop, open-source alternatives)	**04**

6	**Data Management and Database Systems** 6.1 Introduction to herbarium management software (e.g., Specify, BRAHMS, TROPICOS) 6.2 Cataloging specimens and data entry standards	**03**
7	**Geographic Information Systems (GIS) for Digital Herbaria** 7.1 Introduction to GIS in botanical studies 7.2 Geo-referencing herbarium specimens (using latitude, longitude, elevation data) 7.3 Mapping plant distribution and ecological analysis.	**04**
8	**Taxonomic and Ecological Research with Digital Herbaria** 8.1 Utilizing digital herbarium data for taxonomic research 8.2 Plant identification using digital keys and databases 8.3 Ecological and biogeographical analysis of digital collections 8.4 Case studies of research using digital herbarium data	**04**

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a. https://www.kloranebotanical.foundation/en/botanical-tools
b. https://www.kew.org/science/digitising-kews-collections
c. https://rprcbbsr.in/View/digital_herbarium.aspx
d. http://elearning.bsmrau.net

S.Y.B.Sc. Botany [Semester - III]

Course Category –Vocational Skill Courses (VSC)

Course Code - VSC-223-BOT-P

Course Title: Green Cover and Carbon Crediting

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To identify and classify various green cover types through field-based observation and analysis.
2. To apply practical methodologies for carbon stock estimation, including biomass assessment and soil carbon evaluation.
3. To analyze carbon-crediting mechanisms by conducting carbon footprint assessments and evaluating real-world carbon trading practices.
4. To assess afforestation, reforestation, and industrial green belt policies through case studies and field surveys.
5. To develop hands-on experience with remote sensing, GIS tools, and open-source applications for green cover mapping and carbon stock monitoring.

COURSE OUTCOMES:

CO1: Identify and classify different types of green cover (forests, grasslands, urban vegetation) and assess their carbon sequestration potential through field-based studies.

CO2: Apply vegetation sampling techniques (quadrat, transect, and point sampling) to estimate biomass and soil carbon stocks in various ecosystems.

CO3: Perform carbon stock estimation using allometric equations, GIS mapping, and remote sensing tools to analyze green cover distribution.

CO4: Evaluate carbon-crediting mechanisms by calculating carbon footprints and understanding their application in real-world carbon trading scenarios.

CO5: Conduct policy reviews and case studies on afforestation, reforestation, and industrial green belt initiatives to assess their effectiveness in carbon sequestration.

CO6: Develop practical strategies for enhancing green cover and integrating carbon crediting methodologies through hands-on fieldwork and data analysis.

Sr. No.	Title of the Practical	No. of Practical
1	Survey and Identification of Green Cover Types (Forests, Grasslands, Urban Green Spaces)	01 P
2	Vegetation Sampling Techniques: Quadrat and Transect Sampling Methods	01 P
3	Biomass Estimation of Trees and Shrubs using Non-Destructive Methods	01 P
4	Soil Carbon Stock Assessment using Soil Sampling and Lab Analysis	01 P
5	Application of Remote Sensing and GIS in Mapping Green Cover	01 P
6	Carbon Stock Calculation using different methods	01 P
7	Carbon Footprint Calculation of Individuals and Institutions.	01 P
8	Field Visit to an Industrial Green Belt: Analysis of Tree Cover and Policies	01 P

9	Tree Census of urban/ rural areas like institutional buildings, gardens, public amenities, private properties etc.	**02 P**
10	Study on carbon sequestration potential of the studied area based on the tree census practical.	**01 P**
11	Hands-on Training on carbon credit calculation and market mechanisms.	**01 P**
12	Policy Analysis: Reviewing the Maharashtra Tree Act and Guidelines on Green Belt Development by CPCB.	**01 P**
13	Green audit of institutional campus and Report Writing.	**02 P**

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S.Y.B.Sc. Botany [Semester - III]

Course Category – Vocational Skill Courses (VSC)

Course Code - VSC-224-BOT-P

Course Title: Plant Ecology and Biodiversity

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To understand the use and application of basic ecological instruments in field studies.
2. To estimate vegetation quantitatively using quadrat and line transect methods.
3. To analyze soil and water parameters for assessing environmental quality.
4. To study biomass production and productivity in grassland ecosystems.
5. To evaluate biodiversity and pollution levels using ecological indices and bioindicators.
6. To promote field-based ecological understanding through visits to natural ecosystems.

COURSE OUTCOMES:

CO1: Demonstrate skills in using ecological instruments and field sampling techniques.
CO2: Quantify plant community characteristics and interpret species-area relationships.
CO3: Analyze physico-chemical properties of soil and water in different habitats.
CO4: Assess primary productivity and biomass in terrestrial ecosystems.
CO5: Evaluate environmental health using BOD, COD, Palmer's Index, and biodiversity indices.
CO6: Prepare scientific reports based on ecological field visits and environmental monitoring.

Sr. No.	Title of the Practical	No. of Practical
1	Study of different ecological instruments.	01 P
2	Determination of the minimum size of the quadrat to be required for reliable estimation of vegetation by the species area-curve method.	01 P
3	Study of the community by the quadrat method.	01 P
4	Study of vegetation by line transect / belt method.	01 P
5	Study of biomass and net productivity of grassland.	01 P
6	Determination of pH, EC, moisture content and water holding capacity of the garden and grassland soil.	02 P
7	Estimation of pH, turbidity, and temperature of different water bodies.	01 P
8	Determination of dust holding capacity of leaves of different species.	01 P
9	To determine COD of clean and polluted water by standard method.	01 P
10	To determine BOD of clean and polluted water by using Winkler's method.	01 P
11	Study of water quality by Palmer's Indices.	01 P
12	Compare the diversity of different locations by using Simpson's Index.	02 P
13	Visit to grassland/ Forest/ Wetland/ Sanctuary/ Restoration site etc., and submission of visit report.	01 P

References:

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S.Y.B.Sc. Botany [Semester - III]
Course Category –Indian Knowledge Systems (IKS)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Indian Knowledge Systems (IKS) - (1T = 2C)	IKS-BOT - T	Medicinal Plants in Traditional Systems of Medicine	2 C

S.Y.B.Sc. Botany [Semester - III]

Course Category – Indian Knowledge Systems (IKS)

Course Code – IKS-BOT- T

Course Title: Medicinal Plants in Traditional Systems of Medicine

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

Course Objectives:

1. Understand the foundational principles of Indian medical traditions.
2. Explore the historical, philosophical, and scientific dimensions of Ayurveda and related systems.
3. Examine the integration of body, mind, spirit, and environment in health.
4. Evaluate the relevance of IKS-based health sciences in contemporary contexts.

Course Outcomes (COs):

CO1: Students will achieve a clear understanding of the foundational principles and core concepts of Indian medical traditions, especially Ayurveda.

CO2: They will be able to analyze the historical development, philosophical underpinnings, and scientific basis of Ayurveda and related Indian Knowledge Systems (IKS).

CO3: They will be able to interpret the holistic framework of Indian health sciences, emphasizing the interconnectedness of body, mind, spirit, and environment.

CO4: They will be able to critically evaluate the applicability and relevance of IKS-based health practices in addressing contemporary health and wellness challenges.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction** 1.1 Introduction 1.2 Definition and concept 1.3 Objectives of IKS 1.4 Need and Importance of IKS 1.5 Fields of IKS	**02**
2	**Traditional Medicine System in India (under AYUSH)** 2.1 Introduction, definition and concept 2.2 Medicine Systems in India: Ayurveda, Siddha, Unani, Yoga, Naturopathy, and Homeopathy 2.3 Other Medicine systems: Ethnomedicine	**03**
3	**Foundations of Indian Medical Thoughts** 3.1 Introduction 3.2 Concept of Health (Swasthya) and Disease (Vyadhi) 3.3 Tridosha theory: Vata, Pitta and Kapha 3.5 Panchamahabhuta (Five elements) and Prakriti (body constitution) 3.6 Sources of knowledge: Vedas, Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam	**03**
4	**Ayurveda – Principles and Practice** 4.1 Introduction 4.2 Eight branches of Ayurveda (Ashtanga Ayurveda) 4.2.1 Kaya Chikitsa (General medicine)	**07**

	4.2.2 Shalya Tantra (Surgery) 4.2.3 Shalakya Tantra (ENT & Eye diseases) 4.2.4 Kaumarbhritya (Pediatrics) 4.2.5 Agada Tantra (Toxicology) 4.2.6 Rasayana (Rejuvenation) 4.2.7 Vajikarana (Aphrodisiacs) 4.2.8 BhutaVidya (Psychiatry) 4.3 Ayurvedic diagnostic techniques: Nadi Pariksha (pulse), tongue, eye and urine analysis. 4.4 Treatment modalities: 4.4.1 Ahara (Diet), 4.4.2 Vihara (Lifestyle) 4.4.3 Aushadha (Medicine) 4.4.4 Panchakarma (Detoxification therapies) 4.5 Sanitation, seasonal regimens (Ritucharya), and daily routines (Dinacharya).	
	Credit-II	
5	**Yoga and Health** 5.1 Introduction, definition and History of Yoga 5.2 Ashtanga Yoga (Eight limbs) 5.3 Health benefits of Yoga 5.4 Therapeutic Yoga for stress, anxiety, lifestyle diseases. 5.5 Integration of Yoga with Ayurveda.	**04**
6	**Siddha and Unani Systems** 6.1 Siddha medicine: 6.1.1 Definition and concept 6.1.2 Origin and Philosophy 6.1.3 Diagnosis in Siddha medicine 6.1.4 Treatment methods 6.1.5 Medicines used 6.2 Unani medicine: 6.2.1 Definition and Concept 6.2.2 Origin and Philosophy 6.2.3 Diagnosis in Unani medicine 6.2.4 Treatment methods 6.2.5 Medicines Used	**06**
7	**Ethno-medicine: Indigenous Health Systems and Healing Practices** 7.1 Introduction, definition and concept 7.2 Ethnic societies in Maharashtra 7.3 Ethno-medicinal plants and health care 7.4 Integrating Traditional and Modern Medicine: Challenges and Opportunities	**03**
8	**IKS and Contemporary Healthcare** 8.1 Scientific validation of Ayurvedic practices. 8.2 Integration with modern medicine (AYUSH). 8.3 Ethical issues: Intellectual property, biopiracy, standardization. 8.4 National and global initiatives (Ministry of AYUSH, Central Council of Indian Medicine (CCIM), WHO)	**02**

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2. Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B. Bhat, Vinayak Rajat, Nagendra Pavana R.N.PHI, ISBN: 9789391818203
3. The Heart of Yoga–T.K.V. Desikachar
4. Light on Yoga–B.K.S. Iyengar
5. Ayurveda: The Science of Self-Healing-Dr. Vasant Lad
6. The Complete Book of Ayurvedic Home Remedies- Dr. Vasant Lad
7. Ayurveda: A Life of Balance-Maya Tiwari
8. National Institute of Siddha eBook
9. Siddha Medicine: A Beginner's Guide to the Ancient Indian Healing System by Dani Twain
10. Siddha Medicine: A Handbook of Traditional Remedies-Dr. Thottam
11. Introduction to Siddha Medicine-T. Thirunarayanan
12. Introduction to Unani Medicine-CCRUM (Central Council for Research in Unani Medicine, India)
13. Basics of Unani Medicine- Hakim Syed Zillur Rahman
14. Indian Systems of Medicine– K. Nishteswar
15. Dictionary of Indian Folk Medicine and Ethnobotany-S. K. Jain
16. Notable Plants in Ethno-medicine of India-S. K. Jain

S.Y.B.Sc. Botany [Semester - III]
Course Category –Field Projects (FP)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Field Projects (FP) - (1T = 2C)	FP-231-BOT	Field Project	2 C

S.Y.B.Sc. Botany [Semester - III]

Course Category – Field Project (FP)

Course Code – FP-231-BOT

Course Title: Field Project

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To provide students with hands-on experience in botanical research, observation, and experimentation.
2. To develop critical thinking skills in analyzing botanical concepts and applying them to real-world problems.
3. To develop effective communication skills in presenting botanical information and research findings.

