Annexure - A (1-65)



# Ch. Ranbir Singh University, Jind

## Scheme of Examination and Syllabus for

## Under-Graduate Programme

## Subject: Botany

**Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner)**

**DEPARTMENT OF BOTANY, Ch. Ranbir Singh University, Jind**
**Scheme of Examination for Under-Graduate Programme**
**Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24**
**(in phased manner)**
**Subject : Botany**

| SEMESTER-1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Remarks** | **Course** | **Paper(s)** | **Nomenclature of Paper** | **Credits** | **Hours/ Week** | **Internal marks** | **External Marks** | **Total Marks** | **Exam Duration** |
| Scheme A & C | CC-1 MCC-1 4 credit | B23-BOT-101 | Diversity of Microbes, Algae, Fungi and Archegoniates | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme C only | MCC-2 4 credit | B23-BOT-102 | Conservation Biology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A | CC-M1 2 credit | B23-BOT-103 | Plant Diversity | 1 | 1 | 10 | 20 | 30 | 3 hrs. |
| | | | Practical | 1 | 2 | 5 | 15 | 20 | 4 hrs. |
| Scheme A & C | MDC-1 3 credits | B23-BOT-104 | Fundamentals of Botany | 2 | 2 | 15 | 35 | 50 | 3 hrs. |
| | | | Practical | 1 | 2 | 5 | 20 | 25 | 4 hrs. |
| Scheme C only | CC-M1 4 credit | From Available CC-M1 of 4 credits as per NEP | | | | | | | |
| Scheme A & C | AEC-1 2 credit | From Available AEC-1 of two credits as per NEP | | | | | | | |
| | SEC-1 3 credit | From Available SEC-1 of three credits as per NEP | | | | | | | |
| | VAC-1 2 credit | From Available VAC-1 of two credits as per NEP | | | | | | | |

| SEMESTER-2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Remarks** | **Course** | **Paper(s)** | **Nomenclature of Paper** | **Credits** | **Hours/ Week** | **Internal marks** | **External Marks** | **Total Marks** | **Exam Duration** |
| Scheme A & C | CC-2 MCC-3 4 credit | B23-BOT-201 | Plant Taxonomy and Ecology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme C only | DSEC-2 4 credit | B23-BOT-202 | Plant Propagation | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A only | CC-M2 2 credit | B23-BOT-203 | Plants for Human Welfare | 1 | 1 | 10 | 20 | 30 | 3 hrs. |
| | | | Practical | 1 | 2 | 5 | 15 | 20 | 4 hrs. |
| Scheme A & C | MDC-2 3 credits | B23-BOT-204 | Economic Botany | 2 | 2 | 15 | 35 | 50 | 3 hrs. |
| | | | Practical | 1 | 2 | 5 | 20 | 25 | 4 hrs. |
| Scheme C only | CC-M2 4 credit | From Available CC-M2 of 4 credits as per NEP | | | | | | | |
| Scheme A & C | AEC-2 2 credit | From Available AEC-2 of two credits as per NEP | | | | | | | |
| | SEC-2 3 credit | From Available SEC-2 of three credits as per NEP | | | | | | | |
| | VAC-2 2 credit | From Available VAC-2 of two credits as per NEP | | | | | | | |
| Internship of 4 credits of 4-6 weeks duration after 2nd Semester | | | | | | | | | |

| SEMESTER-3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Remarks | Course | Paper(s) | Nomenclature of Paper | Credits | Hours/ Week | Internal marks | External Marks | Total Marks | Exam Duration |
| Scheme A, B & C | CC-3 MCC-4 4 credit | B23-BOT-301 | Plant Physiology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | MCC-5 4 credit | B23-BOT-302 | Plant Stress Physiology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A, B & C | MDC-3 3 credits | B23-BOT-303 | Ornamental Plants and Propagation | 2 | 2 | 15 | 35 | 50 | 3 hrs. |
| | | | Practical | 1 | 2 | 5 | 20 | 25 | 4 hrs. |
| Scheme A & C | CC-M3 4 credits | From Available CC-M3 of 4 credits as per NEP | | | | | | | |
| Scheme B only | CC-M3 (V) 4 credits | From Available CC-M3(V) of 4 credits as per NEP | | | | | | | |
| Scheme A, B & C | AEC-3 2 credit | From Available AEC-3 of two credits as per NEP | | | | | | | |
| | SEC-3 3 credit | From Available SEC-3 of three credits as per NEP | | | | | | | |
| Scheme C only | VAC-3 2 credits | From Available VAC-3 of two credits as per NEP | | | | | | | |
| Scheme B only | MCC-3 | MCC-2 FROM SCHEME C OF FIRST SEMESTER | | | | | | | |

| SEMESTER-4 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Remarks** | **Course** | **Paper(s)** | **Nomenclature of Paper** | **Credits** | **Hours/ Week** | **Internal marks** | **External Marks** | **Total Marks** | **Exam Duration** |
| Scheme A, B & C | CC-4 MCC-6 4 credit | B23-BOT-401 | Cytology and Genetics | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | MCC-7 4 credit | B23-BOT-402 | Plant Molecular Biology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | MCC-8 4 credit | B23-BOT-403 | Plant Breeding | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | DSE-1 4 credit Select one option | B23-BOT-404 | Plant Tissue Culture | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| | | B23-BOT-405 | Bioethics, Biosafety and IPR | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A, B & C | CC-M4 (V) 4 credits | From Available CC-M4(V) of 4 credits as per NEP | | | | | | | |
| | AEC-4 2 credit | From Available AEC-3 of two credits as per NEP | | | | | | | |
| Scheme C only | VAC-4 2 credits | From Available VAC-4 of two credits as per NEP | | | | | | | |
| Scheme A & B | VAC-3 2 credits | From Available VAC-3 of two credits as per NEP | | | | | | | |
| Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester) | | | | | | | | | |

| SEMESTER-5 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Remarks | Course | Paper(s) | Nomenclature of Paper | Credits | Hours / Week | Internal marks | External Marks | Total Marks | Exam Duration |
| Scheme A, B & C | CC-5 MCC-9 4 credit | B23-BOT-501 | Economic Botany and Plant Biotechnology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | MCC-10 4 credit | B23-BOT-502 | Reproduction in Higher Plants | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | DSE-2 4 credit Select one Option | B23-BOT-503 | Plant Biochemistry and Metabolism | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| | | B23-BOT-504 | Modern Plant Systematics | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | DSE-3 4 credit Select one Option | B23-BOT-505 | Natural Plant Products | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| | | B23-BOT-506 | Plants and Medicines | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A & C | CC-M5 (V) 4 credits | From Available CC-M5(V) of 4 credits as per NEP | | | | | | | |
| Scheme A, B & C | Internship 4 credits | Internship#4 credit after 4th semester | | | | | | | |

