



Savitribai Phule Pune University, Pune

(Formerly, University of Pune)

Two Years Post Graduate Degree Program in Botany

(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for

M.Sc. Botany, Part - I

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

To be implemented from

Academic Year 2023-2024

Framed by

BOARD OF STUDIES IN BOTANY

Savitribai Phule Pune University,

Ganeshkhind, Pune -07.

AIMS AND OBJECTIVES

The Board of Studies in Botany, Savitribai Phule Pune University, Pune believes that curriculum designed as per NEP 2020, the employability oriented diversified course content and rigorous as well as critical assessment of educational achievements by the students play complementary roles in shaping their education. The current curriculum revised as per the guidelines of NEP 2020 for the postgraduate programme of Botany (M.Sc. Botany) proposes up-to-date higher education as a combination of subject cored generalized as well as skill oriented specialized education by introducing in-depth learning concepts. The students will achieve lifelong learning goals and become confident enough by illustrating courtesy to the immense world of basic and applied knowledge of plants and introducing them to the methodology of systematic academic enquiry. Students will receive wide exposure to the applied aspects of various branches of botany and its implication for achieving the sustainable goals of the nation.

PROGRAM OUTCOMES (POS)

The curriculum of Post Graduate degree in Botany (M.Sc. Botany) as per the guidelines of NEP-2020 for the affiliated colleges of Savitribai Phule Pune University, Pune is designed to equip the students of Botany with crucial fundamental as well as advanced subject domain knowledge and 21st century technical, practical and communication skills related to plant world in a universal way. Students would be trained and acquire the basic and progressive knowledge from entrepreneurship based industry oriented thrust areas of plant sciences through the use of distinctive combination of mandatory major core courses with the in-depth exposure of multidisciplinary components of elective courses, research methodology as well as on job trainings / internship and research projects. This upgraded curriculum shall develop educated outcome-oriented candidature, nurtured with discovery, learning, equipped with practice and skills to deal practical problems and competent with recent pedagogical trends in education including e-learning, flipped class and hybrid learning, experiential learning to develop into responsible citizen with their knowledge gained in the field of plant sciences for nation-building and transforming the country to lead the world in the coming future.

After successful completion of the Post Graduate (M.Sc.) Degree program, the students would be able to:

P01: Attained thoughtful proficiency in the field of plant sciences.

P02: Acquired ability to perform in multidisciplinary domains.

P03: Attained ability to exercise intelligence of scientific knowledge for investigation and innovation and sustenance of the world.

P04: Learnt value based ethical practices and principles and should be committed to professional ethics.

P05: Incorporated 21st century skill oriented self-directed and life-long learning.

P06: Obtained ability to inculcate the knowledge of plant science in diverse contexts with global perspective.

P07: Attained 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 physiology, biochemistry and molecular biology of plants and its implementation for the improvement of crop productivity.

PSO3: Acquire and utilize the skills of post-harvest techniques, landscape designing 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:** Becomes 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: M. Sc. Botany

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 M. Sc., Part - I (Semester I and Semester II), from August 2023.

For M. Sc., Part - II (Semester III and Semester IV), from August 2024.

4. Preamble -

Plants produce all types of ecosystems, making them the only supreme foundation for all scientific fields, they are essential to the survival and existence of all other life forms on earth. The study of botany has great potential to help the country achieve its sustainable goals through both basic and applied research. The world's overpopulation of people, combined with the daily growing problems of environmental pollution brought on by unfavourable climatic changes, global warming, and natural disasters, is having an alarming impact on the growth, development, and productivity of food (especially plants).

Botany is the only supreme foundation of all disciplines of sciences, because only the plants being the producers of all kinds of ecosystems are playing pivotal role in survival and existence of all other living things on the earth. Botany subject has tremendous capacity through its exploitation at basic and applied levels to accomplish the sustainable goals of the nation. In the current scenario, the overgrowing human population of the world as against the day-by-day increasing problems of environmental pollution associated with the adverse climatic changes, global warming, natural calamities, are severely affecting the growth, developments and productivity of the produce (especially plants) to alarming levels. Students with backgrounds in the life sciences should be encouraged to pursue higher education in plant sciences, with a focus on creating solutions for sustainable development through the application of the most cutting-edge information, knowledge, and skills of fundamental and applied branches. With this in mind, the curriculum for the M.Sc. in Botany has been created to give students the information and abilities they will need to manage issues relating to the demands and concerns of the human population and the environment. All efforts are made to ensure high standards of education in order to achieve these objectives by putting into practice various measures to improve the teaching-learning process, examination and evaluation techniques, and ensuring that students are developed holistically in accordance with the objectives and standards of National Education Policy 2020. The well-designed M.Sc. Botany curriculum combine a thorough understanding of the subject's essential concepts with an emphasis on disciplines related to advanced agriculture, the plant-based industry, and pharmaceutical companies. This will encourage

and draw students of life sciences to pursue graduate degrees in botany (M.Sc. and Ph.D.) in order to become successful businesspeople, skilled employees, or advanced farmers who can solve societal and environmental problems as a component 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.

The M.Sc. Botany curriculum provides a comprehensive theoretical and practical knowledge base for solving issues related to plant sciences, including environmental pollution control, biodiversity conservation, green belt and green crediting, carbon sequestration, organic farming, soil health, plant nutrition, plant wealth and plant-based resource management, plant and microorganism interactions, plant pathogens and diseases. Students will be able to stand independently and confidently in the voyage of plant sciences.

5. Eligibility Criteria -

The basic criteria for first year Post Graduate Degree in Botany (M.Sc. Botany, Part - I) admission will be B.Sc. degree with Botany as Major / Principal subject OR B.Sc. degree with Botany as subsidiary subject OR Graduate from any subjects of Life Sciences, Plant Sciences, Biotechnology, Microbiology, Environmental Sciences, Agricultural Sciences and Pharmaceutical Sciences. 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.

A student from other university shall be eligible for admission to Post Graduate degree, who scores minimum 55% marks or B+ Grade in the subject at graduate level with Botany as a principal subject.

The basic criteria for second year Post Graduate Degree in Botany (M.Sc. Botany,

Part - II) admission will be the students, who have completed the first year of Post Graduate Degree (M.Sc. Botany, Part – I) or B.Sc. Honors (04 years) with the Botany as Major or Principal subject.

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

7. Duration of the Course – Total 02 years (Part I and Part II)

8. No. of semesters – Four semesters

Part I – Semester I and II and **Part II** – Semester III and IV

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 to 15 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 practical should conduct 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.

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

• **Theory Paper of 04 Credits -**

- Internal Exam (30 M) + University Theory Exam (70 M) = Total 100 M
- Duration: For Internal exam = 01 hour and for University Exam = 03 hours.

• **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.

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. On Job Training /Internship / Field Project: Every student should go through On Job training OR Internship OR Field Project Work after second semester and submit the Report as the part of evaluation.

b. There shall be at least a short tour (up to 3 days) and a long tour (not exceeding 10 days) per year for all M. Sc. I and M. Sc. II students. The long tour may be arranged to a region out of the state covering various Botanical Regions/ Research Institutes/ Centers and Universities. Tours are the part of curriculum and are 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 has 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 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 2 Credit courses

- In the University Theory Examination, a student will have to solve the question paper of 35 marks for the courses of 02 Credits.
- The paper setter should set the paper on entire syllabus for total of 60 marks, including optional questions.
- For 02 Credits course (30 clock hour lectures), paper setter should allot 02 marks per lecture and accordingly, questions should be set for 30 lectures, 60 marks on entire syllabus of the course.

Question paper pattern

Time: 2 Hours]

[Maximum Marks: 35

Note: All questions are compulsory.

Que. 1) Answer the following questions. (01 Mark each) 5M

- a)
- b)
- c)
- d)
- e)

Que. 2a) Explain in brief any one of the following. 6M

- i.
- ii.

Que. 2b) Describe any one of the following. 4M

- i.
- ii.

Que. 3a) Explain in brief any one of the following. 6M

- i.
- ii.

Que. 3b) Describe any one of the following. 4M

- i.
- ii.

Que. 4) Write notes on (Any four, 2.5 marks for each question). 10M

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

CREDIT FRAMEWORK FOR M.Sc. BOTANY, Part - I, SEMESTER - I (Level 6.0)

COURSE DETAILS	COURSE TYPE	COURSE CODE	COURSE TITLE	CREDITS
Mandatory Major Core Theory Courses (10C)	Core	BOT 501 MJ	Plant Taxonomy - I (Algae and Fungi)	2 C
	Core	BOT 502 MJ	Plant Taxonomy - II (Bryophytes and Pteridophytes)	2 C
	Core	BOT 503 MJ	Plant Physiology	2 C
	Core	BOT 504 MJ	Plant Biochemistry	2 C
	Core	BOT 505 MJ	Green Belt and Green Credit	2 C
Mandatory Major Core Practical Courses (4C)	Core	BOT 506 MJP	Practical Based on BOT 501 MJ and BOT 502 MJ	2 C
	Core	BOT 507 MJP	Practical Based on BOT 503 MJ and BOT 504 MJ	2 C
A. Total Credits for Major Core Courses for Semester - I				14 C
Mandatory Major Elective Courses (Any One) (4C = 2T + 2P)	Elective Theory Course (Any One)	BOT 510 MJ	Landscape and Gardening	2 C
		BOT 511 MJ	Post-Harvest Technology of Commercial Crops	
		BOT 512 MJ	Biodiversity Conservation and Utilization	
		BOT 513 MJ	Integrated Pest Management (IPM)	
		BOT 514 MJ	Seed Science	
	Elective Practical Course based on Theory (Any One)	BOT 515 MJP	Practical Based on BOT 510 MJ	2 C
		BOT 516 MJP	Practical Based on BOT 511 MJ	
		BOT 517 MJP	Practical Based on BOT 512 MJ	
		BOT 518 MJP	Practical Based on BOT 513 MJ	
		BOT 519 MJP	Practical Based on BOT 514 MJ	
B. Total Credits for Major Elective Courses for Semester - I				4 C
Research Methodology (RM) (4C = 2T + 2P)	RM Theory	BOT 541 MN	Research Methodology in Plant Sciences	2 C
	RM Practical	BOT 542 MNP	Practical Based on BOT 541 MN	2 C
C. Total Credits for Research Methodology for Semester - I				4 C
Total Credits for Semester - I (A+B+C)				22 C