COURSE OUTCOMES:

Upon completing this course the students shall be able to

1. Apply botanical knowledge to real-world problems, including conservation, agriculture, and environmental sustainability.
2. Develop skills in scientific inquiry, including observation, experimentation, and data analysis.

PROJECT REQUIREMENTS

1. Topic Selection: Choose a topic related to botany, such as plant ecology, plant anatomy, or plant physiology, Mutation breeding, Organic farming, Biofertilizers, Biopesticides, Ethnobotany, Plant Tissue Culture, Mushroom Technology, etc.
2. Literature Review: Conduct a literature review to understand the current state of knowledge on the topic.
3. Fieldwork: Conduct fieldwork to collect data, samples, or observations.
4. Data Analysis: Analyze data and interpret results.
5. Report Writing: Write a comprehensive report on the project.

FIELDWORK GUIDELINES

1. Safety Precautions: Follow safety guidelines and protocols during fieldwork.
2. Field diary: Maintain a proper field diary
3. Data Collection: Collect accurate and reliable data.
4. Sample Collection: Collect and preserve plant samples according to guidelines.

REPORT REQUIREMENTS

1. Introduction: Introduce the topic, objectives, and significance of the study.
2. Methodology: Describe the research methodology and fieldwork procedures.
3. Results: Present findings and results.
4. Discussion: Interpret results and discuss implications.
5. Conclusion: Summarize key findings and implications.

EVALUATION CRITERIA

Student field project should be evaluated for total 50 marks (15 marks for internal and 35 marks for external evaluation). During internal assessment, following points should be considered:

1. Appropriateness of the field project
2. Punctuality of the student
3. Field work
4. Field diary
5. Viva voce

The criteria for external evaluation should be

1. Originality and significance of the project, its relevance to the field, and potential impact.
2. Soundness of methodology, research design, and approach.
3. Quality, accuracy, and thoroughness of data collection, analysis, and interpretation.
4. Validity and significance of findings, conclusions, and recommendations.
5. Clarity, organization, and effectiveness of the project report and presentation.

TIMELINE

1. Project Proposal: Submit a project proposal outlining the topic, objectives, and methodology at the starting of the course
2. Fieldwork: Conduct fieldwork according to the approved proposal.
3. Report Submission: Submit the final report within the specified timeframe.

RESOURCES

1. Faculty Guidance: Students will receive guidance from faculty members.

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S.Y.B.Sc. Botany [Semester - IV]

Course Category – Major Core Courses (MJ)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Major Core Courses (2T + 1P) x 2C = 6C	BOT-251-MJ	Plant Anatomy and Embryology	2 C
	BOT-252-MJ	Plant Biotechnology	2 C
	BOT-253-MJP	Practical Based on BOT-251-MJ and BOT-252-MJ	2 C

S.Y.B.Sc. Botany [Semester - IV]

Course Category – Major Core Course (MJ)

Course Code – BOT-251-MJ

Course Title: Plant Anatomy and Embryology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To understand the structure, classification, and function of various plant tissues and tissue systems.
2. To explore the organization and mechanical support system in plant organs such as root, stem, and leaf.
3. To study the normal and anomalous secondary growth in dicot and monocot stems.
4. To examine the development and structure of reproductive structures such as anther and ovule.
5. To understand the processes of microsporogenesis, megasporogenesis, pollination, and fertilization.
6. To describe the formation and structure of embryo and endosperm in angiosperms.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1: Identify and describe different plant tissues and their functions in anatomical sections.
CO 2: Explain the distribution and role of mechanical tissues in supporting plant organs.
CO 3: Differentiate between normal and anomalous secondary growth with suitable examples.
CO 4: Describe the development and structure of male and female reproductive organs in flowering plants.
CO 5: Explain the processes involved in pollination, fertilization, and double fertilization.
CO 6: Compare the structural differences between dicot and monocot embryos and recognize various types of endosperm.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Plant Anatomy** 1.1 Introduction. 1.2 Definition. 1.3 Scope and importance.	**01**
2	**Plant Tissues** 2.1 Ground tissues - structure and functions of parenchyma, chlorenchyma, collenchyma, and sclerenchyma. 2.2 Vascular tissues: structure and function of xylem and phloem; types of vascular bundles. 2.3 Secretory tissues: laticiferous and glandular.	**04**
3	**Epidermal Tissue System** 3.1 Epidermis - structure and function of uniserriate (single-layered) and multiserriate (multi-layered) epidermis.	**02**

	3.2 Stomata – typical structure and function of stomata. 3.3 Epidermal outgrowths- non-glandular and glandular trichomes.	
4	**Mechanical Tissue System** 4.1 Principles involved in distribution of mechanical tissues – Inflexibility, Incompressibility, Inextensibility and Shearing stress. 4.2 Tissues providing mechanical support, their distribution in leaf, stem and root of dicots and monocots.	**03**
5	**Normal secondary growth** 5.1 Introduction and definition. 5.2 Normal secondary growth in annual (*Helianthus*) and perennial stem (*Annona*). 5.3 Structure and function of periderm, bark, tyloses, growth rings and lenticels.	**03**
6	**Anomalous secondary growth** 6.1 Introduction and definition. 6.2 Causes of anomalous secondary growth in plants. 6.2 Anomalous secondary growth in dicot stem (*Bignonia*) and monocot stem (*Dracaena*).	**02**
	CREDIT II	**15**
7	**Introduction to Plant Embryology** 7.1 Introduction. 7.2 Definition. 7.3 Scope and importance.	**01**
8	**Microsporangium, Microsporogenesis and Male gametophyte** 8.1 Microsporangium: structure of tetrasporangiate anther, tapetum - types and functions. 8.2 Microsporogenesis: Definition, process; Types - Successive and simultaneous; Types of microspore tetrad. 8.3 Male gametophyte: Structure of pollen grain; development of male gametophyte.	**05**
9	**Megasporangium, Megasporogenesis and Female gametophyte** 9.1 Megasporangium: Typical structure of ovule; Types of ovules – Anatropous, Orthotropous, Amphitropous, Campylotropous, and Circinotropous. 9.2 Megasporogenesis: Definition, Tenuinucellate and Crassinucellate ovules;Types of megaspore tetrads. 9.3 Female gametophyte: Structure of typical 8-nucleate embryo sac; Types and development of embryo sacs – Monosporic, Bisporic and Tetrasporic.	**06**
10	**Pollination and Fertilization** 10.1 Introduction and definition, 10.2 Types of pollination; Entry of pollen tube; Discharge of pollen tube content, Fusion of gametes, Syngamy, Triple fusion. 10.3 Significance of double fertilization.	**02**
11	**Embryo and Endosperm** 11.1 Typical structure of dicot and monocot embryo. 11.2 Types of endosperm: Nuclear, Helobial, and Cellular.	**01**

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1. Esau, K. (1977). Anatomy of seed plants (2nd ed.). New York: John Wiley & Sons.

2. Fahn, A. (1990). Plant anatomy (4th ed.). Oxford: Pergamon Press.
3. Pandey, B. P. (2016). Plant anatomy (Revised ed.). New Delhi: S. Chand & Company Ltd.
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7. Raghavan, V. (2000). Developmental biology of flowering plants. New York: Springer.
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9. Shivanna, K. R. (2003). Pollen biology and biotechnology. Enfield, NH: Science Publishers.
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12. Beck, C. B. (2010). An introduction to plant structure and development: Plant anatomy for the twenty-first century (2nd ed.). Cambridge: Cambridge University Press.
13. Archive.org link: https://archive.org/details/AnatomyOfSeedPlantsByKatherineEsau
14. Free biology books by OpenStax with plant biology chapters: https://openstax.org/subjects/science
15. Covers plant anatomy and reproduction well for foundational understanding. Download PDFs:https://ncert.nic.in/textbook.php

S.Y.B.Sc. Botany [Semester - IV]

Course Category – Major Core Course (MJ)

Course Code – BOT-252-MJ

Course Title: Plant Biotechnology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To understand the basics and importance of plant biotechnology.
2. To learn plant tissue culture methods and their applications.
3. To study the production and uses of Single Cell Protein.
4. To explore enzyme technology and its industrial uses.
5. To understand genetic engineering, fermentation, and biofuel technologies.

COURSE OUTCOMES:

After successful completion of this course, students will be able to:

CO 1: Understand the basic concepts, scope, and interdisciplinary nature of plant biotechnology and tissue culture.

CO 2: Explain the principles of sterilization, nutrient media preparation, micropropagation, and their applications.

CO 3: Describe the production and importance of Single Cell Protein (SCP) and industrially important enzymes.

CO 4: Understand the tools and methods of genetic engineering and their applications in crop improvement.