| SEMESTER-6 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Remarks | Course | Paper(s) | Nomenclature of Paper | Credits | Hours / Week | Internal marks | External Marks | Total Marks | Exam Duration |
| Scheme A, B & C | CC-6 MCC-11 4 credit | B23-BOT-601 | Plant Anatomy & Embryology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | MCC-12 4 credit | B23-BOT-602 | Plant Pathology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | DSE-4 4 credit Select one Option | B23-BOT-603 | Agroforestry | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| | | B23-BOT-604 | Post-harvest Technology of Fruits & Vegetables | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme B & C | DSE-5 4 credit Select one Option | B23-BOT-605 | GIS and Remote Sensing | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| | | B23-BOT-606 | Evolutionary and Behavioural Biology | 3 | 3 | 20 | 50 | 70 | 3 hrs. |
| | | | Practical | 1 | 2 | 10 | 20 | 30 | 4 hrs. |
| Scheme A only | CC-M6 4 credits | From Available CC-M6 of 4 credits as per NEP | | | | | | | |
| Scheme A only | CC-M7(V) 4 credits | From Available CC-M7(V) of 4 credits as per NEP | | | | | | | |
| Scheme B only | CC-M5(V) 4 credits | From Available CC-M5(V) of 4 credits as per NEP | | | | | | | |
| Scheme C only | CC-M6(V) 4 credits | From Available CC-M6(V) of 4 credits as per NEP | | | | | | | |
| Scheme C only | SEC-4 2 credit | From Available SEC-4 of two credits as per NEP | | | | | | | |

| SEMESTER-7 (FOR HONOURS/HONOURS WITH RESEARCH IN BOTANY) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Remarks** | **Course** | **Paper(s)** | **Nomenclature of Paper** | **Credits** | **Hours/ Week** | **Internal marks** | **External Marks** | **Total Marks** | **Exam Duration** |
| for Honours in Botany/Honours with Research in Botany (For Scheme B & C) | CC-H1 4 credit | B23-BOT-701 | Algae & Fungi | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | CC-H2 4 credit | B23-BOT-702 | Bryophytes & Pteridophytes | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | CC-H3 4 credit | B23-BOT-703 | Cytogenetics & Plant Breeding | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | DSE-H1 4 credit Select one Option | B23-BOT-704 | Microbiology and Biostatistics | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | | B23-BOT-705 | Basics of Genomics and Proteomics | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | | B23-BOT-706 | Computational Biology | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | PC-H1 4 credit | B23-BOT-707 | Practical Based on B23-BOT-701 TO 704/705/707 | 4 | 8 | 30 | 70 | 100 | 6 hrs. |
| | CC-HM1 4 credit | From Available Minor of 4 credits as per NEP | | | | | | | |

| SEMESTER-8 (FOR HONOURS IN BOTANY) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Remarks | Course | Paper (s) | Nomenclature of Paper | Credits | Hours/ Week | Internal marks | External Marks | Total Marks | Exam Duration |
| Honours in Botany (For Scheme B & C) | CC-H4 4 credit | B23-BOT-801 | Microbiology and Biostatistics | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | CC-H5 4 credit | B23-BOT-802 | Natural Resources & Biodiversity | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | CC-H6 4 credit | B23-BOT-803 | Gymnosperm & Ethanobotany | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | DSE-H2 4 credit Select one option | B23-BOT-804 | Molecular Genetics | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | | B23-BOT-805 | Plant Morphogenesis | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | PC-H2 4 credit | B23-BOT-806 | Practical Based on B23-BOT-801 TO 804/805 | 4 | 8 | 30 | 70 | 100 | 6 hrs. |
| | CC-HM2 4 credit | From Available Minor of 4 credits as per NEP | | | | | | | |

| OR SEMESTER-8 (FOR HONOURS WITH RESEARCH IN BOTANY) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Remarks | Course | Paper (s) | Nomenclature of Paper | Credits | Hours/ Week | Internal marks | External Marks | Total Marks | Exam Duration |
| Honours with Research in Botany (For Scheme B & C) | CC-H4 4 credit | B23-BOT-801 | Microbiology and Biostatistics | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | CC-H5 4 credit | B23-BOT-802 | Natural Resources & Biodiversity | 4 | 4 | 30 | 70 | 100 | 3 hrs. |
| | Project/Dissertation 12 credit | B23-BOT-807 | Project/Dissertation | 8+4 | - | - | - | - | - |
| | CC-HM2 4 credit | From Available Minor of 4 credits as per NEP | | | | | | | |

# Syllabus
## Subject : Botany

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **1st** | | |
| Name of the Course | **Diversity of Microbes, Algae, Fungi and Archegoniates** | | |
| Course Code | **B23-BOT-101** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-1/MCC-1** | | |
| Level of the course (As per Annexure-I | 100-109 | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will be able to understand the general characteristics of bacteria, actinobacteria, viruses and fungi.<br>2: Students will develop a conceptual understanding of Phycology.<br>3: Students will gain knowledge on the concepts of Bryology.<br>4: Basic understanding of the biology of pteridophytes will be developed by the students.<br>---<br>5*. Students will gain the knowledge of practical aspects of microorganisms, algae, fungi, lichens, bryophytes, and pteridophytes. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | | **Time: 3 Hours** | |

| PRACTICAL | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 10** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Bacteria: Structure, nutrition, reproduction and economic importance.<br><br>Viruses: General account of Viruse including structure of TMV and Bacteriophages.<br><br>Algae: General characters, Introductory classification; economic importance; and life cycle (excluding development) of *Nostoc* (Cyanophyceae).*Volvox*, (Chlorophyceae), *Vaucheria* (Xanthophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae).<br><br>Fungi: General characters, Introductory classification; economic importance; and life-history of *Phytophthora* (Mastigomycotina), *Penicillium* (Ascomycotina), *Puccinia* (Basidiomycotina), *Colletotrichum* (Deuteromycotina). | 11 |
| II | General account of Lichens, types, ecological and economic importance.<br><br>Bryophyta: Bryophytes: General characteristics, classification upto classes (Smith, 1935), alternation of generations, structure and reproduction (excluding development) of Marchantia (Hepaticopsida), Anthoceros (Anthocerotopsida), Funaria (Bryopsida), ecological and economic importance of bryophytes. | 11 |
| III | Pteridophyta: General characters, classification upto classes (A. R. Smith, 2006), structure and reproduction (excluding development) of Rhynia (Psilopsida): Structure and | 11 |

| | | |
|---|---|---|
| | reproduction (excluding development) of Selaginella (Lycopsida), Equisetum (Sphenopsida) and Pteris (Pteropsida). heterospory and seed habit, stelar evolution; Ecological and economic importance. | |
| IV | **Gymnosperms:** General characteristics, classification up to classes (Smith 1955), morphology, anatomy and reproduction of *Cycas*, *Pinus*, *Ephedra* (developmental details not to be included); Distribution and economic importance; General account of paleobotany and Geological time scale. | 12 |
| V* | **Viruses**: EMs/Models of viruses: TMV, Line drawing/Photograph of Lytic and Lysogenic Cycles.<br>**Bacteria**: Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.<br>**Cynobacteria & Algae**: Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Vaucheria*, *Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.<br>**Fungi**: Study of vegetative & reproductive structures of *Phytophthora, Mucor*, *Puccinia, Penicillium* & *Colletotrichum*: Asexual and sexual stages through temporary preparations and permanent slides.<br>**Lichens**: Study of slides/photographs of lichens (crustose, foliose and fruticose).<br>***Marchantia***- Morphology of thallus, W.M. rhizoids and scales, V.S. thallus with gemma cup, W.M. gemmae, V.S. antheridiophore, archegoniophore, L.S. sporophyte (temporary/permanent slides).<br>***Anthoceros***- Morphology of thallus, W.M. rhizoids, V.S. thallus, VS Antheridia and Archegonia, L.S. sporophyte (temporary/permanent slides).<br>***Funaria***- Morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, L.S. capsule (temporary /permanent slides).<br>***Selaginella***- Morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll, L.S. strobilus (temporary/ permanent slide).<br>***Equisetum***- Morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore, W.M. spores (wet and dry) (temporary slides); T.S. rhizome (permanent slide).<br>***Pteris***- Morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores, T.S. rhizome, W.M. prothallus with sex organs and young sporophyte (temporary/permanent slide).<br>***Cycas***- Morphology (coralloid roots, bulbil, leaf, megasporophyll), T.S. coralloid root, T.S. rachis, V.S. leaflet, | 30 |

| | | |
|---|---|---|
| | V.S. microsporophyll, W.M. microspores, L.S. ovule, T.S. root (temporary/ permanent slide).<br>***Pinus***- Morphology (long and dwarf shoots, W.M. dwarf shoot, male cones and female cones), W.M. dwarfshoot, T.S. needle, T.S. stem, L.S./T.S. male cone, W.M. microsporophyll, W.M. microspores (temporary slides), L.S. female cone (temporary/ permanent slide).<br>***Ephedra***- Morphology, T.S. internode, L.S./T.S. male and female strobili, W.M. spores (wet and dry),T.S. rhizome (temporary/permanent slide).<br>**Excursion Report**: Report on excursion tours with photographs, collection and preservation specimens related to Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms. | |