CREDIT FRAMEWORK FOR M.Sc. BOTANY, Part - I, SEMESTER - II (Level 6.0)

COURSE DETAILS	COURSE TYPE	COURSE CODE	COURSE TITLE	CREDITS
Mandatory Major Core Theory Courses (10C)	Core	BOT 551 MJ	Plant Taxonomy - III (Paleobotany and Gymnosperms)	2 C
	Core	BOT 552 MJ	Taxonomy of Angiosperms	2 C
	Core	BOT 553 MJ	Cytogenetics and Plant Breeding	2 C
	Core	BOT 554 MJ	Molecular Biology	2 C
	Core	BOT 555 MJ	Pharmacognosy	2 C
Mandatory Major Core Practical Courses (4C)	Core	BOT 556 MJP	Practical Based on BOT 551 MJ and BOT 552 MJ	2 C
	Core	BOT 557 MJP	Practical Based on BOT 553 MJ and BOT 554 MJ	2 C
A. Total Credits for Major Core Courses for Semester - II				14 C
Mandatory Major Elective Courses (Any One) (4C = 2T + 2P)	Elective Theory Course (Any One)	BOT 560 MJ	Hydroponics Technology	2 C
		BOT 561 MJ	Post-Harvest Technology of NTFP (Non-Timber Forest Products)	
		BOT 562 MJ	Plant Resource Management & Geo-Spatial Techniques	
		BOT 563 MJ	Plant-Microbe Interaction	
		BOT 564 MJ	Seed Technology	
	Elective Practical Course based on Theory (Any One)	BOT 565 MJP	Practical Based on BOT 560 MJ	2 C
		BOT 566 MJP	Practical Based on BOT 561 MJ	
		BOT 567 MJP	Practical Based on BOT 562 MJ	
		BOT 568 MJP	Practical Based on BOT 563 MJ	
		BOT 569 MJP	Practical Based on BOT 564 MJ	
B. Total Credits for Major Elective Courses for Semester - II				4 C
On Job Training / Internship (4C)	OJT	BOT 581 OJT/FP	On Job Training (OJT) / Internship / Field Project Work in industry or research institutes	4 C
C. Total Credits for On Job Training for Semester - II				4 C
Total Credits for Semester II (A+B+C)				22 C
Total Credits for M.Sc., Part - I (Semester I + II)				44 C
BOT = Botany; C = Credit; MJ = Major Theory; MJP = Major Practical; MN = Minor Theory; MNP = Minor Practical; OJT = On Job Training; FP = Field Project				

Syllabus for M. Sc. Botany, Part - I
Semester - I
As Per National Education Policy (2020)

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Core Theory Course

Course Code – BOT 501 MJ

Title of the Course: PLANT TAXONOMY - I (Algae and Fungi)

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I: ALGAE**15L****Unit I: General account of Algae****4L**

1. A) Introduction and general characters of algae.
B) Contribution of Indian Phycologist (Prof. M.O.P. Iyengar, Prof. T. V. Deshikachary, Prof. V. Krishnamurthy, Prof. M S. Balakrishnan, Prof. Y. Bharadwaj).
2. Classification of Algae by F. E. Fritsch, (1935,1948); G. M. Smith (1950,1965); Chapman and Chapman (1969), Bold and Wynne (1978,1985).

Unit II: Salient features of major groups of algae**6L**

With emphasis on cell structure, thallus organization, reproduction and life history patterns of Prokaryotic algae (Cyanophyta / cyanobacteria) and Eukaryotic algae (Chlorophyta, Charophyta, Euglenophyta, Bacillariophyta, Phaeophyta, Rhodophyta)

Unit III: Applied aspects of Algae**5L**

1. Status of Indian seaweed resources, algal based industries in India; Seaweeds - marine algal farming and its applications.
2. Role of Algae in biofuel, agriculture, nutraceuticals, pharmaceuticals and biomedical industries and its applications.
3. Algae as water quality indicator; concept and control measures of algal blooms, Red tide and algal toxins.

Credit – II: FUNGI**15L****Unit I: Basics of Mycology****2L**

1. The status of Kingdom-Fungi. Principles of important systems of classification of Fungi up to the rank of classes of Lichenized and Non-Lichenized fungi.
2. Classification Systems as per Ainsworth (1973) and Alexopoulos, Mims and Blackwell (1996) up to the classes.

Unit II: Fungal Groups

5L

1. Study of the classes Myxomycetes, Plasmodiophoromycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes with reference to: a) Classification up to the rank of orders; b) Range of structure and organization of vegetative and reproductive bodies; c) Methods of reproduction; and d) Life-cycle.
2. Study of Standard keys for identification of major groups of fungi, its use and method of preparation of artificial keys for fungal identification.

Unit III: Growth and Reproduction

2L

Nutritional in fungi, Overview of Economically and Industrially important fungi (Food and Feed, Biocontrol, Medicine, Alcohol, Bioremediation etc.)

Unit IV: Fungal associations

3L

1. Lichenized fungi: General account of lichens with special reference to -
a) Habitat, Structure and organization of lichens; b) Method of reproduction;
c) Physiological relationship of mycobiont and phycobiont. Helotism; d) Key for identification of lichenized fungi; Economic importance of lichens.
2. Mycorrhizae: a) Types of mycorrhizae and its industrial importance.
b) Procedure for preparation of Mycorrhizal products for farmers.

Unit V: Applied Mycology

3L

Fungal bioprospecting, Biocontrol, Fungal databases and its use. Steps in preparation of Fungi (Fungal Flora). New trends in fungal classification as per International Code of Nomenclature (ICN) for Algae, Fungi, and Plants and Paleo-mycology.

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FUNGI

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Core Theory Course

Course Code – BOT 502 MJ

Title of the Course: PLANT TAXONOMY - I

(Bryophytes and Pteridophytes)

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I: BRYOPHYTES**15L****Unit I Introduction, general bryophytes and classification****4L**

1. Introduction, Origin, and General Characteristics.
2. Affinities with Thallophytes and Pteridophytes.
3. Distribution, Habitat, and Life cycle.
4. Reproduction.
5. Classification of Bryophytes- G. M. Smith and R. M. Schuster (1972).

Unit II Study of group of Bryophytes**8L**

Salient features of important groups and orders of Bryophytes with emphasis on the given genera including Distribution, Morphology, Anatomy and Reproduction of Marchantiales- *Plagiochasma*, Sphaerocarpaceae- *Sphaerocarpus*, Jungermanniales- *Porella*, Calobryales- *Calobryum*, Anthocerotales- *Anthoceros*, Sphagnales- *Sphagnum*, Funariales- *Funaria*, Takakiales – *Takakia*.

Unit III Structure, reproduction and economics**3L**

1. Bryophytes -Adaptations to Land Habit.
2. Amphibians of Plant Kingdom.
3. Apogamy, Apospory and Heterospory.
4. Rhizoids and Scales.
5. Evolution of Sporophyte, Theory of sterilization and reduction.
6. Economic and Ecological importance.

Credit - III: PTERIDOPHYTES **15L**

Unit I: Pteridophytes **3L**

1. Introduction and General characteristics of Pteridophytes.
2. Asporous, Heterosporous, Stele and sori evolution, Seed habit, Fossil Pteridophytes and Ethnobotanical importance.
3. Classification of Pteridophytes by Sporne (1975) and A. R. Smith (2006).

Unit II: Psilopsida **3L**

Distribution, General characteristics, Morphology, anatomy, and reproduction of Psilopsida; Life cycle study of *Psilotum*

Unit IV: Lycopsidea **3L**

Distribution, General characteristics, Morphology, anatomy, and reproduction of Lycopsidea; Life cycle study of *Selaginella*

Unit V: Sphenopsida **3L**

Distribution, General characteristics, Morphology, anatomy, and reproduction of Sphenopsida; Life cycle study of *Equisetum*.

Unit VI: Pteropsida **3L**

Distribution, General characteristics, Morphology, anatomy, and reproduction of Pteropsida; Life cycle study of *Pteris*.

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National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Core Theory Course****Course Code – BOT 503 MJ****Title of the Course: PLANT PHYSIOLOGY****[No. of Credits: 2 Credit]****[Total 30 Lectures]**

Credit - I	15L
Unit I: Photosynthesis	8L
Light harvesting complexes (Reaction center, antenna pigments), mechanism of electron transport, Kok curve, Kautsky curve, C ₃ cycle, RUBISCO activity, C ₄ and CAM cycle, Photorespiration.	
Unit II: Respiration	7L
Glycolysis, Citric acid cycle (Krebs cycle), Respiratory Electron Transport System (ETS) and ATP synthesis, alternate oxidase, Gluconeogenesis, Pentose Phosphate Pathway, Hexose Monophosphate Shunt, Cyanide Resistant Pathway.	
Credit - II	15L
Unit I: Translocation of organic solutes	3L
Source and Sink relationship, Loading and unloading of phloem and mechanism of transport of solutes (Munch hypothesis).	
Unit II: Stress physiology	4L
Definition, Types, Response of plants to biotic (pathogen and insect) and abiotic (drought, Salinity and Temperature) stress.	
Unit III: Plant hormones	4L
Biosynthesis, storage, breakdown and transport, physiological effects and mechanism of action of Brassinosteroids, Polyamines, Jasmonic Acids, Salicylic Acids.	
Unit IV: Sensory photobiology	4L
Structure, function and mechanism of action of phytochrome, Cryptochrome and Phototropins.	