CO 5: Demonstrate knowledge of fermentation technology, bioreactor types, biofuel production, and downstream processing.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction to Plant Biotechnology** 1.1. Introduction and Definition. 1.2. Scope and importance of plant biotechnology.	**02**
2	**Plant Tissue Culture Technology** 2.1. Introduction, definition, concept of cellular totipotency, differentiation, dedifferentiation, and re-differentiation. 2.2. Sterilization – definition, methods of sterilization. 2.3. Nutrient medium – definition and concept of medium; composition of Murashige and Skoog (MS) medium. 2.4. Micropropagation – definition and concept; stages of micropropagation - Stage I: Mother plant selection; Stage II: Initiation / establishment; Stage III: Multiplication; Stage IV: Rooting; Stage V: Hardening and acclimatization. 2.5. Applications of plant tissue culture.	**05**
3	**Single Cell Protein (SCP) Production Technology** 3.1. Introduction, concept and definition of SCP. 3.2. Importance of protein in diet.	**03**

	3.3. Production of SCP from *Spirulina* and Yeast. 3.4. Importance and acceptability of SCP.	
4	**Enzyme Technology** 4.1. Introduction and definition; properties and classification of enzymes. 4.3. Industrial applications of enzymes. 4.4. Importance and commercial production of amylases, proteases and lipases w.r.t source organism, substrate, growth conditions and purification of enzyme. 4.5. Enzyme immobilization –definition and concept. 4.6. Immobilization methods – a) Chemical – Adsorption; covalent bonding – support and cross-linking; b) Physical – Entrapment and Encapsulation.	**05**
	Credit II	**15**
5	**Genetic Engineering Technology** 5.1. Introduction, definition and concept of genetic engineering. 5.2. Tools of genetic engineering – a) Restriction enzymes and DNA ligases. b) Gene cloning vectors – concept of gene cloning, Types of vectors – plasmid: pBR322 and lambda phage vector. 5.3. Methods of gene transfer in plants – a) Vector mediated gene transfer*: Agrobacterium tumefaciens* – structure of Ti plasmid and process of T-DNA gene transfer in plant. b) Direct gene transfer: Electroporation, microinjection and Biolistic gene gun. 5.4. Application of plant genetic engineering for crop improvement – Insect pest resistance – Bt-cotton; Improved seed production and yield – GM mustard Dhara Mustard Hybrid-11 (DMH-11), Abiotic stress tolerance – proline synthesis using p5CS gene; Herbicide resistance – glyphosate resistant soybean.	**07**
6	**Fermentation Technology** 6.1. Introduction, definition, and concept of fermentation. 6.2. Organisms and substrates involved in fermentation process 6.3. Types of culture: a) Batch culture – phases of microbial growth in batch culture b) Continuous culture 6.4. Solid and liquid state fermentation 6.5. Bioreactor (Fermenters) – definition; Types of Bioreactors – Tubular Tower, Stirred Tank, Digestive Tank bioreactor. 6.6. Concept of scaling up. 6.7. Downstream processing.	**05**
7	**Biofuel Technology** 7.1. Introduction, definition, and concept of biofuel. 7.2. Types of renewable and non-renewable energy sources. 7.3. Definition, concept and production of Biogas, Biodiesel and Bio-hydrogen.	**03**

References:

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2. B.D. Singh (4thEdn 2012) Biotechnology-expanding horizons, Kalyani Publishers.
3. Bhojwani, S. S., &Razdan, M. K. – Plant Tissue Culture: Theory and Practice (Elsevier)
4. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction (Wiley-Blackwell)
5. Chaplin, M. F., &Bucke, C. – Enzyme Technology (Cambridge University Press)
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8. Demirbas, A. – Biofuels: Securing the Planet's Future Energy Needs (Springer)
9. Dubey, R. C. – A Textbook of Biotechnology (S. Chand Publishing)
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14. Kothari, R., Tyagi, V. V., Pathak, A., &Tyagi, S. K. – "Waste to energy: A way from renewable energy sources to sustainable development." Renewable and Sustainable Energy Reviews (Journal Article)
15. Kumar, P., Barrett, D. M., Delwiche, M. J., & Stroeve, P. – "Methods for Pretreatment of Lignocellulosic Biomass for Efficient Hydrolysis and Biofuel Production." Industrial & Engineering Chemistry Research (Journal Article)
16. Primrose, S. B., Twyman, R. M., & Primrose, S. – Principles of Gene Manipulation and Genomics (Wiley-Blackwell)
17. Reinert, J., & Bajaj, Y. P. S. – Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture (Springer-Verlag)
18. Satyanarayana, U. – Biotechnology (Books and Allied Pvt. Ltd.)
19. Smith, R. H. – Plant Tissue Culture: Techniques and Experiments (Academic Press)
20. Stanbury, P. F., Whitaker, A., & Hall, S. J. – Principles of Fermentation Technology (Butterworth-Heinemann)
21. Trevor Palmer – Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (Horwood Publishing)
22. Trivedi, P. C. – Plant Biotechnology: New Vistas (Panima Publishing)
23. Vyas, S. P., & Dixit, V. K. – Pharmaceutical Biotechnology (CBS Publishers)
24. Waites, M. J., Morgan, N. L., Rockey, J. S., &Higton, G. – Industrial Microbiology: An Introduction (Wiley-Blackwell)
25. Whitaker, J. R., Voragen, A. G. J., & Wong, D. W. S. (Eds.) – Handbook of Food Enzymology (Marcel Dekker Inc.)

S.Y.B.Sc. Botany [Semester - IV]
Course Category – Major Core Course (MJ)
Course Code – BOT-253-MJP
Course Title: Practical Based on BOT-251-MJ and BOT-252-MJ

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To understand the structure and function of plant tissues through the study of epidermal, mechanical, and vascular tissues.
2. To differentiate normal and anomalous secondary growth in dicot stems using double stained temporary preparations.
3. To study reproductive structures such as anther, ovules, endosperms, embryos, and in vivo pollen germination.
4. To gain hands-on experience in plant tissue culture techniques including media preparation, sterilization, and explant inoculation.
5. To explore microbial biotechnology applications through SCP production and citric acid estimation using *Aspergillus niger*.
6. To develop skills in enzymology and biotechnology instrumentation including enzyme activity assays and enzyme immobilization.

COURSE OUTCOMES:

CO 1: Students will be able to identify and describe epidermal tissue structures, stomata, and mechanical tissue distribution in plant organs.

CO 2: Students will demonstrate the ability to prepare and analyze normal and anomalous secondary growth sections using double staining techniques.

CO 3: Students will understand the development and structure of reproductive parts like anther, ovules, embryos, and endosperms through microscopic study.

CO 4: Students will acquire basic skills in media preparation, aseptic handling, and explant inoculation in plant tissue culture.

CO 5: Students will demonstrate knowledge of microbial fermentation processes and estimate biochemical products such as citric acid.

CO 6: Students will perform enzyme activity assays and immobilization techniques and understand the working of essential biotechnology instruments.

Sr. No.	Title of the Practical	No. of Practical
	Credit I – Practical Based on BOT 251 MJ	
1	Study of epidermal tissue system – Epidermis, stomata and epidermal outgrowths.	01 P
2	Study of the distribution of mechanical tissues in root, stem and leaf; and principles involved in it.	01 P
3	Study of normal secondary growth in dicot stem – *Annona* and *Helianthus*. (Double stained temporary preparation).	01 P
4	Study of anomalous secondary growth in *Bignonia* and *Dracaena* stem. (Double stained temporary preparation).	01 P

5	Demonstration of T.S. of tetrasporangiate anther and types of ovules.	**01 P**
6	Study of in vivo pollen grain germination in any suitable plant.	**01 P**
7	Demonstration of types of endosperms and embryos.	**01 P**
	Credit II– Practical Based on BOT 252 MJ	
8	Instrument / equipment used in plant tissue culture – principle and working of autoclave, hot air oven, laminar air flow, pH meter.	**01 P**
9	Production of SCP using *Spirulina* / Yeast and study of its commercial product (Demonstration).	**01 P**
10	Preparation of MS medium and inoculation of nodal sector / apical meristem / embryo.	**02 P**
11	Production of citric acid by *Aspergillus niger*and estimation of citric acid by titration method.	**01 P**
12	To study the activity of catalase enzyme extracted from suitable plant material.	**01 P**
13	To immobilize the enzyme amylase (or yeast invertase) using sodium alginate and calcium chloride.	**01 P**
14	Visit to tissue culture / biotechnology industry / fermentation industry / effluent treatment plant and submission of visit report.	**01 P**

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1. Bhojwani, S. S., & Bhatnagar, S. P. (2015). The embryology of angiosperms (5th ed.). Vikas Publishing House.
2. Chopra, V. L., &Nasim, A. (Eds.). (1990). Genetic engineering and biotechnology: Concepts, methods, and applications. Oxford & IBH Publishing.
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S.Y.B.Sc. Botany [Semester - IV]

Course Category –Minor Courses (MN)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Minor Courses (1 T + 1P) x 2C = 4 C (Any one Theory and Practical course from basket)	BOT -291-MN	Hybrid Seed Production	2 C
	BOT-292-MN	Biological Techniques	2 C
	BOT-293-MN	Herbal Product Technology	2 C
	BOT-294-MNP	Practical based on BOT-291-MN	2 C
	BOT-295-MNP	Practical based on BOT-292-MN	2 C
	BOT-296-MNP	Practical based on BOT-293-MN	2 C

S.Y.B.Sc. Botany [Semester - IV]

Course Category – Minor Course (MN)

Course Code – BOT-291-MN

Course Title: Hybrid Seed Production

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To understand the concept and step of hybridization.
2. To understand the Heterosis and Inbreeding depression.
3. To understand the role of apomixis, male sterility and self-incompatibility.
4. To gain the knowledge regarding basic principles in hybrid seed production.
5. To learn hybrid seed production in cotton and maize.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1: Acquainted with the concept and steps of hybridization.
CO2: Understand the basic concept of Heterosis and Inbreeding depression.
CO3: Understand role of apomixis, male sterility and self-incompatibility in hybrid seed production.
CO4: Gain the knowledge regarding basic principles in hybrid seed production.
CO5: Describe the commercial cultivation techniques and value addition processes of selected horticultural crops.
CO6: Learn hybrid seed production in cotton and maize.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	**15**
1	**Introduction to Hybridization** 1.1 Introduction, Definition and concept of hybridization. 1.2 Objectives and types of hybridization- Interspecific, Intraspecific, and Intergeneric. 1.3 Steps in hybrid seed production: Selection of parents, emasculation, bagging, pollination, tagging, and collection of hybrids. 1.4 Applications of hybridization.	**03**
2	**Heterosis and inbreeding depression** 2.1 Introduction, definition and concept. 2.2 Genetic basis of Heterosis and inbreeding depression 2.3 Commercial utilization	**03**
3	**Apomixis** 3.1 Introduction, definition and concept of apomixs. 3.2 Classification of apomixes. 3.3 Detection of apomixes. 3.4 Advantages of apomixes.	**04**
4	**Male sterility** 4.1 Introduction, definition and its importance.	**05**

	4.2 Types of male sterility - 4.2.1 GMS - Introduction and its use in hybrid seed production. 4.2.2 CMS- Introduction and its use in hybrid seed production. 4.2.3 CGMS- Introduction, seed production of A, B and R-Lines. 4.3 Application of male sterility.	
	CREDIT II	**15**
5	**Self- incompatibility** 5.1 Introduction, definition and concept. 5.2 Types of self incompatibility: Heteromorphic and Homomorphic 5.3 Utilization in production of hybrids	**03**
6	**Basic principles of hybrid seed production** 6.1 Introduction, definition of variety and its type. 6.2 Selection of site for seed production. 6.3 Different techniques in Emasculation, pollination and precautions to be taken. 6.4 Use of male sterility and Gametocides. 6.5 Sowing, row spacing, fertilizer and irrigation. 6.6 Isolation, planting ratio and seed rate. 6.7 Rouging and pollen shedders. 6.8 Pollen viability. 6.9 Pollen storage. 6.10 Stigma receptivity.	**06**
7	**Hybrid seed production** 7.1 Introduction and concept of hybrid seed production. Hybrid seed production in - 7.2 Maize (Fodder Crop), 7.3 Cotton (Fiber Crop), 7.4 Soybean (Oil Seed Crop) with respect to following points - 7.4.1 Source of seed. 7.4.2 Selection of field (Land requirement). 7.4.3 Isolation distance. 7.4.4 Sowing. 7.4.5 Cultural practices (Fertigation, Irrigation, plant protection). 7.4.6 Rouging. 7.4.7 Harvesting and threshing.	**06**

References:

1. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi.
2. Plant breeding-B.D Singh, Kalyani Publishers, New Delhi.
3. Essentials of Plant Breeding- Phundan Singh, 2008.
4. Experimental Seed Science and Technology –Umarani et. al. 2006.,Agrobios, Jodhpur.
5. Plant Breeding: Principles and Methods- Phundan Singh, 2009. Kalyani Publishers, New Delhi.
6. Seed Technology- Agrawal, 2005. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

7. Principles of crop production-Reddy, 2008. Kalyani Publishers, New Delhi.
8. Seed Technology-Harpal Singh Tomar.
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S.Y.B.Sc. Botany [Semester - IV]
Course Category –Minor Course (MN)
Course Code – BOT-292-MN
Course Title: Biological Techniques

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce fundamental principles and instrumentation of key biological techniques.
2. To develop practical understanding of electrophoresis, chromatography, and spectrophotometry.
3. To familiarize students with hybridization (blotting) techniques for nucleic acids and proteins.
4. To explain data analysis techniques in biology using biostatistics.
5. To enhance students' ability to apply biological tools in research and diagnostics.