**Suggested Evaluation Methods**

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|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11th Edition. McGraw Hill International.
- Lee, R.E. (2018) Phycology. 5th Edition. Cambridge University Press.
- Aluwalia, A.S. (2020). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.
- Dube, H.C. (2012). An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., Delhi. 4th edition.
- Mehrotra, R.S. and Aggarwal, Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi, India.
- Sharma, O.P. (2017). Text Book of Pteridophyta, McMillan India Ltd.
- Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
- Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge

University Press.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Gymnosperms, S. Chand. Delhi, India.
- Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand. Delhi, India

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A – Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **1st** | | |
| Name of the Course | **Conservation Biology** | | |
| Course Code | **B23-BOT-102** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MCC-2** | | |
| Level of the course (As per Annexure-I | 100-109 | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1: Students will comprehend the fundamental principles of biodiversity.<br>2: Students will acquire a conceptual understanding of the classifications used by the IUCN.<br>3: Students will acquire knowledge about the principles of conservation laws and international legislation.<br>4: Students will develop a foundational understanding of international legislation.<br>5*. Student will learn about the practical approaches to protect and restore the biological communities. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | | **Time: 3 Hours** | |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 10** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Biodiversity: Types of Biodiversity; Level of Biodiversity: genetic, species and ecosystem; Patterns of biodiversity; Factors affecting biodiversity: over exploitation, habitat loss and degradation, invasive species, disease, natural calamities, global change.<br>Concept of endemism in plants, endemic plants of Western Ghats. | 11 |
| II | IUCN categories: not evaluated; data deficient; least concern; near threatened, vulnerable, endangered, critically endangered, extinct in wild; extinct categories. Principles of conservation; in situ and ex situ conservation; Economics of conservation | 11 |
| III | Conservation laws and international legislation. Soil erosion and conservation methods. Conservation of Forests: Afforestation, Reforestation, Monoculture and their effects. Conservation of water: water scarcity, rain water harvesting, watershed management. World Biodiversity hotspots; Wetlands. | 11 |
| IV | Categories of Protected areas: IA Strict Nature reserves, IB Wilderness area; II National Park; III Natural monument or feature; IV Habitat or species management area; V Protected landscape/seascape; VI Protected area with sustainable use of natural resources, Sustainable development goals.<br>Recent conservation approaches in India. | 12 |

| | | |
|---|---|---|
| V* | • To determine the Calcium content of soil samples using titration method.<br>• To estimate available $N_2$ in a given soil sample.<br>• To determine the role of $CO_2$ evolution from the given soil sample.<br>• To calculate their phosphorous content of the given soil sample.<br>• To interpret the Annual Forest report with reference to Haryana.<br>• To study the Biosphere reserves of India - National park, wildlife sanctuaries in Haryana. | 30 |

| **Suggested Evaluation Methods** | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Wetlands Through Time By Stephen F. Greb, William A. DiMichele Published by Geological Society of America, 2006
- Introduction to Conservation Genetics: Richard Frankham, Jonathan D. Ballou and David A. Briscoe By Richard Frankham, David Anthony Briscoe, Jonathan D. Ballou, Karina H. Cambridge University Press, 2012
- Plant Conservation Genetics By Robert J. Henry Published by Cambridge University Press, 2012.
- Wetlands By William J. Mitsch, James G. Gosselink Published by John Wiley and Sons, 2007.
- Hunter Jr., M. L. Fundamentals of Conservation Biology. Blackwell Science, Malden, Massachusetts, U.S.A 2021.
- Red Data Books Vols. 1 to 4. Botanical Survey of India, Dehradun
- Benson EE. Plant Conservation Biotechnology. Agrosciences, New Delhi, 2014.

- Gaston KJ. Biodiversity: An Introduction, 2/e. Agrosciences, New Delhi, 2004.
- Megadiversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots By AB Chaudhuri, D. D. Sarkar Published by Daya Books, 2004.
- 2000 IUCN Red List of Threatened Species By Craig Hilton-Taylor, Russell A. Mittermeier, International Union for Conservation of Nature and Natural Resources Species Survival Commission, BirdLife International, Conservation International Published by IUCN, 2000.
- Ex Situ Plant Conservation: Supporting Species Survival in the Wild By Edward O. Guerrant, Kayri Havens, Mike Maunder, Peter H. Raven Published by Island Press, 2004.


| **Session: 2023-24** | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **1st** | | |
| Name of the Course | **Plant Diversity** | | |
| Course Code | **B23-BOT-103** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-M1** | | |
| Level of the course (As per Annexure-I | 100-109 | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1: The general characteristics of microorganisms, algae, fungi, and lichens will be understandable to students.<br>2: Students will acquire a conceptual grasp of bryophytes and pteridophytes.<br>3: Students will acquire knowledge about the fundamental features of gymnosperms.<br>4: Students will acquire a foundational understanding of angiosperm morphology.<br>5*. Student will gain the knowledge about the practical aspects related to identification, structure, economic values of microorganisms, algae, fungi, bryophytes, pteridophytes gymnosperms, and angiosperms. | | |
| Credits | Theory | Practical | Total |
| | 1 | 1 | 2 |

| Contact Hours | 1 | 2 | 3 |
|---|---|---|---|

**THEORY**

| | |
|---|---|
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 20**<br>**Internal Assessment Marks: 05**<br>**End Term Exam Marks: 15** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | General characteristics, morphology and economic importance of viruses, bacteria, algae, fungi and lichens. | 4 |
| II | General characteristics, morphology and economic importance of Bryophytes and Pteridophytes. | 4 |
| III | General characteristics, morphology and economic importance Gymnosperms. | 4 |
| IV | General characteristics, morphology and economic importance of Angiosperms. | 3 |
| V* | • Identification of some common algae and fungi.<br>• Morphological study of some common Bryophytes.<br>• Morphological study of some common Pteridophytes.<br>• Morphological study of some common Gymnosperms.<br>• Morphological study of some common Angiosperms. | 30 |