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National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Core Theory Course****Course Code – BOT 504 MJ****Title of the Course: PLANT BIOCHEMISTRY****[No. of Credits: 2 Credit]****[Total 30 Lectures]**

Credit - I	15L
Unit I: Solutions and Buffers	3L
Concept of pH, pOH and pK _w , Henderson-Hasselbalch equation and its significance, mechanism of buffer action and buffers in biological system. Solutions: Concentration, Normality, Molality, Molarity, Percentage solution, Parts Per Million.	
Unit II: Lipid metabolism	4L
Biosynthesis of fatty acids, oxidation of fats, alpha-oxidation, beta-oxidation, glyoxylate cycle.	
Unit III: Nucleotide metabolism	3L
Structure, Nucleotide synthesis and nucleotide degradation.	
Unit IV: Secondary metabolites	5L
Primary and secondary metabolites in plants as important natural products; Shikimate pathway and its role in biosynthesis of secondary metabolites, Biosynthesis of terpenes, phenols and nitrogenous compounds and their role.	

Credit - II **15L**

Unit I: Amino acids **5L**

Classification, structure and properties of amino acids, Biosynthesis of amino acids with reference to GS and GOGAT in plants, Proline metabolism-a target for metabolic engineering of stress tolerance, amino acid breakdown-deamination, transamination, reductive amination.

Unit II: Proteins **5L**

Structure and function of Myoglobin, Keratin, Haemoglobin, Hydrophathy plot, Ramachandran plot, Motif and fold, Storage Proteins and Heat Shock Proteins.

Unit III: Enzymology **5L**

Classification, Active sites, Enzyme kinetics, Michaelis-Menton equation, Mechanism of action- inhibition of enzymes, Regulation of enzyme, Allosteric inhibition with reference to ATcase, Isozymes with reference to LDH, ribozymes, abzymes, co-enzymes and cofactor.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Core Theory Course

Course Code – BOT 505 MJ

Title of the Course: GREEN BELT AND GREEN CREDIT

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit –I: GREEN BELT	15L
Unit I: Greenbelt and its significance.	3L
Unit II: Plants and mitigation of pollution.	3L
Unit III: Modelling of greenbelt and plantation design.	3L
Unit IV: Nursery and propagation of greenbelt plants.	3L
Unit V: Tree legislation-importance and Maharashtra Tree Act 1975 and 2016 with reference to tree census.	3L
Credit – II: GREEN CREDITS	15L
Unit I: Objectives and Mechanism of the Green Credit Programme.	2L
Unit II: Tree Plantation-based, Water-based and Sustainable Agriculture based Green Credit	5L
Unit III: Waste Management and Air Pollution Reduction based Green Credit.	4L
Unit IV: Mangrove Conservation and Restoration based Green Credit.	2L
Unit V: Ecomark based Green Credit: Sustainable building and infra based Green Credit	2L

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Core Practical Course

Course Code – BOT 506 MJP

Title of the Course: PRACTICAL BASED ON BOT 501 MJ and BOT 502 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

PRACTICALS ON ALGAE**4P**

1. Methods of algae collection and describing algae in technical terms and Demonstrations of algal products. **1P**
2. Morphological observations, documentation (description and illustrations) and classification with reasons of at least 3 taxa belonging to:
 - a) Cyanophyta **1P**
 - b) Chlorophyta, Chrysophyta and Euglenophyta **1P**
 - c) Phaeophyta and Rhodophyta **1P**

PRACTICALS ON FUNGI**4P**

1. Study of any two members from each class with reference to their systematic position, thallus and Reproductive structures (*Arcyria / Stemonitis, Saprolegnia, Phytophthora, Pleurotus, Xylaria / Rhopalostroma / Peziza / Phyllachora, Ganoderma / Daedalea / Lenzites, / Colletotricum / Fusarium / Stilbella* and *Trichoderma*). **2P**
2. Preparation of a Key for general identification of fungi (Non-Lichenized fungi) and Lichens (Lichenized fungi), preparation of fungal herbarium and use of fungal databases. **1P**
3. Cultivation of any one industrially important macro-fungus like *Auricularia, Calocybe, Hypsizyphus, Volvariella* etc. **1P**

PRACTICALS ON BRYOPHYTES**3P**

1. Study of morphology and anatomy of thallus / habit and reproductive structures (through section cutting and permanent slides) of any four representative genera available or as studied in theory **1P**
2. Comparative anatomical study of sporophytes (with the help of permanent micro slides or images) of any four representative genera available or as studied in theory. **1P**
3. Observation, imaging and scaling of spores/sporophyte (section cutting and Photography- camera/mobile etc.) of any two representative genera available or as studied in theory. **1P**

PRACTICALS ON PTERIDOPHYTES**3P**

1. Study of Morphology, Anatomy and Reproductive parts of -
2. Psilopsida, Lycoposida, Sphenopsida and Pteropsida. **2P**
3. Stellar Evolution-Identification of different types of steles studied as per syllabus. **1P**

Note: Botanical excursion and submission of any two photographs of Algae, Fungi, Bryophytes and Pteridophytes from each groups with description along with tour report is Mandatory and it should be counted as one practical.

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Core Practical Course****Course Code – BOT 507 MJP****Title of the Course: PRACTICAL BASED ON BOT 503 MJ and BOT 504 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]****PRACTICALS BASED ON PLANT PHYSIOLOGY**

1. To determine the chlorophyll a / b ratio in C₃ and C₄ plants. **1P**
2. Separation of amino acids or sugars from the phloem sap using paper chromatography. **1P**
3. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis. **1P**
4. Estimation of proline in response to salt or drought stress. **1P**
5. Estimation of lycopene by spectrophotometric method. **1P**
6. Separation of pigments using column chromatography. Determination of absorption spectra of each pigment. **1P**
7. Comparative study of gibberellic acid (GA₃) and abscisic acid (ABA) on percent seed germination and seedling growth. **1P**

PRACTICALS BASED ON BIOCHEMISTRY

1. Preparation of standard solutions (Percent, Molar, Normal) of different concentrations; Preparation of buffers solutions. **1P**
1. Estimation of proteins by Bradford Method. **1P**
2. Estimation of total free amino acids by spectrophotometry. **1P**
3. Separation of seed storage proteins by SDS PAGE. **1P**
4. Estimation of free fatty acids by Titration method. **1P**
5. Qualitative tests for Lipids, Nucleotides, Terpens and Phenols. **1P**
6. Estimation of total phenols. **1P**
7. Determination of enzyme activity: Amylase/ Catalase/ Peroxidase. **1P**

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Theory Course

Course Code – BOT 510 MJ

Title of the Course: LANDSCAPE AND GARDENING

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I: Landscape and its Elements	15L
Unit I: Introduction	2L
Definition of Landscape Design; Definition of Landscape Development; History of Landscape Gardening; Scope and Importance.	
Unit II: Soft Elements in Landscape Gardening	6L
Trees; Shrubs; Climbers; Ground Covers; Cacti and Succulents; Bulbous plants; Seasonals / Annuals; and Lawn.	
Unit III: Principles of Landscape Gardening	4L
Focal Point; Unity; Mobility; Scale and Proportion; Axis; Texture; Mass effect; Tone and Colour.	
Unit IV: Hard Elements in Landscape Gardening	3L
Walkway; Driveway; Entrance; Pergolas; Arches; Dry Walls; Benches; Fountains and Waterfalls.	
Credit – II: Landscape Types and Application	15L
Unit I: Types of Landscape Gardening	3L
Unit II: Landscape Designing	3L
Designing process; Use of Grid; Landscape Plan –Basic, Manual, Computerized (AutoCAD).	
Unit III: Landscaping for Residents, Hospitals, Institutions, Industries etc.	4L
Unit IV: Landscape Irrigation	2L
Unit V: Maintenance of Landscape	3L

REFERENCES

1. Floriculture in India, Dr. G. S. Randhawa, Dr. Amitabha Mukhopadhaya, Allied Publishers Limited.
2. Fundamentals of Landscape Gardening by Dr. B. K. Dhaduk, Alka Singh, Sudha Patil.
3. Landscape Designing and Ornamental Plants by HS Grewal, Parminder Singh Page No. 43-61.
4. A Handbook of Landscape-CPWD.
5. Complete Gardening In India –Gopalswami Iyengar.
6. Ornamental gardening in India- Misra.

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Elective Theory Course****Course Code – BOT 511 MJ****Title of the Course: POST HARVEST TECHNOLOGY OF
COMMERCIAL CROPS****[No. of Credits: 2 Credit]****[Total 30 Lectures]****Credit - I****15L****Unit I: Harvesting Techniques and Post-Harvest Management****4L**

Harvesting Techniques: Timing and methods of harvesting for different crops, Best practices for minimizing post-harvest losses during harvest.

Harvest Management: Definition, Significance, Importance, Need, Nutritional Value (Cereals, Pulses, Vegetables, Fruits, Medicinal Plants, etc.).

Unit II: Maturity Indices and Pre-harvest practices**4L**

Maturity Indices: Judging Maturity in Horticultural Produce, Computational, Physical, Chemical & Physiological methods of maturity.

Pre-harvest Practices: Influence of plant growth regulators as pre harvest application on post-harvest storage life and quality. Growth and developmental processes during stress manipulation of developing crop.

Unit III: Harvesting, Post-Harvest Losses and treatments**5L**

Harvesting: Tools and Methods, Handling of horticultural produces, Necessary care during Harvesting.

Post-harvest losses: Principles, Types, Advantage, Causes and factors affecting the quality, procedure, maturity and harvesting indices.

Postharvest Treatments: Grading, Cleaning and Washing, Curing, Blanching, Pack house operation, Waxing, Irradiation, Prepackaging, Techniques for preserving and enhance product quality (drying, cooling and freezing).

Unit IV: Post-Harvest Processing**2L**

Cleaning, sorting, and grading of produce, Techniques for preserving and enhancing product quality (drying, cooling, and freezing), Value-added processing options (canning, juicing, fermenting, etc.).

Credit -II **15L**

Unit I: Packaging operation **3L**

Benefits, Function, Requirement for an ideal package, Prevention for mechanical damage, Cooling, Ventilation, packing materials CFB packing and others, plastic containers and paper trays, Modern packaging systems, packing method for different types produce.

Unit II: Handling and Transportation **4L**

Handling techniques to minimize physical damage and bruising, Transportation systems and considerations for maintaining produce quality.