COURSE OUTCOMES (COs):

After successful completion of the course, students will be able to:

CO1: Explain the working principles, components, and applications of pH, EC meters, and spectrophotometers.

CO2: Perform gel electrophoresis (agarose and PAGE) and interpret results with appropriate staining and visualization.

CO3: Describe and differentiate Southern, Northern, and Western blotting techniques and their applications.

CO4: Apply chromatography principles to separate and analyze biological compounds using paper, TLC, and column methods.

CO5: Analyze biological data using basic statistical tools and interpret graphical and quantitative outputs.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction to basic biological techniques** 1.1. Principle, components, procedure and applications of pH meter and Electrical Conductivity (EC) meter.	**03**
2	**Gel Electrophoresis** 2.1. Principles of gel electrophoresis 2.2. Types: a) **Agarose gel electrophoresis:** Principle; types – horizontal and vertical; Components: agarose gel matrix or media; instrumentation – electrophoretic unit (electrophoresis tank and power supply), gel casting trays and combs; electrophoresis buffer - Tris-acetate-EDTA (TAE) Tris-borate-EDTA (TBE), and sample loading buffer; staining and visualization - DNA/RNA: Ethidium bromide (EtBr) and SYBR Green or GelRed.	**06**

	Stepwise procedure of agarose gel electrophoresis – gel casting, sample loading, electrophoresis, staining and visualization. **b) Polyacrylamide Gel Electrophoresis (PAGE) –** Principle; Types - Native PAGE and SDS-PAGE; Components: gel matrix – stacking and separating gel; Chemical components of PAGE and their role – Acrylamide, Bisacrylamide, Sodium dodecyl sulphate (SDS), Urea, Ammonium persulfate (APS), N, N, N′, N′-tetramethylethylene-diamine (TEMED); gel casting tray and comb, electrophoresis tank and power supply, buffer solutions – Tris-acetate-EDTA (TAE) and Tris-borate-EDTA (TBE), loading dye, DNA/protein ladder or marker; staining and visualization of protein: Commassie Brilliant Blue, Silver staining, western blotting Stepwise procedure of PAGE – gel casting, sample loading, electrophoresis, staining and visualization. 2.5. Limitations and Trouble shootings 2.6. Applications of gel electrophoresis	
3	**Hybridization (Blotting) Techniques** 3.1. Southern hybridization for DNA – principle, procedure – DNA isolation, restriction digestion, gel electrophoresis, denaturation, blotting (transfer) using nitrocellulose or nylon membrane, fixation, hybridization and detection; Applications of southern hybridization. 3.2. Northern hybridization for RNA – principle, procedure – RNA extraction, gel electrophoresis, transfer / blotting, fixation, hybridization using labelled DNA/RNA probe and detection; Applications of northern blotting. 3.3. Western hybridization for Proteins – principle, procedure – protein extraction, SDS-PAGE, protein transfer to membrane, blocking, primary and secondary antibody incubation, and detection; Applications of western blotting.	**06**
	Credit II	**15**
4	**Chromatography Techniques** 4.1 Introduction and definition of chromatography 4.2 Basic principles of chromatography - Partition and adsorption chromatography; Mobile and stationary phases 4.3 Classification of chromatographic techniques: 4.3.1 Based on physical state: Gas and Liquid Chromatography 4.3.2 Based on mechanism: Adsorption, Partition, Ion-exchange, Size-exclusion, and Affinity. 4.4 Paper Chromatography: Principle, types (ascending, descending, circular); Solvent systems and Rf value calculation; Applications. 4.5 Thin Layer Chromatography (TLC): Plate preparation, stationary phases, developing solvents; Visualization techniques (UV light, iodine vapor, spraying reagents); Quantitative analysis using TLC. 4.6 Introduction to Column Chromatography; Ion Exchange Chromatography; Gas Chromatography and High-Performance Liquid Chromatography (HPLC)	**05**
5	**Spectrophotometry** 5.1 Introduction and definition of spectrophotometry.	**05**

	5.2 Principle of spectrophotometry – Beer Lambert Law 5.3 Types of absorption: UV, Visible and Infra Red (IR); Light Source; Monochromator; Cuvette Detector 5.4 UV-Visible Spectrophotometry: Instrumentation and working; Absorption spectra and λmax; Applications in qualitative and quantitative analysis. 5.5 IR Spectrophotometry: Principle of IR absorption; Functional group identification; IR instrumentation (FTIR basics)	
6	**Biostatistics and Data Analysis** 6.1 Introduction, Definition, scope, and importance of biostatistics in biology. 6.2 Types of data: Qualitative and quantitative; Types of variables: Discrete and continuous 6.3 Data collection methods: Primary and secondary data; Data tabulation and graphical representation (bar diagram, histogram, pie chart, line graph) 6.4 Measures of Central Tendency: Mean, median, and mode - definitions, formulas, and calculation. 6.5 Range, variance, standard deviation, coefficient of variation; Basic concepts of probability: definitions and rules. 6.6 Data Analysis: Sampling methods - random and non-random; Concept of population vs sample; Null and alternative hypotheses; Basics of t-test and chi-square test.	**05**

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1. Boyer, R. (2012). Modern Experimental Biochemistry (3rd ed.). Pearson Education.
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3. Cooper, T. G. (1977). The Tools of Biochemistry. Wiley-Interscience.
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S.Y.B.Sc. Botany [Semester - IV]

Course Category –Minor Course (MN)

Course Code – BOT-293-MN

Course Title: Herbal Product Technology

[No. of Credits: 2 C] **[No. of Lectures: 30 L]**

OBJECTIVES:

1. To introduce the concept, types, and importance of herbal products.
2. To familiarize students with methods of preparation and classification of herbal products.
3. To impart knowledge on extraction techniques and quality control of herbal formulations.
4. To understand the pharmacological uses of common medicinal plants.
5. To promote awareness about commercialization, marketing, and documentation of herbal knowledge.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Define and differentiate various types of herbal products and their applications.

CO2: Demonstrate preparation methods for herbal formulations like decoctions, tinctures, and powders.

CO3: Apply suitable extraction and standardization techniques for herbal products.

CO4: Describe the pharmacological importance of selected medicinal plants.

CO5: Collect, record, and report traditional herbal knowledge from local sources.

Sr. No.	Topic Details	No. of Lectures
	Credit I	**15**
1	**Introduction to Herbal Products** 1.1 Introduction and definition of herbs 1.2 Concept of Herbal products. 1.3 Scope and Importance of Herbal Products, 1.4 Identification and authentication of herbal materials, 1.5 Adulteration.	**02**
2	**Types of Herbal Products** 2.1 Introduction 2.2 Concept of Cosmetics, Nutraceuticals and pharmaceuticals. 2.3Herbal Cosmetics: Shampoos, Creams, Soaps, Lotions,Ointments. 2.4 Herbal Nutraceuticals: Health Drinks and Tea, Dietary Supplements. 2.5 Herbal Pharmaceuticals: Tablets, Syrups, Capsules.	**04**
3	**Herbal Products and Methods of Preparation** 3.1 Classification of Herbal products based on botanical characteristics: 3.1.1 Herbs –e.g., Tulsi, Brahmi 3.1.2 Shrubs – e.g., Adulsa, Lemon grass 3.1.3 Trees – e.g., Neem, Arjuna 3.1.4 Climbers and Creepers – e.g., Giloy, Betel/ pepper or pimpli 3.2 Methods of Herbal product preparation	**04**

	3.2.1 Decoctions (Kadha) – Boiling herbs in water 3.2.2 Infusions – Soaking herbs in hot/cold water 3.2.3 Tinctures – Alcoholic extracts 3.2.4 Powdered drugs (Churna) – Dried and powdered plant material 3.2.5 Medicated oils/ghee – Used in Ayurvedic treatments.	
4	**Extraction and Processing of Herbal Products** 4.1 Extraction Methods 4.1.1 Maceration- hot and cold method, 4.1.2 Simmering, 4.1.3 Soxhlet, 4.1.4 Steam Distillation, 4.1.5 Supercritical Fluid Extraction. 4.2 Purification and isolation of bioactive compounds - Standardization and Quality Control of Herbal drugs	**04**
	Credit-II	**15**
5	**Pharmacological evaluation** 5.1 Pharmacological properties and uses of common medicinal plants: Neem, Tulsi, *Aloe vera*, Ashwagandha, Adulsa and Turmeric.	**02**
6	**Quality Control and Regulatory Aspects** 6.1 WHO and AYUSH Guidelines for Herbal Products, 6.2 Good Manufacturing Practices (GMP) and Safety Standards, 6.3 Adulteration, Contaminants, and Detection Methods.	**04**
7	**Commercialization and marketing of herbal products** 7.1 Entrepreneurship in Herbal Industry, 7.2 Market research and analysis 7.3 Business planning 7.4 Market Trends and Consumer Demand for Herbal Products. 7.5 Packaging, Labelling, and Branding Strategies.	**04**
8	**Documentation of Local Herbal Knowledge** 8.1 Students interview with local vendors, traditional healers, or family members about herbs used for common ailments (cold, wounds, digestion, skin issues), 8.2 Introduction to Basic Observational Recording and Report preparation.	**05**

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S.Y.B.Sc. Botany [Semester - IV]

Course Category – Minor Course (MN)

Course Code – BOT-294-MNP

Course Title: Practical based on BOT-291-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. Demonstrate hybrid seed production in cotton and maize.
2. Identify male sterile plants and confirm sterility using acetocarmine test.
3. Study pollen viability and seed extraction methods.
4. Calculate seed rate and NPK dose for hybrid crops.
5. Understand harvesting, plant protection, and farm machinery use.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Perform hybrid seed production techniques in field crops..
CO2: Identify and confirm male sterility using lab techniques.
CO3: Apply seed extraction and pollen viability methods.
CO4: Calculate agronomic inputs like seed rate and fertilizers.
CO5: Analyze hybrid seed production practices during field visits.