**Suggested Evaluation Methods**

| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |
|---|---|

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11th Edition. McGraw Hill International.
- Lee, R.E. (2018) Phycology. 5th Edition. Cambridge University Press.
- Ahluwalia, A.S. (2020). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.
- Dube, H.C. (2012). An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., Delhi. 4th edition.
- Mehrotra, R.S. and Aggarwal, Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi, India.
- Sharma, O.P. (2017). Text Book of Pteridophyta, McMillan India Ltd.
- Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
- Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Gymnosperms, S. Chand. Delhi, India
- Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand. Delhi, India


| **Session: 2023-24** | |
|---|---|
| **Part A – Introduction** | |
| Subject | **BOTANY** |
| Semester | **1st** |
| Name of the Course | **Fundamentals of Botany** |

| Course Code | B23-BOT-104 | | |
|---|---|---|---|
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | MDC-1 | | |
| Level of the course (As per Annexure-I | 100-109 | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1: Students will gain a foundational understanding of the biology of microorganisms, algae, fungi and lichens.<br>2: Students will develop a conceptual understanding of bryophytes and pteridophytes.<br>3: Students will acquire knowledge about the fundamental characteristics of gymnosperms and the challenges related to their propagation.<br>4: Students will acquire a basic understanding of angiosperm morphology.<br>5*. Students will be able to learn the practical aspects of microorganisms, algae, fungi and students will be able to identify the major groups of plants and compare the characteristics of higher plants(angiosperms and gymnosperms)and lower plants (bryophytes and pteridophytes). | | |
| Credits | Theory | Practical | Total |
| | 2 | 1 | 3 |
| Contact Hours | 2 | 2 | 4 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 25**<br>**Internal Assessment Marks: 05**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact |
|---|---|---|

| | | Hours |
|---|---|---|
| I | General characteristics, morphology and economic importance of viruses, bacteria algae, fungi and lichens. | 7 |
| II | General characteristics, morphology and economic importance of Bryophytes and Pteridophytes. | 7 |
| III | General characteristics, morphology and economic importance Gymnosperms. | 8 |
| IV | General characteristics, morphology and economic importance of Angiosperms. | 8 |
| V* | • Cynobacteria&Algae: Study of slides of *Nostoc* and *Volvox* through permanent slides.<br>• *Penicillium*: Asexual stage and sexual structures through permanent slides.<br>• *Agaricus*: Specimens of button stage and full grown mushroom.<br>• *Marchantia & Funaria*- morphology of thallus through permanent slides.<br>• *Selaginella & Equisetum*- morphology specimen study.<br>• *Cycas & Pinus* - morphology specimen study.<br>• Study of vegetative and floral characters of the one or two members of some important families<br>• Excursion Report: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Archegoniates and Angiosperms. Mounting of a collected, properly dried and pressed specimen of minimum 20 wild plants with herbarium label. | 30 |
| **Suggested Evaluation Methods** | | |
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | | **End Term Examination:** |
| **Part C-Learning Resources** | | |

**Recommended Books/e-resources/LMS:**


- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. (2019) Prescott's Microbiology. 11th Edition. McGraw Hill International.
- Lee, R.E. (2018) Phycology. 5th Edition. Cambridge University Press.
- Ahluwalia, A.S. (2020). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi.
- Dube, H.C. (2012). An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., Delhi. 4th edition.
- Mehrotra,R.S. and Aggarwal, Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi, India.
- Sharma, O.P. (2017). Text Book of Pteridophyta, McMillan India Ltd.
- Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
- Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Gymnosperms, S. Chand. Delhi, India
- Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand. Delhi, India


## Second Semester

| Session: 2023-24 | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |
| Semester | **2nd** |
| Name of the Course | **Plant Taxonomy and Ecology** |
| Course Code | **B23-BOT-201** |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-2/MCC-3** |
| Level of the course (As per Annexure-I | |

| Pre-requisite for the course (if any) | | | |
|---|---|---|---|
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will gain knowledge about taxonomy, including the rules of nomenclature and other essential aspects.<br>2: Students will acquire a conceptual understanding of angiosperm classification systems and the diversity of families within them.<br>3. Students will gain knowledge about Ecology and Environmental interactions.<br>4: Students will acquire a conceptual understanding of ecosystem structure, environmental pollution and biodiversity conservation.<br>5*. Students will gain the knowledge about the diagnostic features, morphology, internal structure, economic value of angiosperms and ecological concepts and biodiversity indices. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Botanical nomenclature and major rules of ICBN and ICN; Keys to identification of plants.<br>General introduction and importance of herbaria and botanical gardens. Documentation of Floristic Diversity: Brief idea about floras, monographs and journals.<br>Brief idea of taxonomic evidences. | 11 |

| | | |
|---|---|---|
| | Types of inflorescence, flower and parts of flower. | |
| II | Artificial, natural and phylogenetic classifications. Bentham and Hooker system of classification (upto series), Angiosperm Phylogeny Group- general account.<br>Diagnostic features and economic importance of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Rutaceae, Leguminosae, Apocynaceae, Lamiaceae, Solanaceae, Asteraceae, Poaceae and Orchidaceae. | 12 |
| III | Ecology: Definition; scope and importance; levels of organization. Environmental factors- climatic factors, edaphic factors, topographic; and Biotic factors.<br>Population Ecology: Basic concept; characteristics; biotic potential, growth curves; ecotypes and ecads.<br>Community Ecology: Concepts; characteristics (qualitative and quantitative-analytical and synthetic); methods of analysis; ecological succession. | 11 |
| IV | Ecosystem: Structure and functions (trophic levels, food chains, food webs, ecological pyramids and energy flow).<br>Phyto-geography: Phyto-geographical regions of India; vegetation types of India (forests).<br>Environmental Pollution: Sources, types and control of air and water pollution.<br>Global Change: Greenhouse effect and greenhouse gases; impacts of global warming; carbon trading.<br>Biodiversity: levels, types, significance, threats and conservation. | 11 |
| V* | • Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gaugeand lux meter.<br>• Determination of pH, and analysis of two soil samples for carbonates, chlorides and sulphates by rapid field test.<br>• Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.<br>• To determine inorganic carbon content of given soil samples.<br>• To determine organic carbon content of given soil samples by acid dilution method.<br>• (a) Study of morphological adaptations of hydrophytes and | 30 |

| | | |
|---|---|---|
| | xerophytes (four each). (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes (Orchid) and Predation (Insectivorous plants) using museum specimens/ live plants.<br>• Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus or nearby fields by species area curve method (species to be listed).<br>• Quantitative analysis of herbaceous vegetation in the college campus or nearby fields for frequency and comparison with Raunkiaer's frequency distribution law.<br>• Study of vegetative and floral characters of the one or two member of each family/sub-family mentioned in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).<br>• Excursion Report: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Angiosperms. Mounting of a collected, properly dried and pressed specimen of minimum 20 wild plants with herbarium label. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, G. (2021). Plant Systematics: An Integrated Approach, CRC Press.
- Sharma, O.P. (2017). Plant Taxonomy, Mc Graw Hill Publication.
- Levetin, E. & McMahon, K. 2015. Plants and Society, McGraw-Hill Education. 7th edition.
- Smith, T.M. & Smith, R.L. 2014. Elements of Ecology. Pearson. 9th edition.
- Gangulee, Das and Datta (2011). College Botany Volume 1, New Central Book Agency
- Gangulee, Das and Datta (2011). College Botany Volume 2, New Central Book Agency
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Gymnosperms, S. Chand.
- Taylor, E.L., Taylor, T.N., Krings, M. (2009). Paleobotany: The Biology and Evolution of Fossil Plants, Academic Press.
- Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand.
- Pandey, B.P. (2001). A Textbook of Botany-Angiosperms, S. Chand.
- Chapman, J.L. & Reiss, M.J. 1999. Ecology: Principles and Applications. Cambridge

University Press.
- Odum E.P. (1971): Fundamentals of Ecology 3rd edition. Saunders College Publishing/Harcourt Brace.