Storage Facilities and Techniques: Types of storage facilities (cold storage, warehouses, silos, etc.). Optimal storage conditions for different crops/plants (temperature, humidity, ventilation). Control of pests and diseases during storage.

Precooling: Room cooling, forced air cooling and hydro cooling, icing, vacuum cooling, ice bank cooler and evaporative cooling.

Unit III: Concept of marketing **4L**

Market analysis and identifying target markets, Packaging and branding for effective product presentation.

Distribution: Distribution channels, (wholesaling, retailing, merchandizing and integration) Logistic management, analysis of Pesticides and fungicide residues, Export and quarantine requirements, quality management insect and pest infestation and control measure. Financing and Economic Aspects: Cost analysis of post-harvest operations, Economic considerations for post-harvest management decisions, Value chain analysis and optimization.

Unit IV: Quality and safety standards **2L**

Quality of fresh produce, components, systems, Grading, assurance and control, Methods for assessing and maintaining product quality, Quality standards and certifications, Quality control checks throughout the post-harvest chain.

Unit V: Labeling and labeling Act, Nutrition labeling **2L**

TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations. Food safety- Hazard analysis and critical control points (HACCP).

REFERENCES

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Theory Course

Course Code – BOT 512 MJ

Title of the Course: BIODIVERSITY CONSERVATION AND UTILIZATION

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Introduction	3L
Introduction to Biodiversity: Concept, definition, importance of biodiversity.	
Unit II: Types of diversity	4L
Species diversity, Genetic diversity and Ecosystem diversity, Biological Diversity.	
Unit III: Biodiversity pattern	3L
Definition, Mega diversity countries, loss of biodiversity and its reasons, Phytogeographic regions of India, Biodiversity hotspots of India, Endemism in India, Keystone and Flagship species.	
Unit IV: Conservation	5L
Concept and need for biodiversity; Strategies for plant conservation; Social approach to Conservation- Sacred Groves, Sthalavrikshas, People's Movement for Biodiversity Conservation, Chipko Movement, Chico River Dam and Tribal Campaign Methods of conservation: In-situ Conservation: Introduction, Protected Areas, Biosphere Reserves, National Parks and sanctuaries. Ex-situ Conservation: Germplasm Collections, Botanical Gardens, Seed Banks, Test-tube Gene Banks, Pollen Banks, Field Gene Banks, DNA Banks, <i>In-vitro</i> Conservation Methods.	
Credit - II	15L
Unit I: Biodiversity Management	5L
Organizations associated with Biodiversity management, Participatory Forest Management: ICUN, UNEP, WWF, FAO, WCMC. CBD- Convention on Biological diversity, Trade Related Intellectual Property Rights, CITES, International Undertaking on Plant Genetic resources and Farmers Rights, ITTA and ITTO,	

National Legislation; Biodiversity Acts and Biodiversity Register.

Unit II: Biodiversity Utilization**4L**

Concept, need and strategies of sustainable utilization; Uses of plant biodiversity – Food, Phytochemicals, Timber, Fiber, Aesthetic components, genetic resources.

Unit III: Industries based on bioresources**6L**

Definition of bioresources, types of bioresources; Industries dependent on wild bioresources with respect to source, processing and end product- food, fuel, perfume, rubber, oil, dyes, medicines, ornamental and horticulture, paper and biopesticides.

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M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Theory Course

Course Code – BOT 513 MJ

Title of the Course: INTEGRATED PEST MANAGEMENT (IPM)

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Introduction to Integrated Pest Management	3L
IPM's definition and guiding principles; A historical perspective on pest control techniques; Significance of sustainable pest management.	
Unit II: Pest Identification and Damage Assessment	3L
Common pests in both agricultural and non-agricultural environments; Detection of pest damage symptoms; Pest population monitoring techniques.	
Unit III: Cultural and Physical Control Methods	3L
Crop rotation and diversification; Habitat manipulation and cultural practices; Physical barriers and exclusion techniques.	
Unit IV: Chemical Control in IPM	3L
Types and modes of action of pesticide and fungicide; Application techniques and safety precautions for pesticide and fungicide; Pesticide resistance management.	
Unit V: Pest Ecology	3L
Ecological interactions between pests, host plants, and natural enemies; Biological control and its use in integrated pest management.	
Credit -II	15L
Unit I: Alternative Pest Management Strategies	3L
Biopesticides and their types; Genetic control methods; Biotechnology applications in pest management.	
Unit II: Integrated Pest Management Programs	3L
Designing and implementing IPM programs; Decision-making processes in IPM; Case studies and success stories of IPM implementation.	

Unit III: Economic, Social, and Environmental Considerations**3L**

Cost-benefit analysis of different pest management strategies; Socio-economic implications of pest control methods; Environmental impact assessment in IPM.

Unit IV: Emerging Issues and Future Trends in IPM**3L**

Climate change and its impact on pest management; New technologies and innovations in IPM; Global perspectives on IPM implementation.

Unit V: Bio-efficacy**3L**

Evaluation of toxicity of pesticides; Constrains and strategies in implementation of IPM; Validation of IPM.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Theory Course

Course Code – BOT 514 MJ

Title of the Course: SEED SCIENCE

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Introduction, Seed and its morphology	5L
Definition of Seed Science, Scope and Importance.	
Seed: definition; Difference between seed and grain; Orthodox and Recalcitrant seed; Classes of seed; Seed structure (embryo, endosperm and seed coat); Chemical composition of seed (carbohydrates, proteins, oils, fats and other).	
Unit III: Seed Legislation and Seed Law Enforcement	5L
Definition; Types of Seed Legislation; Seed Legislation in India; Statutory Bodies and Agencies in India under Seed Act 1966; Statutory requirements for Sale of Seed; Penalties for Offenders.	
Unit III: Seed Dormancy and Seed Germination	5L
Definition of dormancy and its types: Causes of seed dormancy and Methods of breaking dormancy; Definition of seed germination; Types of germination and Factors affecting seed germination; Seed vigor, Seed ageing and Seed viability.	
Credit - II	15L
Unit I: Seed Quality Testing	6L
Definition; Seed quality characteristics; Parameters for testing seed quality – a) GOT (grow out test); b) Germination testing, its methods (paper, sand and soil); c) Moisture testing: Moisture Meter and Air oven method; d) Physical purity analysis; e) Biochemical tests (Quick viability test (Tz), Peroxidase and Phenol Colour test); Seed Health Testing.	
Unit II: Seed Pathology	4L
Definition; Mechanism of seed transmission and entry point of seed infection (soil, air, insect and nematodes); Quarantine for seed; Integrated management of seed borne diseases.	

Unit III: Seed Entomology**5L**

Relation of insects and plants; Pest of fiber crop, pulses, vegetable and storage grain pest (Any one example from each) with respect to their lifecycle, way of infestation and control measures (Physical, Chemical and Biological).

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National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Elective Practical Course****Course Code – BOT 515 MJP****Title of the Course: PRACTICAL BASED ON BOT 510 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

-
- | | |
|---|----|
| 1. To study of Soft Elements / Plant Identification as studied in Theory. | 2P |
| 2. To study of Hard Elements in Landscape Gardening | 2P |
| 3. To study application of Principles of Landscape Gardening | 1P |
| 4. To study Types of Landscape Gardening | 1P |
| 5. To study Landscape Designing Process | 2P |
| 6. To study Landscape Development. | 2P |
| 7. To study implementation work of landscape irrigation. | 1P |
| 8. To study Maintenance activities of Landscape gardening. | 2P |
| 9. Site visit to different Landscape Projects. | 2P |

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M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Practical Course

Course Code - BOT 516 MJP

Title of the Course: PRACTICAL BASED ON BOT 511 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

1. Analyzing maturity stages of commercially important crops.	1P
2. Study of pre-cooling methods.	1P
3. Study the grading and sorting of agricultural commodities.	1P
4. Study of wax coating of agricultural commodities.	1P
5. Quality evaluation of different agricultural commodities.	1P
6. Primary processing of selected agricultural commodities.	1P
7. Preparation of value-added products from fruits and vegetables.	1P
8. Studies on different packaging materials used for agricultural commodities.	1P
9. Study of various types of dryers.	1P
10. Quality standards of major agricultural commodities.	1P
11. Sanitary and Phyto-sanitary measures during export of horticultural produce.	1P
12. Supply chain management of agricultural commodities.	1P
13. List and cost of equipment, utensils, additives required for small scale processing Industry.	1P
14. Visit to fruit and vegetable processing units.	1P
15. Visit to cold storage and CA storage units.	1P

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M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Practical Course

Course Code – BOT 517 MJP

Title of the Course: PRACTICAL BASED ON BOT 512 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

- | | |
|---|----|
| 1. Finding minimum size of sampling unit for studying specific plant community. | 1P |
| 2. Determination of species richness, similarity and diversity indices in different plant Communities. | 1P |
| 3. Study of vegetation by using diversity indices e.g. Simpson's Index and Shannon-Weiner Index. | 1P |
| 4. Case study of any one in-situ conserved species. | 1P |
| 5. Case study of any one ex-situ conserved species | 1P |
| 6. Conservation of any two indigenous or endemic species–Submission of report. | 2P |
| 7. Observation and documentation of various aspects of any one keystone species (e. g. <i>Ficus</i> , <i>Bombax</i>) | 1P |
| 8. Extraction of essential oils by using Clevenger apparatus. | 2P |
| 9. Extraction of oil from any oil seed by using soxhlate apparatus | 1P |
| 10. Extraction of dye from any one plant resource flower, fruit, bark, etc. and dyeing of cloth. | 1P |
| 11. Visit to any forest / nearby biodiversity area to document bioresources with respect to its uses. | 2P |
| 12. Study of medicinal plants from nearby area. | 1P |

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Major Elective Practical Course****Course Code – BOT 518 MJP****Title of the Course: PRACTICAL BASED ON BOT 513 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