Sr. No.	Title of the Practical	No. of Practical
1	Study of layout for hybrid seed production in cotton, Bajra and maize.	01
2	To demonstrate hybrid seed production technique in cotton.	01
3	To demonstrate hybrid seed production technique in maize.	01
4	Identification of genetic male sterile plants at bud initiation stage and study laboratory method for confirmation of sterility in maize by acetocarmine test under microscope.	01
5	To study percent pollen viability with suitable example.	01
6	To study the calculation of seed rate required for sowing with suitable examples (Cotton, Maize/ Soyabean, Wheat /Ground Nut, Sorghum).	01
7	Demonstration of different farm equipment's and machineries used in hybrid seed production.	01
8	To understand the different harvesting and threshing methods used in hybrid seed production with suitable examples.	02
9	To understand isolation distance required for different classes of seed (Foundation and Certified Seed).	01
10	To study the plant protection methods in hybrid seed production.	02
11	To understand the calculation of NPK dose for hybrid seed production in any suitable crop.	01
12	Visit to R&D field and submission of report.	02

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S.Y.B.Sc. Botany [Semester - IV]

Course Category – Minor Course (MN)

Course Code – BOT-295-MNP

Course Title: Practical based on BOT-292-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To introduce the fundamental principles of analytical and separation techniques used in biological sciences.
2. To provide hands-on experience in electrophoresis, chromatography, spectrophotometry, and instrumentation.
3. To demonstrate hybridization techniques for detection of nucleic acids and proteins.
4. To develop basic skills in data recording, analysis, and presentation using statistical tools.
5. To enhance analytical thinking and laboratory proficiency through practical experiments.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Explain the working principles and applications of biological instruments like pH and EC meters.

CO2: Perform and interpret results from electrophoresis, chromatography, and spectrophotometric techniques.

CO3: Demonstrate the process and significance of blotting techniques in molecular biology.

CO4: Apply biostatistical tools to analyze and represent biological data accurately.

CO5: Develop competency in handling laboratory procedures and troubleshooting technical errors.

Sr. No.	Title of the Practical	No. of Practical
1	To measure the pH of different solutions using a pH meter.	01
2	To measure the electrical conductivity (EC) of soil and water samples using a conductivity meter.	01
3	To perform Agarose Gel Electrophoresis for separation of DNA samples and visualize DNA bands using Ethidium Bromide or GelRed under UV light.	02
4	To separate proteins using SDS-PAGE, stain and visualize protein bands using Coomassie Brilliant Blue.	02
5	Demonstration of Southern blotting technique for DNA hybridization.	01
6	Demonstration of Western blotting technique for protein detection.	01
7	To separate amino acids or plant pigments using Paper Chromatography and calculate Rf values.	01
8	To separate compounds using Thin Layer Chromatography (TLC) and visualize spots using iodine or UV.	02
9	To determine the λmax of a colored solution using UV-Visible Spectrophotometer.	01
10	To estimate protein concentration using the Biuret or Lowry method and measure absorbance.	01

11	To calculate mean, median, mode, standard deviation, and variance from given biological data.	**01**
12	To construct bar diagrams, histograms, and pie charts using biological data (manual or Excel).	**01**

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S.Y.B.Sc. Botany [Semester - IV]

Course Category – Minor Course (MN)

Course Code – BOT-296-MNP

Course Title: Practical based on BOT-293-MN

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To introduce the fundamental principles of analytical and separation techniques used in biological sciences.
2. To provide hands-on experience in electrophoresis, chromatography, spectrophotometry, and instrumentation.
3. To demonstrate hybridization techniques for detection of nucleic acids and proteins.
4. To develop basic skills in data recording, analysis, and presentation using statistical tools.
5. To enhance analytical thinking and laboratory proficiency through practical experiments.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Explain the working principles and applications of biological instruments like pH and EC meters.

CO2: Perform and interpret results from electrophoresis, chromatography, and spectrophotometric techniques.

CO3: Demonstrate the process and significance of blotting techniques in molecular biology.

CO4: Apply biostatistical tools to analyze and represent biological data accurately.

CO5: Develop competency in handling laboratory procedures and troubleshooting technical errors.

Sr. No.	Title of the Practical	No. of Practical
1	Identification of Tulsi (*Ocimum sanctum*), Neem (*Azadirachta indica*), and Brahmi (*Bacopa monnieri*) based on color, odor, taste, texture, and microscopic characteristics such as stomata, trichomes, and vascular elements.	01
2	Study of diagnostic characters of powdered herbal drugs like Amla, Ashwagandha, and Reetha under compound microscope, focusing on trichomes, starch grains, vessels, fibers, and calcium oxalate crystals.	01
3	Detection of phytoconstituents such as alkaloids, flavonoids, saponins, tannins, phenolics, and steroids in aqueous and alcoholic extracts of selected herbs using qualitative color reactions.	01
4	Perform simple tests to detect adulterants in powdered herbal drugs such as turmeric (with chalk/starch), ashwagandha (with starch), and chili powder (with brick powder).	01
5	Estimate the presence of non-drug materials (e.g., insects, stones, stems) and evaluate moisture content using drying methods to assess shelf stability.	01
6	Determine total ash, acid-insoluble ash, and extractive values in water and alcohol to assess the purity and solubility profile of herbal raw drugs.	01

7	Prepare a natural shampoo using Reetha, Amla, and Shikakai. Evaluate parameters such as pH, foam height, viscosity, cleansing ability, and organoleptic properties.	**01**
8	Formulate a skin-friendly face pack using multani mitti, turmeric, and sandalwood. Evaluate texture, pH, drying time, spreadability, and user acceptability.	**01**
9	Prepare a health-promoting herbal tea using Tulsi, lemongrass, and ginger. Evaluate aroma, taste, appearance, and antioxidant potential (optional).	**01**
10	Prepare a traditional herbal decoction (Kadha) using Tulsi and Adulsa following Ayurvedic principles of boiling, filtration, and storage.	**01**
11	Prepare herbal tablets/capsules using powdered forms of Ashwagandha or Giloy. Evaluate weight variation, disintegration time, hardness, and packaging methods.	**01**
12	Prepare a hydro-alcoholic extract (tincture) from Neem leaves using maceration technique. Evaluate extraction yield and discuss solvent system and storage.	**01**
13	Prepare an infusion from peppermint or chamomile flowers and compare with decoction. Evaluate clarity, aroma, and organoleptic quality.	**01**
14	Prepare a multipurpose herbal balm using camphor, eucalyptus oil, menthol, and beeswax. Evaluate spreadability, melting point, and skin compatibility.	**01**
15	Industrial exposure visit to understand herbal raw material sourcing, processing, standardization, product formulation, quality control, and packaging. Students must submit a structured report.	**01**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Generic Elective (GE) / Open Elective (OE)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Generic Elective (GE) / Open Elective (OE) – (1P = 2C) (Any one from basket)	OE-251-BOT- P	Floriculture and Pomoculture	2 C
	OE-252-BOT- P	Nursery Techniques	2 C

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code – OE-251-BOT-P

Course Title: Floriculture and Pomoculture

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To identify and classify commercially important flower and fruit crops based on their morphology and economic value.
2. To study key varieties, cultivation practices, and harvesting techniques of major floricultural crops like rose, chrysanthemum, tuberose, and carnation.
3. To gain hands-on experience in propagation methods and plant growth regulator applications in floriculture.
4. To understand physiological and biochemical maturity indices in locally grown fruit crops.
5. To acquire skills in post-harvest processing and value addition techniques for fruits.

COURSE OUTCOMES (COs):

CO1: Students will be able to accurately identify and describe commercial flower and fruit crops along with their classification.

CO2: Students will demonstrate knowledge of key floricultural crops, their varieties, and appropriate cultivation and harvesting methods.

CO3: Students will acquire practical skills in propagation techniques such as cutting, grafting, layering, and basic tissue culture.

CO4: Students will understand the role and application of plant growth regulators in enhancing flowering, yield, and post-harvest quality.

CO5: Students will be able to process fruit products like jam, jelly, squash, and marmalade with an understanding of preservation and quality standards.

Sr. No.	Title of the Practical	No. of Practical
1	Identification and Description of Commercially Important Flowers. Classification of floricultural crops with examples.	01 P
2	Identification and Description of Chrysanthemum and Tuberose. Types and any three varieties of each with characters and harvesting.	01 P
3	Identification of commercially important flower crop: Rose. Different species of commercial importance, three varieties of each with uses and harvesting.	02 P
4	Identification and Description of Carnation. Study of different varieties, pruning techniques and commercial uses.	01 P
5	Propagation Methods in Floriculture. Hands-on experience with cutting, grafting, layering, and tissue culture techniques	01 P
6	Use of Plant Growth Regulators in Flower Crops. Application of PGRs in flowering induction, yield improvement, vase life Enhancement and harvesting techniques.	01 P

7	Identification and Classification of Commercially Important Fruit Crops. Tropical and subtropical fruits of our country, Study of morphological and agronomic characteristics of major fruit crops	**02 P**
8	Maturity Indices and Estimation of Fruit Maturity. Study of physiological and biochemical maturity indicators in locally grown fruits.	**01 P**
9	Preparation of Jam, Jelly, Squash, Candy & Marmalade. Processing techniques, preservation methods, and quality assessment.	**03 P**
10	Exposure visits to commercial floricultural polyhouse and orchard.	**02 P**

References:

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code – OE-251-BOT-P

Course Title: Floriculture and Pomoculture (फुलशेती आणि फळशेती)

[No. of Credits: 2 C] (मराठीत अभ्यासक्रम) [No. of Lectures: 60 L]

उद्दिष्टे (OBJECTIVES):

१. फुलशेतीतील महत्त्वाच्या फुलांची ओळख करून देणे.
२. मुख्य फुलपिकांचे प्रकार, जाती आणि लागवडीसाठी तांत्रिक ज्ञान देणे.
३. फुलशेतीतील पुनरुत्पादन तंत्र आणि पीजीआर वापर यांची माहिती देणे.
४. फळपिकांची व्यावसायिक ओळख व त्यांचे उत्पादन वैशिष्ट्य सांगणे.
५. फळांच्या परिपक्वतेचे निकष व त्याचे मूल्यांकन शिकवणे.
६. फळप्रक्रिया उत्पादनांची निर्मिती प्रक्रिया शिकवणे.

COURSE OUTCOMES (COs):

CO1: विद्यार्थी व्यावसायिकदृष्ट्या महत्त्वाच्या फुलांची ओळख, जाती व त्यांचे उत्पादन तंत्र समजू शकतील.
CO2: विद्यार्थी शेवंती, निशिगंध, गुलाब व कार्नेशन या प्रमुख फुलपिकांच्या जाती, छाटणी तंत्र व उपयोग समजू शकतील.
CO3: विद्यार्थी फुलशेतीतील विविध पुनरुत्पादन पद्धती (कटिंग, ग्राफ्टिंग, लेयरिंग, टिश्यू कल्चर) प्रत्यक्ष अनुभवातून आत्मसात करू शकतील.
CO4: विद्यार्थी वनस्पती वाढ नियंत्रकांचा फुलपिकांतील वापर व त्याचा परिणाम याचे विश्लेषण करू शकतील.
CO5: विद्यार्थी फळपिकांची वर्गवारी, परिपक्वतेचे निकष व उत्पादन वैशिष्ट्ये स्पष्ट करू शकतील.
CO6: विद्यार्थी फळप्रक्रिया उत्पादने तयार करण्याचे तंत्र, साठवण व गुणवत्ता मूल्यांकन आत्मसात करू शकतील.