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A – Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **2nd** | | |
| Name of the Course | **Plant Propagation** | | |
| Course Code | **B23-BOT-202** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **DSEC-1** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire knowledge regarding the fundamental aspects of plant propagation.<br>2: Students will develop a conceptual understanding of seed propagation.<br>3: Students will gain knowledge about vegetative propagation methods.<br>4: Students will acquire a conceptual understanding of cell and tissue propagation techniques.<br>5*. Students will be able to demonstrate the basic principles and practical consideration of in vitro plant cell/tissue culture, plant propagation methods, sterilization methods, tools and techniques. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | | **Time: 3 Hours** | |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attemptquestion No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | General aspects of plant propagation: Evolution of plant propagation techniques; Biology of plant propagation: impact of genes; Effect of environment on propagation: Greenhouse systems, environmental control | 11 |
| II | Seed propagation: Seed development, principles and practices of seed selection, techniques of seed production and handling, principles and techniques of seed propagation. | 11 |
| III | Vegetative propagation: Principles and Practices of Clonal Selection; Principles and techniques of propagation by cuttings; Principles and techniques of Grafting and Budding; Layering and Its Natural Modifications; Propagation by Specialized Stems and Roots | 12 |
| IV | Cell and Tissue propagation: Principles and Techniques of Micropropagation from Meristematic Tissue; Principles and Techniques of Plant Tissue Culture from Non-meristematic Tissue. | 11 |
| V* | • Study of tools used in plant propagation.<br>• Cutting techniques of selected plants: hardwood cuttings, softwood cuttings, greenwood cuttings, semi-ripe cuttings, root cuttings and leaf cuttings.<br>• Layering and air-layering in selected plants.<br>• Grafting and division.<br>• Micropropagation: Sterilization of explants, dissection of meristematic regions, media preparation and explant proliferation.<br>• Preparation of compost/growing media.<br>• Hardening and aftercare of propagated plants. | 30 |

**Suggested Evaluation Methods**

| Internal Assessment:<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |
|---|---|

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Razdan,M.K. 2019.Introduction To Plant Tissue Culture. OXFORD &IBH Publishing. 3rd edition.
- Loyola-Vargas,V.M.& Ochoa-Alejo,N. 2018.Plant cell culture protocols. Humana Press. 4th edition.
- Beyl, C.A. & Trigiano, R.N. 2014. Plant Propagation Concepts and Laboratory Exercises. CRC Press, Boca Raton, FL. 2nd edition.
- MacDonald, P.T. 2014. The Manual of Plant Grafting: Practical Techniques for Ornamentals, Vegetables, and Fruit. Timber Press, Portland, OR.
- Kyte, L., J. Kleyn, H. Scoggins & M. Bridgen. 2013. Plants from Test Tubes: An Introduction to Micropropagation, Timber Press Inc., Portland, OR. 4th edition.
- Smith, R.H. 2013. Plant Tissue culture: techniques and experiments. Elsevier. 3rd edition.
- Bhojwani, S.S. & Razdan, M.K. 2009. Plant tissue culture: Theory and Practice. Elsevier India Pvt. Ltd.
- George, E.F., Hall, M.A., Klerk, G.J. 2008. Plant Propagation by Tissue Culture, Springer. 3rd edition.
- Dirr, M.A. & Heuser, Jr.C.W. 2006. The Reference Manual of Woody Plant Propagation From Seed to Tissue Culture. Timber Press, Inc. Portland, OR. 2nd edition.


| **Session: 2023-24** | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |
| Semester | **2nd** |
| Name of the Course | **Plants for Human Welfare** |
| Course Code | **B23-BOT-203** |
| Course Type:<br>(CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-M2** |

| | | | |
|---|---|---|---|
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire a foundational understanding of plant diversity.<br>2: Students will develop a conceptual grasp of plants utilized for human welfare.<br>3: Students will gain knowledge about the origins of certain cultivated plants.<br>4: Students will acquire a conceptual understanding of the utilization of fruits, nuts, and other plant components for human welfare.<br>5*. Students will acquire the knowledge about the economic valuable plants and their products. | | |
| Credits | Theory | Practical | Total |
| | 1 | 1 | 2 |
| Contact Hours | 1 | 2 | 3 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 20**<br>**Internal Assessment Marks: 05**<br>**End Term Exam Marks: 15** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Level of plant diversity, agrodiversity.<br>Values and uses of Biodiversity. | 3 |
| II | Role of plants in relation to Human Welfare;<br>Economic and ecological Importance of agro and social forestry.<br>Ornamental plants of India. | 4 |

| | | |
|---|---|---|
| III | Origin of Cultivated Plants<br>Morphology and economic importance of :<br>Food plants - Cereals (Rice, Wheat and Maize).<br>Pulses - Gram, Arhar and Pea. | 4 |
| IV | Fruits and nuts: Important fruit crops and their commercial importance.<br>Spices and condiments.<br>Wood and its uses. | 4 |
| V* | • Identification and study of some important medicinal plants.<br>• Identification and study of some common ornamental plants.<br>• Identification and study of some important cereals.<br>• Identification and study of some important pulses.<br>• Identification and study of some important spice yielding plants.<br>• Study of different types of woods.<br>• Study of different fruit types. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, V., Pande, P.C., Jain, D.K. 2018. Economic Botany, Rastogi Publications.
- Kocchar, S.L. 2016. Economic Botany: A Comprehensive Study, 5 Ed, Cambridge India.
- Wickens, G.E. 2001. Economic Botany: Principles and Practices, Springer.
- Singh, V., Pande, P.C., Jain, D.K. 2018. Economic Botany, Rastogi Publications.
- Daubenmire, R.F. Plants & Environment (2nd Edn.,) John Wiley & Sons., New York 22
- Odum E.P. 2005. Fundamentals of Ecology (5nd Edn.,) Saunders & Co., Philadelphia
- S. Sundar Rajan-2007. College Botany Vol-V, Part 1: Taxonomy and Economic Botany Himalaya Publishing House.
- Susil Kumar Mukharjee-2004. College Botany Vol-III. New Central Book agency, London

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **2nd** | | |
| Name of the Course | **Economic Botany** | | |
| Course Code | **B23-BOT-204** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MDC-2** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will gain a foundational understanding of the origins of significant cultivated plants.<br>2: Students will develop a conceptual understanding of important plants that yield vegetables, fiber, and oil.<br>3: Students will acquire knowledge about the cultivation techniques of essential plants.<br>4: Students will gain a conceptual understanding of the processing methods applied to economically significant plants.<br>5*. Students will be able to gain the knowledge of economic values of cereals, legumes, spices, oil & fibre yielding plants. | | |
| Credits | Theory | Practical | Total |
| | 2 | 1 | 3 |
| Contact Hours | 2 | 2 | 4 |
| **THEORY** | | | |
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** | | |
| **PRACTICAL** | | | |
| **Max. Marks: 25**<br>**Internal Assessment Marks: 05**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** | | |
| **Part B- Contents of the Course** | | | |
| **Instructions for Paper- Setter** | | | |