1. Study of Symptoms of various plant diseases.	1P
2. Study of Plant Pests and Parasites.	1P
3. Study of morphological features and identification of Plant Nematodes.	1P
4. Methods of Pesticide application and their safe use.	1P
5. Calculation of Fungicide sprays concentrations.	1P
6. Media Preparation for Fungi and Bacteria.	2P
7. Isolation of Fungi and Bacterial pathogens from soil.	1P
8. Study of Fungicides and Biopesticides and their Formulations.	2P
9. Collection and preservation techniques of Disease Specimens.	1P
10. Visit to Agricultural or horticultural settings implementing IPM.	2P

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M.Sc. Botany, Part - I (Semester - I)

Mandatory Major Elective Practical Course

Course Code – BOT 519 MJP

Title of the Course: PRACTICAL BASED ON BOT 514 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

1. Study of Monocot and Dicot Seed Structure	1P
2. Study of Seed Germination (Epigeal, Hypogeal and Viviparous types)	2P
3. Study of methods of breaking seed dormancy	1P
4. Study Grow Out Test (GOT)	1P
5. Study of Seed Germination testing methods (Paper, Soil and Sand)	2P
6. Study of Physical Purity Test	1P
7. Study biochemical tests (Quick viability test (Tz), Peroxidase and Phenol colour test) for testing seed quality	1P
8. Study moisture testing with moisture meter and oven method	1P
9. Detection and identification of important seed borne fungi by using different detection Methods- Washing, Agar and Blotter method.	2P
10. Study of important Pest of fiber crop, pulses, vegetable and storage grain, with reference to their life cycle, damage and control measures.	2P
11. Visit to a seed industry/research institute.	1P

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Minor Theory Course****Course Code – BOT 541 MN****Title of the Course: RESEARCH METHODOLOGY****[No. of Credits: 2 Credit]****[Total 30 Lectures]**

Credit - I	15L
Unit I: Research Methodology	4L
Meaning of Research; Objectives of Research; Types of Research: Descriptive Vs Analytical Research, Applied Vs Fundamental Research, Quantitative Vs Qualitative Research, Conceptual Vs Empirical Research; Criteria for Good Research; Significance of Research; Methods and Techniques used in Library, Field and Laboratory Research.	
Unit II: Defining Research Problem	2L
What is a Research Problem? Selecting the Problem; Necessity of Defining the Research Problem; Technique involved in Defining a Research Problem.	
Unit III: Research Hypothesis	4L
What is Hypothesis? Characteristics of Hypothesis; Sources of Hypothesis; Types of Hypotheses: Simple Hypothesis, Complex Hypothesis, Directional Hypothesis, Non-directional Hypothesis, Null Hypothesis, Associative and Causal Hypothesis; Functions of Hypothesis; How will Hypothesis help in Scientific Method?	
Unit IV: Literature Review and References	3L
What is Literature Review? Purpose of Literature Review; Types of Literature Review; How to write a Review Article? Format of Review Article; Difference between Review Articles and Research Papers; Various Referencing Styles - Bibliometric analysis, Systematic Literature Survey, various software's; Introduction to Meta-analysis and analysis software's.	
Unit V: Research Ethics and Intellectual Property Rights	2L
Intellectual Property Rights (IPR); Patent; Copyright.	

Credit - II **15L**

Unit I: Methods of Data Collection **4L**

Collection of Primary Data; Observation Method; Interview Method; Collection of Data through Questionnaires, Likert scale; Documentation of Data; Analysis of Data: Mean, Mode, Median, Standard Deviation, Coefficient of Variation, T-Test, Chi-square test, ANNOVA.

Unit II: Interpretation and Report Writing **3L**

Meaning of Interpretation; Why Interpretation; Steps and Layout of Research Report; Mechanics of Writing a Research Abstract, Paper and Report; Oral and Poster Presentations.

Unit III: Role of Computer in Research **5L**

Basics of Computer and introduction to Microsoft Office (MS Word, Excel, and PowerPoint), Things of Internet; Tabulation and generation of graphs; Micro Imaging System/Digital Photography; Use of tools / techniques for Research; Scientific Search Engines for referencing the research work; Reference Management Software like Zotero /Mendeley; Software for research paper formatting like LaTeX/MS Office; Data analysis: Mean, Mode, Median, Standard Deviation, Coefficient of Variation, T-Test, Chi-square test, ANNOVA; Data interpretation software – SPSS; Software for detection of Plagiarism.

Unit IV: Impact Factor and Scientific Journals **3L**

Concept of Journal Citation Reports (JCR) and Journal Impact Factor (IF); Formula for calculation of IF; Use, significance and limitations of IF; Concept and importance of Citations in research; H-Index, i10-Index; Introduction and concept of UGC CARE listed journals and Journals indexed by Thomson Reuters Scientific.

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- Bill Taylor, Gautam Sinha and Taposh Ghoshal, Research Methodology, PHI Learning Private Limited, New Delhi
- Gurumani N. Research Methodology for Biological Sciences, MJP Publishers, Chennai
- Upagade Vijay and Shende Arvind, Research Methodology, S. Chand & Company Limited,

New Delhi

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R. Panneerselvam, Research Methodology, Prentice Hall of India Private Limited, New Delhi.

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - I)****Mandatory Minor Practical Course****Course Code – BOT 542 MNP****Title of the Course: PRACTICALS BASED ON BOT 541 MN****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

-
- | | |
|---|-----------|
| 1. To learn how to write a review. | 1P |
| 2. To learn how to write a reference. | 1P |
| 3. To create a graph (Line/Bar/Pie) using MS Excel. | 1P |
| 4. To learn how to write an abstract for research article using MS Word. | 1P |
| 5. To learn how to write a research outline and present it using MS PowerPoint. | 1P |
| 6. To study how to check plagiarism for a document using suitable software (Turnitin/Urkund). | 1P |
| 7. To learn microphotography of suitable biological material using digital camera and microscope. | 1P |
| 8. To learn mean, mode, median, standard deviation and coefficient of variation with suitable examples. | 1P |
| 9. To learn T-test and Chi-square test using suitable example. | 1P |
| 10. To learn ANNOVA using suitable data. | 1P |
| 11. To learn how to file a patent form. | 1P |
| 12. Bibliometric analysis using Bibliometrix package of R. | 1P |

Syllabus for M. Sc. Botany, Part - I
Semester - II
As Per New Education Policy 2020

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Theory Course

Course Code – BOT 551 MJ

Title of the Course: PLANT TAXONOMY - III

(Paleobotany and Gymnosperms)

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I: PALEOBOTANY**15L****Unit I:** Geological time scale, Form genera concept.**2L****Unit II: Fossils****3L**

Definition, process of fossil formation, types of fossils - Impression, Compression, Petrification, Pith cast and Coal ball.

Unit III: Study of Fossil Groups**10L**

- a) Psilopsida- Salient features of order Psilophytales, external and internal morphology of *Rhynia*.
- b) Lycopsida- Salient features of order Lepidodendrales, external and internal morphology of *Lepidodendron*.
- c) Sphenopsida- Salient features of Calamitales, external and internal morphology of *Calamites*.
- d) Pteridosperms- External and internal morphology of *Lyginopteris oldhamia*.
- e) Cycadopsida- Salient features of order Cycadeoidales (Bennettitales), external and internal morphology of *Williamsonia*.
- f) Pentoxylae- Salient feature, external and internal morphology of stem [*Pentoxylon*], Leaf [*Nipaniophyllum*].

Credit – II: GYMNOSPERMS **15L**

Unit I: General Aspects of Gymnosperms **3L**

- i. Classification of gymnosperms by Raizda and Sahni, A new classification by Christenhusz et.al 2011.
- ii. Affinities of gymnosperms with Pteridophytes and Angiosperms.
- iii. Distribution of gymnosperms worldwide and India.
- iv. Economic aspects of gymnosperms.

Unit II: General characters, morphology, anatomy, reproductive organs

and affinities of: **12L**

Pteridospermales – *Glossopteris*; Cycadeoidales – *Cycadeoidea*; Pentoxylales – *Pentoxylon*; Cordaitales – *Mesoxylon*; Cycadales – *Zamia*; Ginkgoales – *Ginkgo*; Coniferales–*Araucaria* /*Podocarpus* /*Cupressus* /*Thuja*; Taxales- *Taxus*; Gnetales – *Gnetum*; Epherales – *Ephedra*, and Welwitschiales – *Welwitschia*.

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JOURNALS

1. Phytotaxa
2. Taxon
3. The Journal of Indian Botanical society
4. International Journal of plant sciences

WEBSITES

1. <http://www.mobot.org/MOBOT/research/APweb/>.
2. <https://doi.org/10.12705/Code.2018>

Proposed methods of teaching/ innovative teaching: Classroom teaching, lecture cum demonstration methods, question answer method, brain storming method, assignment method

Innovative teaching: audio video, science museum, ICT enabled teaching, video clips/movies, field trips.

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Theory Course

Course Code – BOT 552 MJ

Title of the Course: TAXONOMY OF ANGIOSPERMS

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I **15L**
Unit I: Systematics **5L**

A key science, importance and major objectives, taxonomic structure and hierarchy, species concept (taxonomic, biological, and evolutionary), alpha and omega taxonomy.

Plant Taxonomy through ages in India: Major contribution of Van Rhee, W. Roxburgh, J. D. Hooker, C. B. Clarke, T. Cooke, H., E.K. Janaki Ammal, K. S. Manilal.

Unit II: International Code of Nomenclature **5L**

History, Principles, Important rules and recommendations with examples, governance of code, Appendices; Name of hybrids.

Aspects of Taxonomy (identification, nomenclature, classification, systematics, molecular systematics); Phases of taxonomy (exploration, consolidation, experimental or biosystematics, encyclopedic).

Unit III: Systems of classification **5L**

Pre-Darwinian e.g. Artificial system by Linnaeus; Post-Darwinian e.g. Natural System by Bentham and Hooker; Phylogenetic system e.g. Conquest general outline of APG IV.