अ. क्र.	प्रात्यक्षिकाचे नाव	प्रात्यक्षिक संख्या
१.	**व्यावसायिकदृष्ट्या महत्त्वाच्या फुलांची ओळख आणि वर्णन –** फुलशेती पिकांचे उदाहरणांसह वर्गीकरण.	०१
२.	**शेवंती आणि निशिगंधाची ओळख आणि वर्णन -** प्रकार आणि प्रत्येकीच्या तीन जाती, त्यांचे लक्षण आणि कापणी.	०१
३.	**व्यावसायिकदृष्ट्या महत्त्वाच्या फुलांच्या पिकाची ओळख: गुलाब -** व्यावसायिक दृष्टिकोनातून महत्त्वाच्या विविध प्रजाती, त्यापैकी प्रत्येकीच्या तीन जाती, त्यांचा उपयोग आणि काढणी.	०२
४.	**कार्नेशनची ओळख आणि वर्णन –** विविध जातींचा अभ्यास, छाटणी तंत्रज्ञान आणि व्यावसायिक उपयोग.	०१
५.	**फुलशेतीतील पुनरुत्पादनाच्या पद्धती -** कटिंग, ग्राफ्टिंग, लेयरिंग आणि टिश्यू कल्चर तंत्रांचा प्रत्यक्ष अनुभव.	०१
६.	**फुलपिकांमध्ये वनस्पती वाढ नियंत्रकांचा (पीजीआर) वापर** फुलोरा निर्मिती, उत्पादन वाढ, फुलदाणीतील आयुष्य वृद्धी आणि कापणी तंत्र यामध्ये पीजीआर चा उपयोग	०१
७.	**व्यावसायिकदृष्ट्या महत्त्वाच्या फळ पिकांची ओळख आणि वर्गीकरण -** आपल्या देशातील उष्णकटिबंधीय आणि उपोष्णकटिबंधीय फळे, प्रमुख फळ पिकांच्या आकारशास्त्रीय आणि कृषी वैशिष्ट्यांचा अभ्यास.	०२

८.	**फळांची परिपक्वता निकष आणि परिपक्वतेचे मूल्यांकन** स्थानिक स्तरावर लागवड करण्यात येणाऱ्या फळांमध्ये शारीरिक (physiological) व जैव रासायनिक (biochemical) परिपक्वतेच्या निर्देशकांचा अभ्यास	०१
९.	**जाम, जेली, स्क्वॅश, कँडी आणि मार्मलेड - तयार करणे** प्रक्रिया तंत्र, जतन पद्धती आणि गुणवत्ता मूल्यांकन.	०३
१०.	**व्यावसायिक फुलशेती पॉलीहाऊस आणि बागेला भेटी देणे.**	०२

संदर्भ ग्रंथ व पुस्तके:

1. भारतामधील संपूर्ण बागकाम – गोपालस्वामी अय्यंगार.
2. प्रगत फुलशेती – आय. एस. यादव आणि एम. एल. चौधरी.
3. भारतामधील फुलशेती – जी. एस. रंधावा.
4. उद्यानविद्येचा पाठ्यपुस्तक – आय.सी.ए.आर. प्रकाशन.
5. शोभेच्या उद्यानविद्या – जे. बी. एडमंड.
6. उद्यान पिकांच्या सुधारित शिफारसी – कार्यपद्धती – कृषी विद्यापीठ, धारवाड आणि बेंगळुरू.
7. हस्तपुस्तिका – कृषी (ICAR 1969) – नवी दिल्ली.
8. आर्थिक वनस्पतीशास्त्राचे पाठ्यपुस्तक – रॉबर्ट हिल.
9. उद्यान पिकांची पुनरुत्पादन पद्धती – ॲड्रिआन आणि ब्रिसिन.
10. वनस्पती पुनरुत्पादन – तत्त्वे व पद्धती – हार्टमन एच. टी. आणि डि. ई. केस्टर.
11. एक्झोटिका – विदेशी वनस्पतींचे सचित्र विश्वकोश (खंड 1 ते 6) – डॉ. अल्फ्रेड बर्ड ग्राफ, रोशर्स कंपनी प्रकाशक, ईस्ट रदरफर्ड, न्यू जर्सी, अमेरिका.

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Generic Elective (GE) / Open Elective (OE)

Course Code – OE-252-BOT-P

Course Title: Nursery Techniques

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

Course Objectives:

- यशस्वी रोपवाटिका स्थापन करण्यासाठी, व्यवस्थापित करण्यासाठी आणि चालवण्यासाठी आवश्यक असलेले ज्ञान आणि व्यावहारिक कौशल्ये विद्यार्थ्यांना सुसज्ज करणे
- प्रसार तंत्रे, रोपवाटिका मांडणी आणि डिझाइन समजून घेणे.
- वनस्पती आरोग्य व्यवस्थापन, व्यवसाय नियोजन आणि विपणन धोरणे समजून घेणे.

Course Outcomes:

- विद्यार्थ्यांना यशस्वी रोपवाटिका स्थापन करण्यासाठी, व्यवस्थापित करण्यासाठी आणि चालवण्यासाठी आवश्यक असलेले ज्ञान आणि व्यावहारिक कौशल्ये प्राप्त होतील.
- त्यांना प्रसार तंत्रे, रोपवाटिका मांडणी आणि डिझाइन समजेल.
- त्यांना वनस्पती आरोग्य व्यवस्थापन, व्यवसाय नियोजन आणि विपणन धोरणे समजतील.

Sr. No.	Name of Practical	No. of Practical
1.	रोपवाटिका व्यवस्थापनात वापरल्या जाणाऱ्या अवजारांचा अभ्यास करणे.	1P
2.	रोपवाटिकांमध्ये वनस्पतींच्या प्रसारासाठी विविध प्रकारच्या माध्यमांचा अभ्यास करणे.	1P
3.	बियाण्याची निष्क्रियता मोडून रोपांची जोमदार वाढ घडवून आणण्यासाठी बियाणे प्रक्रियांचा अभ्यास करणे.	1P
4.	बियाणे उगवण आणि वनस्पतीजन्य प्रसारासाठी वनस्पती वाढ नियामक द्रावणांची तयारी आणि वापर	1P
5.	वेगवेगळ्या रोपवाटिकांची अभ्यास आणि बियाणे पेरणी	1P
6.	रोपे वाढवण्यासाठी कटिंग आणि डोळे भरण करण्याच्या विविध तंत्रांचे सराव करणे.	1P
7.	रोपांची लागवड करताना गुटी कलम आणि भेट कलम यासारख्या विविध तंत्रांचा वापर करणे आणि त्यांचा सराव करणे.	1P
8.	योग्य शोभेच्या पिकासाठी टिशू कल्चर तंत्राचा अभ्यास करणे	1P
9.	नर्सरीमधील रोपांचे सामान्य आजार आणि त्यांचे व्यवस्थापन यांचा अभ्यास करणे	2P
10.	रोपवाटिकांमध्ये आढळणाऱ्या सामान्य कीटकांचा आणि त्यांच्या व्यवस्थापनाचा अभ्यास करणे.	1P
11.	शोभेच्या वनस्पतींसाठी कुंडी भरणे आणि पुनरुज्जीवन करण्याच्या तंत्राचा अभ्यास करणे.	1P
12.	रोपवाटिकेतील रोपांचे उपटणे/खोदणे, लेबलिंग आणि पॅकिंगचा अभ्यास करणे.	1P
13.	रोपवाटिकेच्या कामकाजाचे आर्थिक विश्लेषण करणे	1P
14.	शोभेच्या/भाजीपाला/औषधी/फळे/फुलांच्या पिकांच्या रोपवाटिका/टिशू कल्चर प्रयोगशाळेला भेट द्या	1P

References:

1. Bose, T. K., Jana, B. K., Mitra, S. K., & Sanyal, D. (1999). Nursery and plantation practices in horticulture. Naya Udyog.
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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Vocational Skill Courses (VSC)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Vocational Skill Courses (VSC) - (1T/P = 2C) (Any one from basket)	VSC-271-BOT- P	Mushroom and SCP Technology	2 C
	VSC-272-BOT- P	Fermentation Technology	2 C
	VSC-273-BOT- P	Ethnobotany	2 C

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Vocational Skill Courses (VSC)

Course Code – VSC-271-BOT- P

Course Title: Mushroom and SCP Technology

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To study and handle laboratory equipment used in mushroom and algal biotechnology.
2. To prepare and maintain pure cultures and spawn of Oyster mushroom for cultivation.
3. To practice bed preparation, spawning, cultivation, and harvesting of Oyster mushrooms.
4. To demonstrate post-harvest techniques and value-added product preparation from mushrooms.
5. To prepare culture media and perform laboratory-scale production and harvesting of Spirulina, Yeast, and Chlorella.

COURSE OUTCOMES:

CO1: Students will be able to identify and operate key lab equipment for mushroom and algal culture techniques.

CO2: Students will acquire skills in culturing and spawning techniques for edible mushrooms.

CO3: Students will demonstrate competence in mushroom bed preparation, cultivation, and harvesting practices.

CO4: Students will gain practical knowledge in post-harvest processing and value-added product development of mushrooms.

CO5: Students will develop hands-on experience in microalgal culture, harvesting, drying, and single cell protein production.

Sr. No.	Title of the Practical	No. of Practical
1	To study the various Equipment's for the isolation and culture of mushroom (Autoclave, Laminar Air Flow, Incubator, Distillation Unit, Rotary shaker etc.)	01 P
2	Preparation and Maintenance of culture of Oyster Mushroom.	01 P
3	Preparation of spawn for Oyster mushroom.	02 P
4	Cultivation techniques of mushroom - Preparation of bed from suitable agriculture waste (cleaning, sterilization, bagging etc.) and inoculation of spawn on to the bed.	02 P
5	Study the harvesting techniques of Oyster Mushroom.	01 P
6	To demonstrate the post-harvest techniques (Packaging, drying and canning) of Oyster mushroom and Preparation of value added products (mushroom pickle, mushroom pulav, mushroom soup etc.)	01 P
7	Preparation of suitable media for Spirulina culture and laboratory Scale production of Spirulina.	02 P
8	Study the harvesting techniques, drying and powder preparation of *Spirulina.*	01 P

9	Preparation of suitable media for Yeast/*Chlorella* culture and laboratory Scale production of Yeast/*Chlorella*.	**02 P**
10	Demonstration of Single Cell Protein products from Yeast/*Chlorella.*	**01 P**
11	Visit to the mushroom/Algae cultivation unit.	**01 P**

References:

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6. Suman, B.C. & Sharma, V.P. (2005). Mushroom Cultivation in India. Daya Publishing House.
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11. Giri, S.K. & Prasad, S. (2007). Drying of Oyster Mushroom in Hot Air Chamber. Journal of Food Engineering.
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21. Subramanian, V. (1983). Single Cell Protein. Tata McGraw-Hill.
22. FAO. Single Cell Protein – A Review of Recent Developments.
23. ICAR-DMR Solan. Model Mushroom Unit Layout & Visit Guide.
24. CSIR-NEERI & DBT Guidelines. Demonstration Units for Algal Cultivation.
25. UGC e-PG Pathshala Botany Practical Manuals – Cultivation Techniques of Mushroom & Microalgae.
26. FAO. Mushroom Cultivation: Manual for Growers.
27. CSIR-CFTRI. Spirulina Cultivation and Processing Manual.