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt questi No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Origin of Cultivated Plants<br>Morphology and economic importance of :<br>Food plants - Cereals (Rice, Wheat and Maize).<br>Pulses - Gram, Arhar and Pea. | 7 |
| II | Vegetables: Potato, Tomato and Onion.<br>Fibers: Cotton<br>Oils: Mustard and Coconut. | 7 |
| III | Morphology and economic importance of the following:<br>Spices: Black pepper, Coriander, Ginger, Cloves, saffron.<br>Medicinal Plants: *Cinchona*, *Atropa*, Opium, *Cannabis*, Neem. | 8 |
| IV | Botanical description and processing of:<br>Beverages: Tea and Coffee.<br>Types of wood. | 8 |
| V* | • Study of economically important plants : Wheat, Rice, Maize, Gram, Pea, Arhar, Black pepper, Ginger, Clove, Tea, Coffee, Cotton, Coconut, Mustard and different types of wood.<br>• Collection and preparation of reports on various crops and economically important plants being cultivated/wildly available in your area. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, V., Pande, P.C., Jain, D.K. 2018. Economic Botany, Rastogi Publications.
- Kocchar, S.L. 2016. Economic Botany: A Comprehensive Study, 5 Ed, Cambridge India.
- Wickens, G.E. 2001. Economic Botany: Principles and Practices, Springer.
- Singh, V., Pande, P.C., Jain, D.K. 2018. Economic Botany, Rastogi Publications.
- Daubenmire, R.F. Plants & Environment (2nd Edn.,) John Wiley & Sons., New York 22
- S. Sundar Rajan-2007. College Botany Vol-V, Part 1: Taxonomy and Economic Botany Himalaya Publishing House.
- Susil Kumar Mukharjee-2004. College Botany Vol-III. New Central Book agency, London


## Third Semester

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **3rd** | | |
| Name of the Course | **Plant Physiology** | | |
| Course Code | **B23-BOT-301** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-3/MCC-4** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire an understanding of various physiological process in plants.<br>2: Students will develop a comprehensive knowledge of plant hormones.<br>3: Students will learn about photomorphogenesis and its significance.<br>4: Students will gain a conceptual understanding of plant growth and senescence, including the natural aging process of plants.<br>5*. Students will be able to demonstrate practical aspects and learn the basic concepts of various physiological and biochemical process of plant | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |

| Contact Hours | 3 | 2 | 5 |
|---|---|---|---|

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Plant water relations: absorption, water potential and transpiration; role of micro and macro nutrients. Photosynthesis, Respiration. | 11 |
| II | Biosynthesis, mechanism of action and uses of auxin, gibberellin, cytokinin, abscisic acid, ethylene, Lipid metabolism and Nitrogen metabolism | 11 |
| III | Structure, function and mechanisms of action of phytochromes; stomatal movement; photoperiodism and biological clocks; mechanism of flowering. | 12 |
| IV | Concepts of plant growth; factors affecting germination and dormancy of seeds; physiological and biochemical changes associated with senescence and abscission. | 11 |
| V* | • Demonstration of imbibition by plaster of Paris method.<br>• Demonstration of Osmosis by potato osmoscope method.<br>• To study the Osmotic pressure of onion scale/ Rhoeo leaf peel by plasmolytic method.<br>• To separate photosynthetic pigments by thin layer/paper chromatography.<br>• To study the phenomenon of seed germination (effect of light).<br>• To study the induction of amylase activity in germinating | 30 |

| | | |
|---|---|---|
| | barley grains.<br>• To demonstrate suction due to transpiration.<br>• Determination of glucose by Benedict's solution.<br>• To study the process of etiolation in the laboratory.<br>• To study the action of Ethylene hormone on fruit ripening. | |

| **Suggested Evaluation Methods** | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Pandey, S.N & Sinha BK. 2018. Plant Physiology .Vikas Publishing House Pvt. Ltd. 4th edition
- Jain, V. K. 2017. Fundamentals of Plant Physiology. S. Chand publishing. 20th edition
- Gupta, N.K. Bala, MKSM. Gupta, M. 2016. Practical in Plant Physiology and Biochemistry. Scientific Publishers, India
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. 2015. Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Verma, V. 2015. Plant Physiology 2nd Ed. Athena Academic.
- James, P.G. 2013. A textbook of Plant Physiology. Hardpress Publishing.
- Illahi, I. 2009. *Plant Physiology. Biochemical Processes in Plants.* UGC Press.
- Hopkins, W.G. and Huner, A. 2008. Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
- Salisbury, F.B. and Ross, C.W. 2002. Plant Physiology. Wordsworth Publishing Co. Belmont CA. 7th edition.


| **Session: 2023-24** | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |
| Semester | **3rd** |

| | | | |
|---|---|---|---|
| Name of the Course | **Plant Stress Physiology** | | |
| Course Code | **B23-BOT-302** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MCC-5** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire an understanding of how plants respond physiologically to biotic stress.<br>2: Students will develop a comprehensive knowledge of the genetic mechanisms plants employ to defend against biotic stress.<br>3: Students will learn about the effects of environmental factors on plants.<br>4: Students will gain a conceptual understanding of how plants sense and respond to abiotic stress.<br>5*. Students will be able to demonstrate the practical approach of plant responses under biotic and abiotic stress, and the biochemical test for secondary metabolites. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY**<br>**Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | | **Time: 3 Hours** | |
| **PRACTICAL**<br>**Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | | **Time: 4 Hours** | |
| **Part B- Contents of the Course** | | | |
| **Instructions for Paper- Setter**<br>1. Nine questions will be set in all. All questions will carry equal marks.<br>2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. | | | |
| **Unit** | **Topics** | | **Contact Hours** |

| | | |
|---|---|---|
| I | Physiological responses of plants to biotic stress; mechanisms of defense in plants (mechanical and biochemical) against pathogens, insects, herbivores and wounding; role of plant toxins, and secondary metabolites in defense. | 11 |
| II | Genetic mechanisms of defense during biotic stress; plant-pathogen interaction; role of hormones in regulating biotic stress responses; allelopathy; local acquired resistance, induced systemic resistance and systemic acquired resistance. | 11 |
| III | Impact of environmental factors on plants; physiological and biochemical responses of plants in response to water deficit, salinity, flooding, soil compaction, high and low temperatures, high light intensity, heavy metals and nutrient deficiency. | 12 |
| IV | Abiotic stress sensing mechanisms in plants; Antioxidants and ROS scavenging pathways; molecular chaperones in abiotic stress; role of phytohormones and calcium signaling. | 11 |
| V* | • Study of osmotic potential of plants grown under water-deficit and salinity stress.<br>• Study of transpiration in plants grown under ambient and high light intensities.<br>• Effect of different NaCl concentrations on the photosynthetic rate of plants (*Hydrilla*).<br>• Estimation of catalase activity in stressed plants (salinity and water-deficit).<br>• Estimation of sugar (glucose) content in normal and diseased plants (Black stem rust, Bacterial blight and Leaf curl disease).<br>• Study of the effect of soil compaction on the growth of seedlings of different plants.<br>• Study of allelopathic effect of *Parthenium hysterophorus* crude extracts on the seed germination. | 30 |

| **Suggested Evaluation Methods** | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

| Part C-Learning Resources |
|---|
| **Recommended Books/e-resources/LMS:**<br>• Gupta, D.K. & Palma, J.M. 2021. Plant growth and stress physiology. Springer Cham.<br>• Pandey, S.N & Sinha BK. 2018. Plant Physiology .Vikas Publishing House Pvt Ltd. 4th edition<br>• Jain, V. K. 2017. Fundamentals of Plant Physiology. S. Chand publishing. 20th edition<br>• Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. 2015. Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.<br>• Hota,Dharamvir. 2007. Synthetic plant growth regulators.<br>• Mukherji, S. & Ghosh, A. K. 2005. Plant Physiology. New Central Book Agency, Kolkata.<br>• Basra. A.S., 2004. Plant Growth regulators in Agriculture and Horticulture, International Book Distributing Co.<br>• Dwivedi & Dwivedi 2005. Physiology of abiotic stress in plants. Agro bios. India<br>• Panda S.K. 2002. Advances in Stress Physiology of Plants. Scientific Publishers, Jodhpur. |