Credit – II **15L****Unit I: Study of Plant Families**

Study of plant families with respect to general characters, morphological variations, systematic position, economic importance and affinities following Bentham and Hooker and APG –IV system of classification: Nymphaeaceae, Dipterocarpaceae, Apiaceae (Umbelliferae), Verbenaceae, Asteraceae, Lentibulariaceae, Bignoniaceae, Amaranthaceae, Araceae, Arecaceae, Orchidaceae, and Poaceae.

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JOURNALS

1. Phytotaxa
2. Taxon
3. The Journal of Indian Botanical society
4. International Journal of plant sciences

WEBSITES

1. <http://www.mobot.org/MOBOT/research/APweb/>.
2. <https://doi.org/10.12705/Code.2018>

Proposed methods of teaching/ innovative teaching: Classroom teaching, lecture cum demonstration methods, question answer method, brain storming method, assignment method

Innovative teaching: audio video, science museum, ICT enabled teaching, video clips/movies, field trips.

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - II)****Mandatory Major Core Theory Course****Course Code – BOT 553 MJ****Title of the Course: CYTOGENETICS AND PLANT BREEDING****[No. of Credits: 2 Credit]****[Total 30 Lectures]**

Credit - I: CYTOGENETICS	15L
Unit I: General Introduction to Cytogenetics	2L
Definition, History, Applications of cytogenetics and Techniques of cytogenetics: Karyotyping, Slide Preparation and Analysis.	
Unit II: Chromosomes	2L
Structure and Organization of chromosome, Concept of karyotype, Preparation of chromosome for karyotype, Role of karyotype in plant species identification.	
Unit III: Gene Mapping Methods	3L
Linkage mapping: Two Point and Three Point Test cross, LOD score for linkage testing, QTL mapping, Marker assisted selection (MAS), Mapping by tetrad analysis in Yeast (unordered) and Neurospora (ordered), Somatic cell mapping.	
Unit IV: Mutation	2L
Mutation- causes and detection, Types of Mutation- Spontaneous, Induced, Point, Frameshift Mutation, Lethal, Germline vs somatic mutations.	
Unit V: Variation in chromosome structure	3L
Detection, Duplication, Inversion and Translocation. Cytological consequences of crossing over in Inversion and translocation heterozygotes.	
Unit VI: Variation in chromosome number	3L
Euploidy and Aneuploidy, Classification, method of production, identification and meiotic behavior of aneuploids (Monosomics, Nullisomics and Trisomics). Ploidy: Origin, production of Autopolyploids and Allopolyploids, evolution of major crop plants (Cotton & Wheat).	

Credit – II: PLANT BREEDING	15L
Unit I: General Introduction to Plant Breeding	2L
Definition, Scope and objectives and History of Plant breeding in India.	
Unit II: Activities in Plant Breeding	3L
Creation of variation, Selection, Evaluation, Multiplication and Distribution, Hybridization: Objectives, types, procedure, raising F1 generation, selfing, difficulties in hybridization.	
Unit III: Pureline Selection	2L
Definition, Characters of Pureline selection, Procedure for Pureline selection, Advantages and disadvantages of Pureline selection, Achievements of pureline selection.	
Unit IV: Mass Selection and Clonal Selection.	4L
Mass selection: Definition, Procedure for mass selection, Advantages and disadvantages of mass selection, Achievements of mass selection. Clonal selection: Definition, Characters of clone, Procedure for clonal selection, Advantages and disadvantages of clonal selection and Achievements of clonal selection.	
Unit V: Heterosis and inbreeding depression	2L
Definition, Genetic basis of Heterosis, Genetic basis of Inbreeding depression and Commercial utilization.	
Unit VI: Self-Incompatibility and Male sterility	2L
Genetic basis of self- incompatibility and male sterility, Types of male sterility and their use in hybrid seed production	

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Theory Course

Course Code – BOT 554 MJ

Title of the Course: MOLECULAR BIOLOGY

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I: DNA - Enzymes, Packaging, Replication, Damage and Repair. **15L**

Unit I: DNA Degrading and Modifying Enzymes **3L**

DNA Degrading Enzymes: Nucleases- Endo-nuclease and Exo-nucleases; DNA modifying enzymes: Polymerases, Ligases, Phosphatases and polynucleotide kinases, Phosphorylase, Methylase.

Unit II: DNA Packaging **4L**

DNA Packaging, Nucleosomes, Histones, Need of DNA Packaging, DNA Packaging in Prokaryotes and Eukaryotes.

Unit III: DNA Replication **4L**

General factors of DNA replication, Replication apparatus, structure of DNA polymerases, Mechanism of replication in Prokaryotes and Eukaryotes, Regulation of replication and fidelity.

Unit III: DNA Damage and Repair **4L**

Types of DNA damages, Multiple repair pathway: Nucleotide excision repair, Base excision repair and Mismatch repair system.

Credit – II: Transcription, Translation and Gene regulation. **15L**

Unit I: Transcription **5L**

Definition, Apparatus, Enzymes and factors involved in transcription, Transcription in Prokaryotes and Eukaryotes, RNA processing: m-RNA, r-RNA and t-RNA, Structure of spliceosome and function.

Unit II: Translation**4L**

Definition, Structure of m-RNA, r-RNA and t-RNA, Ribosomal assembly, Genetic Code-Concept and Properties, Coenzymes and factors involved in translation, Mechanism of protein synthesis: Initiation, elongation and termination in prokaryotes and eukaryotes, Post – translational control, Protein folding and processing, Protein targeting, Chaperons and Post – translational modifications.

Unit II: Gene Regulation**4L**

Concept and importance, Positive and Negative regulation, Mechanism of regulation and concept: Lactose, Tryptophan and Arabinose.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Theory Course

Course Code – BOT 555 MJ

Title of the Course: PHARMACOGNOSY

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit I	15L
Unit I: General Pharmacognosy	2L
Definition and scope of Pharmacognosy, Historical background and current trends, Classification of crude drugs, Indian trade in medicinal and aromatic plants.	
Unit II: Cultivation and collection of medicinal Plants	4L
General aspects involved in cultivation of medicinal plants. Factors affecting the cultivation of crude drugs. (I) Exogenous, (II) Endogenous factors, (III) Mineral supplements, (IV) Nutrients, (V) Soil and Soil fertility, (VI) Pest and Pest control, (VII) Plant Growth Regulators, (VIII) Genetic manipulators, and (IX) Diseases management of medicinal and aromatic plants.	
Unit III: Adulteration and Deterioration	5L
Introduction, Types of Adulteration/ Substitution of Herbal drugs, Causes and Measures of Adulteration, Sampling Procedures, Determination of Foreign Matter, detection of heavy metals, pesticide residues, phytotoxin, microbial contamination in herbs and their formulations.	
Unit IV: Extraction Methods and Chromatography	4L
General methods, types and principles of extraction. Selection of solvents for extraction and purification of extracts using chromatographic methods including TLC, HPLC and HPTLC.	
Credit II	15L
Unit I: Ethnobotany	2L
Ethnobotany in herbal drug evaluation, Impact of Ethnobotany in traditional medicine, Role of Ethno-pharmacology in drug evaluation, Reverse Pharmacology.	

Unit II: Pharmacognostic study of the following drugs**5L**

With reference to source, cultivation, collection, macroscopic characters, and application – Isabgol (*Plantago ovata*), Aloes (*Aloe vera*), Digitalis (*Digitalis purpurea*), Dioscorea (*Dioscorea bulbifera*), Safed Musli (*Chlorophytum borivilianum*), Shatavari (*Asparagus racemosus*), Brahmi (*Bacopa monnieri*).

Unit III: Phyto-pharmaceuticals**8L**

Occurrence, isolation and characteristic features (Chemical nature, uses in pharmacy, medicinal and health benefits) of following. a) Carotenoids – i) α and β - Carotene ii) Xanthophyll (Lutein); b) Limonoids – i) d-Limonene ii) α - Terpineol; c) Saponins – i) Shatavarins; d) Flavonoids – i) Resveratrol ii) Rutin iii) Hesperidin iv) Naringin v) Quercetin; e) Phenolic acids- Ellagic acid; f) Vitamins; g) Tocotrienols and Tocopherols; h) Andrographolide (alkaloids), Glycolipids, Gugulipids, Withanolides, Vascine, Taxol and i) Miscellaneous.

REFERENCES

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Practical Course

Course Code – BOT 556 MJP

Title of the Course: PRACTICAL BASED ON BOT 551 MJ and BOT 552 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

PRACTICAL ON PALEOBOTANY**1P**

- Study of the following with the help of slides and/ or specimens. i) Impression, ii) Compression, iii) Petrification, iv) Coal ball, v) *Rhynia*, vii) *Lyginopteris*, viii) *Pentoxylon*, ix) *Nipaniophyllum*, x) *Lepidodendron*.

PRACTICAL ON GYMNOSPERMS**2P**

- Morphological and/or anatomical (double staining) and/or reproductive studies of the following members with the help of live material/or herbarium specimens and/or museum specimens and/or permanent slides of the following orders (Any one Example from each Order): i) Cycadales; ii) Coniferales; and iii) Gnetales.