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Vocational Skill Courses (VSC)

Course Code - VSC-272-BOT- P

Course Title: Fermentation Technology

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To learn the extraction and processing techniques of soybean products such as soymilk and tofu.
2. To understand traditional fermentation methods for preparing probiotic and nutritious beverages.
3. To acquire hands-on skills in preparing indigenous Indian fermented foods and beverages.
4. To study the preparation of Ayurvedic formulations like Asava and Arishta from medicinal plants.
5. To gain practical exposure through industrial visits to fermentation-related industries and document observations.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Extract and prepare soymilk and tofu using standard methods.

CO2: Demonstrate proficiency in fermenting vegetables and grains to produce traditional probiotic drinks.

CO3: Prepare a variety of traditional Indian fermented foods and beverages with proper techniques.

CO4: Understand the formulation and preparation of Ayurvedic Asava and Arishta products.

CO5: Analyze and report on industrial fermentation processes based on firsthand observation during visits.

Sr. No.	Title of the Practical	No. of Practical
1	Extraction of Soymilk from soybean with the help of suitable method.	01 P
2	Preparation of Tofu – Soyapaneer from Soyabean Seeds.	02 P
3	Fermentation of vegetables to obtain probiotic drink – Kanji.	01 P
4	Preparation of traditional, nutritious drink - Ambil from suitable plant material - Barnyard Millet (Bhagar).	02 P
5	Preparation of traditional Indian beverage solkadi from kokam fruits.	01 P
6	Preparation of wine from any suitable fruit (Pomegranate / Sapota / Pineapple or any seasonal fruit available in market).	01 P
7	Preparation of *Asava* (*Aloe vera* / Punarnava).	02 P
8	Preparation of *Arishta* from the suitable plant material (Arjun /Ashoka bark or powder)	01 P
9	Preparation of Malt from the Suitable material (Ragi).	01 P
10	Demonstration of various Indian fermented products:	01 P

	(Idli, Dosa, Meduwada, Wheat Kurdai, Rice Papad)	
11	Industrial Visit to any one Fermentation Industry (Wine / Beer / Sugarcane Industry / Ras Ayurvedic rasashala) located in the nearby area and preparation of Report.	**01 P**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Vocational Skill Courses (VSC)

Course Code - VSC-273-BOT- P

Course Title: Ethnobotany

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To document traditional knowledge related to the use of medicinal plants by various ethnic communities of India for therapeutic and cultural applications.
2. To develop skills in ethnobotanical field methods, including the use of structured questionnaires, interviews, and participatory observation.
3. To study and identify medicinal plants used for treating common ailments in humans and animals based on traditional practices.
4. To analyze the role of Non-Wood Forest Products (NWFPs) and their socio-economic and ecological importance in tribal and rural communities.
5. To design and plan ethnomedicinal gardens and understand their utility for conservation, education, and community health promotion.

Course Outcomes (COs):

After successful completion of the course, students will be able to:

CO1: Identify and document ethnobotanical practices of a specific ethnic community using scientific field methods.

CO2: Explain the medicinal uses of selected plants in traditional systems for treating wounds, child illnesses, gynecological issues, and veterinary ailments.

CO3: Evaluate the applications of NWFPs and traditional grain storage and preservation techniques used by local communities.

CO4: Formulate herbal preparations and ethnoveterinary products based on traditional knowledge and indigenous plants.

CO5: Design an ethnomedicinal garden layout that integrates medicinal, cosmetic, mosquito-repellent, and culturally significant plant species.

Sr. No.	Title of the Practical	No. of Practical
1	Ethnotaxonomy of botanical resources used by various ethnic communities in India (Any one Ethnic community and Five plant resources).	01 P
2	Documentation of medicinal plants used by local tribes/ people in the given format of questionnaire.	01 P
3	Medicinal plants used by various ethnic communities to cure bleeding of wounds. (Any Four - Lantana,Tribulus, Arjun bark, Tulsi, Haldi, Aloe vera)	01 P
4	Applications of medicinal plants used in preparation of Bal Gutti – Soaf, Ajwain, Bal Hirda, Kuda, Sgar gota.	01 P
5	Ethno-veterinary Plant Formulations used for treatment of Lices and Mites on domestic animals (Acorus, Neem, Custard apple seeds)	01 P
6	Study of Non Wood Forest Products and its Applications (Honey any one type, Edible Gum, Dyes- Gokarna flower/ Sugarbeet root, Latex- Papaya)	01 P

7	Preparation of Layout for construction of Ethno-medicinal plants garden.	**01 P**
8	Traditional Indian Remedies used to cure Child diseases (Chicken pox, Stomach Ache, Coughing, loose motions (Neem Leaves, Murud sheng, Balhirda, Pandhara Kuda).	**01 P**
9	Study of Ethnobotanical techniques for the storage of food grains (Rice/ Wheat, Jowar/Maize/ Bajara).	**01 P**
10	Applications of Tannins in Tanning hides, Wines preparation, Medicines, Dyeing, Ink preparation.	**01 P**
11	Applications of *Moringa oleifera* as Kalpavruksha of Indian Economy	**01 P**
12	Study of mosquito repellent plants as per Traditional Indian Knowledge System – Chrysanthemum flowers, Lemon Grass, Neem, Tulsi, Eucaluptus.	**01 P**
13	Study of Plant parts used in Ethno-gynecology formulations – Ashwagandha, Shatavari.	**01 P**
14	Study of plants used in cosmetic ethnobotany for Skincare, Hair Care, Body Care Any Five (Aloe vera/Turmeric/Garlic/Neem/Chana powder/Cucumber fruit, Lemon fruit, Maka, Amla).	**01 P**
15	Field Visit to Botanical Gardens / Sacred Groves/Herbal Gardens with special reference to Ethnobotanical Perspective.	**01 P**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Skill Enhancement Courses (SEC)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Skill Enhancement Courses (SEC) - (1T/P = 2C) (Any one from basket)	SEC-251-BOT - P	Applications of Artificial Intelligence in Botany	2 C
	SEC-252-BOT - P	Value addition to Plant based products	2 C
	SEC-253-BOT - P	Herbal Cosmetics and Nutraceutics	2 C
	SEC-254-BOT - P	Fungal Biotechnology	2 C

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Skill Enhancement Courses (SEC)

Course Code – SEC -251-BOT - P

Course Title: Applications of Artificial Intelligence in Botany

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. Introduce foundational AI tools such as Python, Jupyter Notebooks, and key libraries (TensorFlow, Scikit-learn, Biopython) relevant to botanical data analysis.
2. Demonstrate AI applications in plant identification through image-based classification using open-source datasets.
3. Enable predictive modeling skills to forecast plant growth, yield, and disease using machine learning techniques.
4. Apply NLP techniques for parsing botanical texts and developing taxonomy-based chatbots.
5. Utilize AI for ecological and conservation studies through spatial data analysis and biodiversity monitoring.

COURSE OUTCOMES:

CO1: Students will set up and operate AI environments like Google Colab/Jupyter and use Python for botanical applications.

CO2: Students will classify plant species/images using CNN models trained on datasets such as LeafSnap or Pl@ntNet.

CO3: Students will apply NLP methods to extract and interpret botanical information from textual sources.

CO4: Students will build predictive models to analyze plant growth, stress responses, and yield using environmental data.

CO5: Students will use AI tools in conservation biology to map species distributions and detect ecological changes.

Sr. No.	Title of the Practical	No. of Practical
1	**Introduction to AI and Its Role in Botany** Hands-on with Google Colab / Jupyter Notebooks. Explore open-source botanical datasets (e.g., plant images, herbarium data).	01 P
2	**AI in Plant Identification Using Image Recognition** Use TensorFlow/Keras to classify leaf images. Build a model using the LeafSnap or Pl@ntNet dataset.	01 P
3	**Predictive Modeling in Plant Growth and Disease** Train regression models for plant height/yield prediction based on environmental data. Use CNN to detect diseases (e.g., rust, blight) from plant leaf images.	01 P
4	**Introduction to AI in Ecology**	02 P

	Overview of ecological data types (species count, environmental, spatial) Set up Python environment (Jupyter, pandas, matplotlib)	
5	**Natural Language Processing (NLP) in Botany** Use NLP tools (e.g., spaCy, NLTK) to analyze botanical descriptions. Build a chatbot that answers basic plant taxonomy questions.	**01 P**
6	**Introduction to AI and Bioinformatics** Explore bioinformatics databases (NCBI, UniProt, PDB). Python exercises using Biopython for sequence retrieval and parsing. Intro to machine learning libraries: Scikit-learn, Pandas, NumPy.	**02 P**
7	**Introduction to AI in Agriculture** Introduction to Python, Jupyter Notebook, and basic data handling (Pandas, Numpy). Explore open agricultural datasets (e.g., FAO, ICAR, Kaggle Agri datasets). Create a simple program to analyze crop yield data.	**02 P**
8	**AI for Precision Agriculture** Train regression models to predict irrigation schedules using weather and soil data. Use decision tree classifiers for soil type or crop suitability analysis.	**02 P**
9	**AI in Plant Physiology and Stress Analysis** Use RGB/thermal image data of plants under stress Train a deep learning model to detect stress types Analyze physiological traits: wilting, color change, chlorosis	**02 P**
10	**AI in Conservation and Biodiversity Monitoring** Predict plant distribution using SDMs (Species Distribution Models) Use satellite/drone data to monitor plant communities Detect habitat degradation or invasive species using AI	**01 P**

References:

1. Artificial Intelligence in Agriculture" by C. P. Guntuku et al.
2. Machine Learning for Plant Science" – Elsevier (2021), edited volume
3. Deep Learning for the Life Sciences" – O'Reilly Media (Bharath Ramsundar et al.)
4. Artificial Intelligence in Agriculture and Life Sciences" by Dinesh Peter et al.
5. Deep Learning for the Life Sciences" – Ramsundar et al. (O'Reilly)
6. Botany Illustrated" by Janice Glimn-Lacy & Peter B. Kaufman (for visual datasets)

Research Papers

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8. Singh et al. (2020) – "Machine learning for high-throughput stress phenotyping", Trends in Plant Science.
9. Kamilaris & Prenafeta-Boldú (2018) – "Deep learning in agriculture", Computers and Electronics in
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11. Carrascal et al. (2021) – Combining herbarium data and AI for floristic mapping, Biodiversity Data Journal.