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **3rd** | | |
| Name of the Course | **Ornamental Plants and Propagation** | | |
| Course Code | **B23-BOT-303** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MDC-3** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire an understanding of the history of gardens in India and other countries.<br>2: Students will develop comprehensive knowledge about different groups of plants used as ornamentals.<br>3: Students will learn about flower and seed production.<br>4: Students will gain a deep understanding of vegetative propagation methods for ornamental plants.<br>5*. Students will be able to learn various types of gardens & their significance, management, and methods of propagation of valuable plants. | | |
| Credits | Theory | Practical | Total |

| | | | |
|---|---|---|---|
| | 2 | 1 | 3 |
| Contact Hours | 2 | 2 | 4 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 25**<br>**Internal Assessment Marks: 05**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | History of gardens in India; terrace gardening; popular gardens of India; Types of gardens: Formal and Informal gardens; Styles of gardens: Mughal gardens, Persian gardens, Italian gardens, French gardens, English gardens, Japanese gardens. | 7 |
| II | Significance of Shrubs, trees, palms, ferns, cycads, cacti and succulents, climbers, creepers, indoor plants, water plants, bonsai plants asornamentals. | 7 |
| III | Flower and seed production; protected cultivation of ornamentals; present position and scope of floriculture in India. | 8 |
| IV | Vegetative propagation-principles and practices of clone selection; techniques of cutting, budding, grafting and layering; propagation by specialized stems and roots. | 8 |
| V* | • Preparation of nursery beds – flat, raised and sunken beds<br>• Identification and description of various plants grown in ornamental gardens.<br>• Tools, implements and containers used in ornamental gardening.<br>• Planning, designing and establishment of garden features viz. lawn, hedge and edge, rockery etc.<br>• To study propagation by separation and division technique.<br>• Preparation of land for lawn and planting.<br>• To study propagation by cuttings, layering, grafting and budding<br>• Flower arrangement practices.<br>• Preparation of bouquets, garland. | 30 |

| Suggested Evaluation Methods | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, A.K. & Kumar A. 2023. Plant Propagation and Nursery management. S.K. Kataria and sons.
- Arora, J.S. 2016. Introductory Ornamental Horticulture. Kalyani Publishers. 8th edition.
- Sachdeva, P. & Tongbram, V. 2014. A Naturalist's guide to the trees & Shrubs of India. Prakash Books.
- Jain, S.M. & Ochatt, S.J. 2009. Protocols for in vitro propagation of ornamental plants: 598 (Methods in Molecular Biology). Humana Press.
- Sabina, GT and Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency.
- Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
- Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.
- Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
- Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios
- Lauria A & Victor HR. 2001. Floriculture – Fundamentals and Practices Agrobios.

# Forth Semester

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **4th** | | |
| Name of the Course | **Cytology and Genetics** | | |
| Course Code | **B23-BOT-401** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **CC-4/MCC-6** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will understand the fundamental characteristics of cells.<br>2: Students will acquire comprehensive knowledge about cell division and the central dogma of molecular biology.<br>3: Students will learn about the principles of inheritance in biology.<br>4: Students will develop a thorough understanding of mutations, chromosomal aberrations, and the concept of linkage.<br>5*. Students will be able to understand the basic principles of laws of inheritance, stains & staining techniques, cell division processes, chromosome mapping, and chromosomal aberration. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** | | |
| **PRACTICAL** | | | |
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** | | |

| Part B- Contents of the Course | | |
|---|---|---|
| **Instructions for Paper- Setter**<br>1. Nine questions will be set in all. All questions will carry equal marks.<br>2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. | | |
| **Unit** | **Topics** | **Contact Hours** |
| I | Cell as a unit of Life; The Cell Theory; Prokaryotic and eukaryotic cells; Eukaryotic Cell components<br>Structure and functions of Cell Wall, Plasma Membrane, nucleus, Nuclear Envelope- structure of nuclear pore complex, Golgi Apparatus, Ribosome, Endoplasmic Reticulum, Chloroplast, Mitochondria, Lysosomes, Peroxisomes and Vacuoles. | 11 |
| II | Cell Division: Mitosis and Meiosis.<br>Chromosome: structural organization, ultrastructure of Centromere and Telomere, lampbrush and polytene chromosomes.<br>DNA: structure, types and replication.<br>RNA: structure and types.<br>Genetic code. | 11 |
| III | Mendel's laws of Inheritance.<br>Lethal Genes; Codominance, incomplete dominance; Gene interaction (inter- and intra-allelic); Multiple allelism; Pleiotropism.<br>Chi Square test; Pedigree Analysis.<br>**Cytoplasmic Inheritance:** Kappa particles in Paramecium, leaf variegation in *Mirabilis jalapa,* Shell coiling | 12 |
| IV | Complete &incomplete linkage, recombination frequency, crossing over.<br>Chromosomal aberrations- deletions, duplications, translocations, inversions; Variations in chromosome number- aneuploidy, polyploidy; sex chromosomes and sex determination.<br>Types of mutations, effects of physical & chemical mutagens. | 11 |
| V* | • To study the structure and functioning of a compound microscope.<br>• To study strains and fixatives used in cytogenetics.<br>• To study the karyotype using a given metaphase chromosome picture (*Allium cepa*).<br>• To work out the genetics of a cross from the given $F_2$ harvest.<br>• To study different mitotic stages in root tips of *Allium cepa*.<br>• Meiosis through temporary squash preparation. | 30 |

| | | |
|---|---|---|
| | • Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.<br>• Chromosome mapping using test cross data.<br>• Pedigree analysis for dominant and recessive autosomal and sex linked traits.<br>• Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).<br>• Chromosome anomaly : Translocation Ring, Laggards and Inversion Bridge, break etc through slides. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimoe, D. and Darnell, J. 2021. Molecular Cell Biology, W.H. Freeman and Co., New York., USA. 9th edition.
- Singh, BD. 2020. Genetics. Kalyani Publishers Delhi.
- Pierce BA 2020. Genetics: A Conceptual Approach. Palgrave Macmillan U.K. 7th edition.
- Cummings MR, Klug WS, Spencer, CA, Palladino, MA, Killian D. 2019. Concepts of Genetics, Pearson. 12th edition.
- Karp, G. Iwasa, J. Marshall W. 2019. Cell and Molecular Biology. Concepts and Experiments. John Wiley and Sons. New York. 9th edition.
- Gardner EJ, Simmons MJ, Snustad DP 2012. Principles of Genetics. Wiley India. 8th edition.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. 2010. Introduction to Genetic Analysis.W. H. Freeman and Co., U.S.A. 10th edition.
- Sen, S. Kar, D.K. Johri, B.M. 2005. Cytology and Genetics. Alpha Science International Ltd.
- Dyonsager, V. R. 2000. Cytology and Genetics. TATA and McGraw Hill Publication Co. Ltd, New Delhi. 3rd edition.