PRACTICAL ON ANGIOSPERMS**13P**

- Studies on the families as per Bentham and Hooker's system of classification – any one example form each series available locally **6P**

A) Dicotyledonae:

- Polypetalae: Thalamiflorae, Disciflorae, Calyciflorae
- Gamopetalae: Inferae, Heteromerae, Bicarpellatae
- Monochlamydae: Curvembryae, Microembryae, Unisexuales

B) Monocotyledonae: Epigynae, Coronariae, Calycinae, Glumaceae

- Identification of any two unknown plant specimen (Locally available except horticultural/Cultivated/Ornamental plant specimen) with the help of Flora. **1P**
- Preparation of artificial, indented or bracketed, keys for identification of any ten unknown specimens. **1P**
- Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication etc. **1P**
- Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations. **1P**

6. Field trips around the college Campus, compilation of field notes and preparation of herbarium sheets of such plants. **1P**
7. Preparation of study tour report and submission of 25 correctly identified Herbarium specimens (at least 20 family). **2P**

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Core Practical Course

Course Code – BOT 557 MJP

Title of the Course: PRACTICAL BASED ON BOT 553 MJ and BOT 554 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

PRACTICAL ON CYTOGENETICS AND PLANT BREEDING (Any 08 Practical)

1. Preparation of cytological stains and fixatives, preservation. **1P**
2. Study of external morphology of metaphase chromosome from suitable plant material employing acetoorcein and fulgen stain. **1P**
3. Preparation of C- metaphase chromosomes of appropriate material (*Allium / Aloe*). **2P**
4. Study of Meiotic configuration in *Rhoeo / Tradescantia* buds. **1P**
5. Numerical problem based on Gene mapping using two point and three-point test crosses. **2P**
6. Numerical problem based on *Neurospora* tetrad analysis. **1P**
7. Karyotype analysis of C-metaphase chromosomes using photograph/slide. **1P**
8. Study of Floral Biology and Pollen Viability of any two major crops. **1P**
9. Study of hybridization technique in cotton and maize. **2P**
10. Induction of polyploidy in any suitable crop plants using colchicine, compare the morphological characters using control. **1P**
11. Visit to any Plant Breeding Research Centre and submission of report **1P**

PRACTICAL ON MOLECULAR BIOLOGY (Any 06 Practical)

1. Isolation of prokaryotic DNA and its spectrophotometric estimation or its estimation by DPA method. **2P**
2. Isolation of plant genomic DNA and its analysis by Agarose Gel Electrophoresis. **2P**
3. Check quantity and purity of DNA sample by UV-VIS spectrophotometric method. **1P**
4. Isolation of RNA and its estimation by Orcinol. **1P**
5. Isolation of Seed Storage Proteins from suitable leguminous seeds and its quantification. **1P**
6. SDS-PAGE based separation of proteins and analysis of its molecular weight. **2P**
7. Study of instruments or equipment's used in Molecular Biology: PCR Thermal Cyclers, Gel Documentation System, ELISA Reader, Millipore Distillation Apparatus, Lyophilizes, Refractometer. **2P**

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Theory Course

Course Code – BOT 560 MJ

Title of the Course: HYDROPONICS TECHNOLOGY

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Introduction to hydroponics technology	5L
Definition and Concept, History and origin of Soil-less culture, Present status of Hydroponics - Contrasts with soil-based culture, Types of hydroponics, applications and future developments.	
Unit II: Plant Nutrition: Essential, mineral elements	6L
Functions and effects on plants, Deficiency Symptoms of the following Essential Minerals- N, P, Ca, Mg, K, S, Fe, Mn, Cu, Zn, B, Mo. Environmental and Chemical Factors: Light (Quality, Photoperiodism and systems), Temperature (heating and cooling), Humidity and CO ₂ , pH, PPM / TDS.	
Unit III: Hydroponics entrepreneurship	4L
Definition; Significance of entrepreneurship; Challenges - family, social, technological, financial and policy; Role of government in promoting entrepreneurship; Stages in starting a small scale industry.	
Credit - II	15L
Unit I: Nutrient Solutions and Media Inorganic salts (fertilizers)	8L
Macronutrients, Micronutrients, Formulating, monitoring, and analyzing, pH adjustment, selecting fertilizers and nutrient monitoring; Media used for Hydroponics: Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fiber; Weed management, diseases and pest control, Pollination, making clones of plants.	
Unit II: Techniques in Hydroponics and Cultivation of crop plants	5L
Techniques in Hydroponics – Static solution culture, Continuous – flow Solution	

culture, Aeroponics, Passive sub-irrigation, Ebb and flow or flood and drain irrigation, Deep water culture; Protocols for – Tomato cultivation through Dutch bucket method, Chilly cultivation through NFT system, Spinach through Raft system, Fodder system.

Unit III: Marketing of hydroponics products

2L

Harvesting, grading, storage and marketing process of crops grown under hydroponics system global hydroponic market and commercial hydroponic production.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Theory Course

Course Code – BOT 561 MJ

Title of the Course: POST HARVEST MANAGEMENT OF NTFPs
(Non-Timber Forest Products)

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Post-Harvest Management concept, importance in NTFPs.	3L
Unit II: NTFPs: Concept, Scope and Importance. Livelihood vs NTFPs Sources, Distribution, collection, primary processing and marketing.	3L
Unit III: Bamboo and Canes: Sources, uses, cultivation, and conservation.	2L
Unit IV: Essential Oils - methods of extraction, classification, storage and uses. Non-essential oils – nature, occurrence, methods of extraction, classification and uses.	3L
Unit V: Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants.	4L
Credit - II	15L
Unit I: Resins and Oleoresins, their formation in plants and classification of resins	2L
Unit II: Tans-nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes.	3L
Unit III: Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Wild fruits, spices, poisons and bio-pesticides.	6L
Unit IV: NTFPs and Sustainable Development, IPRs, Traditional Knowledge. Organization and Institutes working in NTFPs sector.	4L

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Theory Course

Course Code – BOT 562 MJ

**Title of the Course: PLANT RESOURCE MANAGEMENT and
GEO- SPATIAL TECHNIQUES**

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit – I: PLANT RESOURCE MANAGEMENT**15L****Unit I: Basis of Plant Resources****2L**

Origin and Basis of cultivated plants, N. I. Vavilov's Centre of Origin of cultivated plants.

Unit II: Plant Utility and exploitation**8L**

Characters and economical importance of plant resources (Two examples of each)
Food - (Cereals, Fruits & Nuts), Fodder & Fiber crops, aromatic plants, Essential Oils and other, Timber. Gums, Resins, Spices. Plants used in beverage industry, Medicine and Narcotics, Natural dyes, Sugars and Starch, energy producing plants, Ornamental plants.

Unit III: Plant resources & Sustainable development**5L**

Basic concepts of sustainable development, industrial ecology and recycling industry (Phytoremediation), Environmental education & awareness, concept and practice of restoration ecology, Strategies for ex-situ and in-situ conservation. National and International environmental conservation strategies and organization.

Credit – II: GEO-SPATIAL TECHNIQUES**15L****Unit I: Remote Sensing****6L**

Overview of Remote sensing and GIS Techniques, Geological maps (Mapping, Measuring, Modelling & Monitoring); Principles of remote sensing and satellite imagery, Image acquisition, pre-processing enhancement, Image classification, Techniques for land cover analysis.

Unit II: Global Positioning System (GPS)**3L**

GPS Principles & fundamentals, GPS data collection & field work Technology, integration of GPS data with GIS.

Unit III: Applications of Geo-Spatial Techniques**6L**

Case studies of geo-spatial techniques in various fields (Geo-coding of Sacred groves, RET species or any other aspect in plant conservation point of view), Ethical and legal consideration in geo-spatial data usage emerging trends in geo-spatial Technology.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Theory Course

Course Code – BOT 563 MJ

Title of the Course: PLANT MICROBES INTERACTION

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit-I: BENEFICIAL INTERACTION AND ADVANCED APPROACH	15L
Unit I: Endophytic fungi	2L
Endophytic fungi, beneficial interaction of endophytes with plants for growth and alleviation of stress condition.	
Unit II: Symbiotic relationship of microbes with plants	5L
Arbuscular Mycorrhizal fungi: Introduction of Arbuscular Mycorrhizal fungi (AMF), Early phase of AMF symbiosis, role of MYC factor during symbiosis, establishment of symbiosis and exchange of nutrients and sugar, prime/induced defense response in plants during AMF symbiosis against various biotic and abiotic stresses, Tri-trophic interaction of plants with herbivores during AMF symbiosis.	
Unit III: <i>Rhizobium</i> symbiosis	2L
<i>Rhizobium</i> host interaction, NOD factor, symbiotic Nitrogen fixation.	
Unit IV: Plant associative and endophytic Bacteria	3L
Introduction, Beneficial interaction of root associative and endophytic bacteria for plant growth promotion. Interaction of root associative and endophytic bacteria for biocontrol against plant pathogen.	
Unit V: Nematode	3L
Interaction of plant parasitic Nematode with plants, isolation, identification, mode of action and interaction of nematophagous microbes (Fungi/bacteria) against Nematode.	

Credit-II: HARMFUL PLANT-PATHOGEN INTERACTION **15L**

Unit I: Bacterial pathogenesis of plants **5L**

Quorum sensing (QS) in plant pathogen, Stomatal Hijacking and Cell Wall-Damaging Enzymes, Plant Manipulation by Pathogenic Bacteria, effector proteins and virulence, function of T3ES, Zig zag model of plant immunity, Antibiotic use in plant agriculture, study of bacterial blight of pomegranate wrt. Causal organism, symptoms, molecular diagnosis and control measures.

Unit II: Phytopathogenic fungi **5L**

Fungal lifestyle: Biotrophs, Necrotrophs and Hemibiotrophs, Mechanisms of host penetration, Pathogenic factors, Role of salicylic acid(SA)and jasmonic acid (JA) in plant defence, Systemic acquired resistance (SAR), Entomopathogenic fungi (*Beauveria sp.*), study of corn smut wrt. Causal organism, symptoms, effectors of *U. maydis*, function of Pep1, control measures of corn smut.

Unit III: Phytophagous insects **5L**

Diversity, foraging strategy, Diet Breadth, Role of reactive oxygen species (ROS) in plant-insect interaction, SA-JA crosstalk in plant-herbivore interaction, plant lectins, Beet Armyworm *Spodoptera exigua* on onions symptoms, biological and chemical control measures.

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National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Theory Course

Course Code – BOT 564 MJ

Title of the Course: SEED TECHNOLOGY

[No. of Credits: 2 Credit]

[Total 30 Lectures]

Credit - I	15L
Unit I: Introduction	2L
Definition of Seed Technology, Scope and Importance.	
Unit II: Seed Industry in India	2L
History of Seed Industry in India; National Seeds Corporation Limited; Indian Society of Seed Technology; National Seeds Programme (NSP); Role of Private Seed Enterprises and their names.	
Unit III: Seed Production	8L
General Principles of seed production. Artificial pollination (Hand pollination, Dusting and Honeybee); Seed production techniques in hybrids (use of Male Sterility, Self-Incompatibility and gametocides); General procedure of seed production (Land requirements, isolation requirements, brief cultural practices, plant protection-physical, chemical and biological, types of chemical pesticides – systemic and contact, rouging, harvesting and threshing).	
Unit IV: Field Inspection	3L
Seed inspector, powers and duties. Number of inspections with reference to stage of crop. Procedure and observations during field inspection.	
Credit - II	15L
Unit I: Seed Sampling	5L
Seed Sampling: Definition, Sampling, Dividing and Mixing Equipment; Procedure of sampling, (Kinds-Primary, composite, submitted and working). Types of seed samples (Service, official and certification sample).	