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13. Fungal Biotechnology in Agricultural, Food, and Environmental Applications by Dinesh K. Maheshwari.
14. Fungi and Biotechnology by R. S. N. Raj and H. S. Saini.
15. Fungal Biotechnology by K. M. Patel.
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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Skill Enhancement Courses (SEC)

Course Code – SEC-252-BOT - P

Course Title: Value addition to Plant Based Products

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To study the botanical identity and medicinal uses of important pharmaceutical and cosmeceutical plants.
2. To demonstrate preparation techniques of herbal and value-added products using native plant resources.
3. To develop skills in formulating natural health, cosmetic, and dye products.
4. To introduce students to traditional and modern herbal processing practices.
5. To promote awareness of sustainable plant-based industries through field visits.

COURSE OUTCOMES:

CO1: Identify and describe the botanical source, parts used, and applications of key medicinal and cosmetic plants.

CO2: Prepare herbal products such as juices, powders, syrups, and cosmetic items using standard methods.

CO3: Demonstrate the ability to formulate natural dyes, mouth fresheners, and biopesticides from plant materials.

CO4: Apply practical knowledge in developing plant-based functional foods and wellness products.

CO5: Understand industry practices through visits to herbal drug, food, or cosmeceutical industries.

Sr. No.	Title of the Practical	No. of Practical
1	Study of plants used in pharmaceutical industry with respect to botanical source, part used and medicinal applications (Any Four – *Adhatoda vasica, Withania somnifera, Boerhavia diffusa, Tribulis terrestris, Mentha piperata, Asparagus racemosus, Azadirachta indica, Ocimum tenuiflorum, Catharenthus roseus*).	01 P
2	Study of plants used in cosmeceutical industry with respect to botanical source, part used and uses (Any Four - *Curcuma longa / Aloe vera / Sapindus laurifolius / Emblica officinalis / Hibiscus rosa sinensis*).	01 P
3	Preparation of value added products from Wheat grass (Gheu Ankur): Wheat Grass Juice and Wheat Grass Powder.	01 P
4	Preparation of Biopesticide using suitable plant materials.	01 P
5	Preparation of Natural Dye from suitable plants – (Any one *Bixa Orellana / Beeta vulgaris / Spinach oleracea / Clitoria ternatea / Curcuma longa / Sczygium cumini / Brassica oleracea purple variety / Carthamus tinctorius*).	01 P
6	Preparation of herbal mouth freshener using suitable medicinal and aromatic plants.	01 P

7	Preparation of Adulsa Cough Syrup / Preparation of Aloe vera juice.	**01 P**
8	Preparation of Value added products from *Moringa oleifera*: leaf powder and leaf tea.	**01 P**
9	Preparation of Coconut milk from Coconut Fruits.	**01 P**
10	Preparation of Probiotic drink from *Macrotyloma uniflorum* (Horse gram/Kulith/Hulge).	**01 P**
11	Preparation of Herbal beverage from *Tinospora cordifolia* (Gulvel /Guduchi).	**01 P**
12	Preparation of Herbal medicated hair oil using suitable plant materials.	**01 P**
13	Preparation of natural lips stick from *Beta vulgais* (Sugar Beet).	**01 P**
14	Study of water purification techniques using suitable plant materials.	**01 P**
15	Visit to herbal Cosmecutical Industry / Food industry/Fodder industry/ Herbal drug Industry.	**01 P**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Skill Enhancement Courses (SEC)

Course Code – SEC-253-BOT - P

Course Title: Herbal Cosmetics and Nutraceutics

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To impart hands-on skills in preparing herbal cosmetics and nutraceutical products using traditional and modern methods.
2. To familiarize students with the use of natural ingredients like herbs, essential oils, and plant extracts in product formulation.
3. To train students in basic product safety evaluation, organoleptic testing, and quality control.
4. To develop knowledge of packaging, labeling, and regulatory aspects of herbal products.
5. To encourage innovation through the design and presentation of a unique herbal product.

COURSE OUTCOMES:

CO1: Students will be able to formulate and prepare a range of herbal cosmetics and nutraceutical products independently.

CO2: Students will identify and select appropriate herbal ingredients based on their therapeutic and cosmetic properties.

CO3: Students will demonstrate the ability to test product safety through pH and sensory evaluations.

CO4: Students will understand and apply principles of eco-friendly packaging and proper labeling for herbal products.

CO5: Students will creatively design, develop, and present an innovative herbal product with documented applications.

Sr. No.	Title of the Practical	No. of Practical
1	Demonstration of herbal cosmetics and nutraceutical products, ingredients and applications.	01 P
2	Preparation of herbal face pack (using Multani mitti, turmeric and neem).	01 P
3	Preparation of herbal hand wash or body wash and shampoo (using reetha, shikakai, *Hibiscus*).	01 P
4	Preparation of herbal lip balm using beet/or any other suitable material and essential oils.	01 P
5	Preparation of herbal hair oil using coconut oil and herbs (Maka, Nir Brahmi, *Hibiscus*, Brahmi, Shikekai, Methi seeds, Amla, Almond etc.).	01 P
6	Preparation of Herbal cream or lotion (*Aloe vera*-based).	01 P
7	Preparation of herbal toothpaste or mouthwash.	01 P
8	Making herbal soaps (cold process or melt-and-pour).	01 P
9	Preparation of Nutraceutical drink: herbal tea/kadha etc.	01 P
10	Formulation of immunity booster balls using herbs, seeds, and dry fruits.	01 P

11	Preparation of herbal digestive churna/powder/Bhasma.	**01 P**
12	Product safety testing (pH, organoleptic characters- Color, taste, texture, smell, etc.), Packaging and labelling of herbal cosmetic/nutraceutical products.	**01 P**
13	Develop and presentation of a unique herbal product and submission.	**03 P**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Skill Enhancement Courses (SEC)

Course Code – SEC-254-BOT - P

Course Title: Fungal Biotechnology

[No. of Credits: 2 C] **[No. of Lectures: 60 L]**

OBJECTIVES:

1. To familiarize students with essential equipment and media for fungal isolation and culture.
2. To isolate and identify fungi from diverse environmental samples using standard microbiological techniques.
3. To prepare fungal crude extracts and assess their potential in enzyme and antibiotic production.
4. To demonstrate industrially relevant fungal processes such as fermentation, enzyme production, and biocontrol.
5. To explore fungal genome databases and introduce applications of myco-nanotechnology in various sectors.

COURSE OUTCOMES:

CO1: Students will gain hands-on experience in using lab equipment and preparing media for fungal studies.

CO2: Students will acquire skills to isolate fungi from soil, air, plants, and mushrooms.

CO3: Students will learn extraction methods and screen fungal metabolites for antibiotic and enzymatic properties.

CO4: Students will understand industrial applications of fungi in fermentation, biocontrol, and biofertilizer production.

CO5: Students will develop awareness of fungal bioinformatics tools and the emerging field of myco-nanotechnology.

Sr. No.	Title of the Practical	No. of Practical
1	To study the various Equipment's for the isolation and culture of fungi (Autoclave, Laminar Air Flow, Incubator, Distillation Unit, Rotary shaker etc.).	01 P
2	Preparation of different media for fungal isolation (PDA, Malt dextrose agar etc.).	02 P
3	Isolation of fungi from environmental samples (soil, air, plant surfaces, Mushroom etc.).	01 P
4	Preparation fungal crude extract by using suitable fungal form (ethanol/methanol/water extract).	02 P
5	To demonstrate industrial technique for the production of antibiotic (*Penicillin*).	01 P
6	To study the production and screening of enzyme from fungal extract (cellulases, amylases etc.).	01 P

7	Demonstration of Yeast fermentation in bread-making and alcohol production.	**01 P**
8	To study the production techniques of fertilizer from *Trichoderma*.	**02 P**
9	Demonstration of Fungal biocontrol agents for plant pathogens.	**01 P**
10	Introduction to fungal genome databases and tools (e.g., GenBank, Blast search, Indexfungorum, Ensembl Fungi, FungiDB etc).	**01 P**
11	Study the myco-nanotechnology and their applications in industry, agriculture, medicine etc.	**01 P**
12	Visit to Biofertilizer/Winery/Bakery industry.	**01 P**

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S. Y. B. Sc. Botany [Semester - IV]

Course Category – Community Engagement Program (CEP)

COURSE DETAILS	COURSE CODE	COURSE TITLES	CREDITS
Community Engagement Program (CEP) - (1T = 2C)	CEP-232-BOT	Community Engagement Program (CEP) and Botany	2 C

S. Y. B. Sc. Botany [Semester - IV]

Course Category – Community Engagement Program (CEP)

Course Code – CEP-232-BOT

Course Title: Community Engagement Program (CEP) and Botany

[No. of Credits: 2 C] [No. of Lectures: 60 L]

OBJECTIVES:

1. To promote awareness, appreciation, and conservation of plant diversity, while nurturing community involvement and education.
2. To understand the principles and practices of community engagement in botany.
3. To develop skills in planning and implementing community engagement programs in botany.
4. To foster partnerships with local communities, organizations, and stakeholders.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Design effective community engagement programs in botany.
2. Collaborate with local communities, organizations, and stakeholders to promote botanical conservation and education.
3. Communicate botanical information effectively to diverse audiences.

PROGRAM PLANNING:

1. Determine the target audience, such as schools, local communities, self-help groups, NGO's or gardening groups.
2. Establish clear objectives, such as promoting plant conservation or educating about botanical concepts.
3. Develop engaging activities, such as workshops, trainings, field trips, or plant exhibitions.

PROGRAM ACTIVITIES:

1. Organize activities promoting plant conservation, such as tree planting or habitat restoration.
2. Provide educational programs on botanical concepts, such as plant identification
3. Engage with local communities and organize exhibitions, plant fairs to showcase local plant species and promote appreciation.
4. Document and promote traditional uses of plants by local communities.
5. Promote urban greening initiatives, such as rooftop gardens or green walls.
6. Empower local communities to lead plant conservation efforts.
7. Deliver public lectures on botanical topics to promote awareness and education.

EVALUATION CRITERIA:

Student Community Engagement Program (CEP) shall be evaluated for total 50 marks (15 marks for internal and 35 marks for external evaluation). During internal assessment following points shall be considered:

- Effectiveness of program design and planning.
- Student participation and engagement in program activities.
- Effectiveness of student communication with community members.
- Demonstration of botanical knowledge and skills.
- Maintenance of program records and documentation.

The criteria for external evaluation shall be

- Clarity, organization, and effectiveness of the report and presentation.
- Assessment of the program's impact on the local community.
- Evaluation of student learning outcomes and skills development.
- Assessment of the program's effectiveness in achieving its objectives.

RESOURCES:

- Botany Expertise: Access to Botany experts and resources.
- Community Partnerships: Partnerships with local farmers, community members, and other stakeholders.
- Logistical Support: Support for program planning, execution, and evaluation.

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