Unit II: Seed Certification**4L**

Definition, concept and objectives of Seed Certification. Seed Certification Agency and Staffing pattern of SCA. Duties and responsibilities of Seed Certification Officer.

Unit III: Seed Processing**6L**

Objectives of seed processing; General layout of seed processing unit; Steps in Seed Processing - Receiving and Drying, Pre-cleaning and Grading, Seed Treatment. Definition, Benefits of Seed Treatment, Types of Seed Treatment, Seed Weighing, Packing and Storage

REFERENCES

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National Education Policy 2020**M.Sc. Botany, Part - I (Semester - II)****Mandatory Major Elective Practical Course****Course Code – BOT 565 MJP****Title of the Course: PRACTICAL BASED ON BOT 560 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

1. Preparation of stock solutions of macro and micronutrients.	2P
2. Preparation of Hoagland's solution.	2P
3. Germination of lettuce seedlings / any commercial plant under controlled conditions.	2P
4. Cultivation of lettuce / any commercial plant in hydroponic NFT system.	3P
5. Cultivation of tomato/ any suitable plant in Dutch bucket system.	3P
6. Cultivation of medicinal plants using hydroponic technique.	2P
7. Visit to an industry/institute for demonstration of hydroponics.	1P

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Practical Course

Course Code – BOT 566 MJP

Title of the Course: PRACTICAL BASED ON BOT 561 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

- | | |
|---|-----------|
| 1. Identification of NTFPs with their sources (any 50 products and sources). | 2P |
| 2. Analyzing maturity stages of commercially important NTFPs. | 1P |
| 3. To study the pre-cooling methods for locally available wild fruits. | 1P |
| 4. To study the grading and sorting of NTFPs (Gums, Herbs, Wild Vegetables, fruits, etc.) | 2P |
| 5. To study the primary processing for medicinal plants. | 1P |
| 6. Preparation of value-added products from NTFPs such as food supplements, nutraceuticals, energy drink, etc. | 1P |
| 7. Studies on different packaging materials used for NTFPs packaging. | 1P |
| 8. To study various methods of drying. | 1P |
| 9. To study quality standards required for export of Agricultural and NTFPs commodities. | 1P |
| 10. Visit to the Plant based processing unit. | 1P |
| 11. Visit to the cold storage Unit /Export unit. | 1P |
| 12. To prepare proposal on PHM unit for NTFPs for submission to bank / Ministry / Organization for getting fund/loan. | 2P |

National Education Policy 2020

M.Sc. Botany, Part - I (Semester - II)

Mandatory Major Elective Practical Course

Course Code – BOT 567 MJP

Title of the Course: PRACTICAL BASED ON BOT 562 MJ

[No. of Credits: 2 Credit]

[Total 60 Lectures]

1. Study of Food plants (Cereals, Fruits & Nuts) one each.	1P
2. Study of Fodder and Fiber Crops, Aromatic Plants, Oils, Timber two each.	2P
3. Study of Plants used in Beverage Industry, Medicine & Narcotics, Natural dyes.	2P
4. Study of Plants used in Sugar & Starch industry, Energy Producing Plants, Ornamental Plants.	2P
5. Introduction of QGIS tool, management, plugin, data linking and toolbox.	2P
6. Vegetation mapping using GPS and GIS.	1P
7. Satellite Image processing and Digital Image Classification- layer tacking, image enhancement, supervised and unsupervised classification.	2P
8. GIS database creation.	1P
9. RS and GIS application in vegetation monitoring using NDVI.	1P
10. Acquisition of ecological data of particular locality by using GPS.	1P

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - II)****Mandatory Major Elective Practical Course****Course Code – BOT 568 MJP****Title of the Course: PRACTICAL BASED ON BOT 563 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

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- | | |
|--|----|
| 1. Preparation of basic growth media for cultivation of bacteria and fungi (PDA & Nutrient agar media). | 2P |
| 2. Isolation and sub-culturing techniques for bacteria and fungi. | 2P |
| 3. Isolation of Rhizobium from root nodules of a leguminous plant. | 2P |
| 4. Gram staining to differentiate between Gram-positive and Gram-negative bacteria. | 1P |
| 5. Study the effect of different antibiotics on bacterial growth. | 2P |
| 6. Histochemical staining to observe Arbuscular Mycorrhizal Fungi (AMF) colonization in roots. | 1P |
| 7. Study of Nematodal diseases through specimens/digital resources. | 1P |
| 8. Study of corn smut diseases with reference to symptoms, disease cycle and control measures through specimens/digital resources. | 1P |
| 9. Study of characters of orders Lepidoptera. | 1P |
| 10. To study the methods of collection and preservation of insects | 2P |

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - II)****Mandatory Major Elective Practical Course****Course Code - BOT 569 MJP****Title of the Course: PRACTICAL BASED ON BOT 564 MJ****[No. of Credits: 2 Credit]****[Total 60 Lectures]**

-
1. Study of the flowers adapted to pollination by different agents such as wind, insects and birds. **1P**
 2. Study of Physical, Chemical and Biological Methods to protect crop plants **2P**
 3. Demonstration of Systemic and contact pesticides with suitable examples and precaution measures. **1P**
 4. Study of Walking Patterns during Field Inspection. **1P**
 5. Study of instruments used in Seed sampling. **1P**
 6. Study how to read, Foundation Seed Tag, Truthful Labeled Seed Tag and Certified Seed Tag. **1P**
 7. Demonstration of seed processing equipment's. **1P**
 8. Study, how to treat seeds by traditional method and by using chemical protectants to avoid pest attack. **1P**
 9. Collection, submission of diseased Seed samples and storage pests (Five Samples Each). **2P**
 10. Visit to any Seed industry/Processing Unit and submission of report. **2P**

National Education Policy 2020**M.Sc. Botany, Part - I (Semester - II)****Course Code – BOT 581 OJT/FP****Title of the Course****ON JOB TRAINING / INTERNSHIP / FIELD PROJECT WORK****[No. of Credits: 4 Credit]****[Total 60 Lectures]**

Students will have to undergo **On Job Training (OJT)** or **Internship** or **Field Project Work (FPW)** as a prerequisite for the completion of first year of Post-Graduation in Botany (M.Sc. Part - I). The tenure of OJT/Internship/FPW should be minimum of a month during the summer vacations. The criteria for the OJT/Internship/FPW are as mentioned below:

On Job Training (OJT) or Internship:

1. The concerned Post Graduate Department should allot OJT's or Internships to the registered students.
2. Head of the Department/PG teacher or the concerned teaching faculty from the host institution should be one of the mentors for OJT's or Internships of the student.
3. OJT's or Internships can be organized at Government, Semi-Government, or Non-Government Organizations (NGOs), Universities, Botanical Survey of India (BSI), Agharkar Research Institute, National Chemical Laboratory (NCL), NCCS, IISER, ICAR-IISR, Maharashtra State Pollution Control Board, Mushroom Production Industries, Research Institutions, Authorized Training Centers, Plant Tissue Culture Laboratories, Industries from Agricultural Sectors, Food Processing Industries, Agricultural Raw Material Processing Industries, Crop plant / Ornamental / Horticultural /Forest Nurseries, Herbal Pharmaceutical and Biotechnological Industries, Biofertilizers Productions Units, Forest Departments, Horticultural Departments, Landscape Designing Institutions, Seed Industries, Survey conducting Institutions, etc.
4. Student should complete the OJT/Internship at the allotted institution in the stipulated period of time.
5. Student should submit, neatly compiled, detailed and certified OJT/Internship Report to the host institution for the award of the degree.
6. The OJT/Internship reports should be evaluated for 100 Marks. i.e.

- 30 Marks for Internal evaluations (Attendance/Performance/Active participation/OJT diary/ notebook/Regular reporting to the department etc.)
- 40 Marks for final Hard Bound OJT report.
- 30 Marks for PowerPoint presentation based on OJT report in the presence of Head of the Department, Mentor, and the Expert out of the institution, preferably from the OJT institutions.

Field Project Work (FPW):

1. The concerned Post Graduate Department should allot Field Project Work to the registered students at the Host institution / Research Institutions / Plant based Industries / Departments of Environment and Sustainable Development under the supervision of teaching faculty as guide and expert from concerned industry/institute as a Co-guide.
2. Student should follow the guidelines of research methodology for completing the field project work
3. He/she should prepare a Field Project Work Report as per the standard format. E.g.
 - Cover page including Title of Work, Name of the Student, Name of the Research Guide, Co-guide, and Name of the Industry/Institute where project has been carried out / Name of the Host Institution /Month and Year of submission.
 - Declaration by the candidate
 - Certificate by the Industry/Institute
 - Contents
 - List of Tables/Graphs/Figures/Photographs etc.
 - Acknowledgement
 - Introduction
 - Objectives
 - Review of Literature
 - Materials and Methods
 - Results and Discussion
 - Summary and Conclusions
 - References
4. Students should be motivated to present the field project work in the form of Poster or Oral presentations at State / National / International Symposia, Seminars, Conferences, etc.

5. The Field Project Report should be submitted to the Host institution for the evaluation in the form of Hard Bound Copy. One copy each should be given to the Research Guide and Co-Guide.
6. Evaluation of the Field Project Work is to be carried out for 100 Marks. It will include 50 Marks for submission of scientifically written, bounded copy of the project report and 50 Marks for the PowerPoint presentation of the work.

Note: 04 Credits will be awarded to the student only after successful submission of On Job Training Report or Internship Report or Field Project Work report with proper certification from the respective Industry or Research Institute.