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **4th** | | |
| Name of the Course | **Plant Molecular Biology** | | |
| Course Code | **B23-BOT-402** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MCC-7** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will gain an understanding of the essential characteristics of DNA.<br>2: Students will acquire comprehensive knowledge about RNA and its functions.<br>3: Students will acquire knowledge about proteins, including their structure and functions.<br>4: Students will develop a comprehensive understanding of the mechanisms and regulation of gene expression.<br>5*. Students will acquire the knowledge of experimentation performed for the identification of DNA/RNA as genetic material, estimation of DNA/RNA, and bacterial growth medium. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** | | |
| **PRACTICAL** | | | |
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** | | |

| Part B- Contents of the Course | | |
|---|---|---|
| **Instructions for Paper- Setter**<br>1. Nine questions will be set in all. All questions will carry equal marks.<br>2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit. | | |
| **Unit** | **Topics** | **Contact Hours** |
| I | Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey &Chase, Avery, McLeod & McCarty), Types of genetic material, denaturation and renaturation, Nucleosome.<br>DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons | 11 |
| II | RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport). | 11 |
| III | Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins). | 12 |
| IV | Control of gene expression at transcription and translation level (regulating the expression of prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). | 11 |
| V* | • Preparation of LB medium and raising E. coli.<br>• Isolation of genomic DNA from E. coli./onion roots<br>• RNA estimation by orcinol method.<br>• DNA estimation by diphenylamine reagent/UV Spectrophotometry.<br>• Photographs establishing nucleic acid as genetic material (Messelson and Stahl's,<br>• Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)<br>• Study of Barr body from buccal smear preparation. | 30 |
| **Suggested Evaluation Methods** | | |

| Internal Assessment:<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |
|---|---|

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimoe, D. and Darnell, J. 2021. Molecular Cell Biology, W.H. Freeman and Co., New York., USA. 9th edition.
- Karp, G. Iwasa, J. Marshall W. 2019. Cell and Molecular Biology. Concepts and Experiments. John Wiley and Sons. New York. 9th edition.
- Krebs, J.E. Goldstein E.S. Kilpatrick S.T. 2017. Lewin's Genes XII. Jones and Bartlett Publishers, Inc. 12th edition.
- Watson, J.D. 2017. Molecular Biology of the gene. Pearson Education India. 7th edition.
- Cooper, G.M. and Hausman, R.E. 2013. The Cell: A Molecular Approach. Sinauer Associates, Sunderland, Massachusetts U.S.A. 6th edition.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2008. The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco. 7th edition.
- Alberts, B. Johnson A. Lewis, J. Raff, M. Roberts K. & Walter P. 2007. Molecular Biology of Cell. W.W. Norton & Company. 5th edition.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. Lippincott Williams and Wilkins, New York. 8th edition.
- Sen, S. Kar, D.K. Johri, B.M. 2005. Cytology and Genetics. Alpha Science International Ltd.


| **Session: 2023-24** | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |
| Semester | **4th** |
| Name of the Course | **Plant Breeding** |
| Course Code | **B23-BOT-403** |
| Course Type:<br>(CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **MCC-8** |
| Level of the course (As per Annexure-I | |

| Pre-requisite for the course (if any) | | | |
|---|---|---|---|
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will develop a foundational understanding of plant breeding principles.<br>2: Students will acquire comprehensive knowledge about the geographical centers of origin and the process of domestication of crop plants.<br>3: Students will gain knowledge about the cytogenetic basis underlying plant breeding techniques.<br>4: Students will develop a comprehensive understanding of the development of mapping populations, QTL analysis, GWAS, and other relevant methodologies used in plant breeding research.<br>5*. Students will develop the practical knowledge about the tools and techniques used in plant breeding. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 50**<br>**Internal Assessment Marks: 15**<br>**End Term Exam Marks: 35** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Objectives of plant breeding; modes of reproduction in crop plants; important achievements and undesirable consequences of plant breeding; floral biology in self- and cross-pollinated species; male sterility in plant breeding. | 11 |
| II | Centers of origin and domestication of crop plants; plant genetic resources; acclimatization; selection methods for self-pollinated, cross-pollinated and vegetatively propagated plants; hybridization for self, cross and vegetatively propagated plants-procedure, advantages and limitations. | 11 |

| | | |
|---|---|---|
| III | Cytogenetic basis of plant breeding-variation in chromosome number, mutation, fertility regulation mechanism, gene recombination in plant breeding; role of mutations, distant hybridization and biotechnology in crop improvement. | 12 |
| IV | Development of mapping population-RIL/NIL/double haploid including CSSL/ BIL lines;QTL mapping bylinkage analysis andby association analysis (GWAS); history, applications andgenetic basis of inbreeding depression andheterosis. | 11 |
| V* | • To study different tools and techniques used in plant breeding.<br>• To study grafting methods and its advantages.<br>• To study different methods of vegetative propagation.<br>• To estimate plant height and tiller number in a rice/wheat variety statistically. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, B.D. 2022. Plant Breeding: Principles and Methods. Medtech Science Press. 12th edition.
- Singh, BD. 2020. Genetics. Kalyani Publishers Delhi.
- Cummings MR, Klug WS, Spencer, CA, Palladino, MA, Killian D. 2019. Concepts of Genetics, Pearson. 12th edition.
- Chopra, V.L. 2018. Plant Breeding: Theory and Practices New India Publishing Agency-NIPA, New Delhi. 2nd edition.
- Simmonds, N.W. & Smart J. 2013. Principles of crop improvement. Wiley India Pvt. Ltd. 2nd edition.
- Acquaah, G. 2012. Principles of Plant Genetics & Breeding. Willey-Blackwell Publishing. 2nd edition.
- Gardner E.J., Simmons M.J., Snustad D.P. 2012. Principles of Genetics. Wiley India. 8th edition.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. 2010. Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
- Brown, J. Caligari, P. & Campos H. 2008. Plant Breeding. Willey-Blackwell Publishing. 2nd edition.

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **4th** | | |
| Name of the Course | **Plant Tissue Culture** | | |
| Course Code | **B23-BOT-404** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **DSE-1** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire a fundamental understanding of plant tissue culture.<br>2: Students will develop comprehensive knowledge about various culture methods used in plant tissue culture.<br>3: Students will gain knowledge about the basic principles of recombinant DNA technology.<br>4: Students will develop a comprehensive understanding of transgenic plants, including methods of gene transfer and selection.<br>5*. Students will gain the knowledge about the tools and techniques used for in vitro plant cell/tissue culture, growth medium, culturing of explants, gene transfer methods genetically modified plants/crops. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** | | |
| **PRACTICAL** | | | |
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** | | |
| **Part B- Contents of the Course** | | | |

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Totipotency; Differentiation and dedifferentiation.<br><br>Methodology: Sterilization (physical and chemical methods), Composition of media; Nutrient and hormone requirements (role of vitamins and hormones), medium for micropropagation/clonal propagation of ornamental and medicinal plants. Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation). | 11 |
| II | Callus subculture maintenance, growth measurements, morphogenesis in callus cultures : Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Anther culture, Embryo culture, Endosperm culture, Embryo rescue technique. Artificial seed production. Hardening and Acclimatization. | 11 |
| III | Recombinant DNA technology-I: Restriction Endonucleases (role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic and Eukaryotic. Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning). Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain genes of interest by genetic selection; complementation, colony hybridization. | 12 |
| IV | Methods of gene transfer- Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics–selectable marker and reporter genes (Luciferase, GUS, GFP). Transgenic plants: Pest resistant (Bt-cotton); herbicide resistant plants (Roundup Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns. | 11 |
| V* | • Preparation of MS medium.<br>• To prepare the slants and petri plates for plant tissue culture.<br>• Demonstration of *in vitro* sterilization and inoculation methods | 30 |

| | | |
|---|---|---|
| | using leaf and nodal explants of tobacco, Datura, *Brassica* etc.<br>• Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds.<br>• Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.<br>• Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.<br>• Isolation and quantification of genomic DNA from bacteria (*E. coli*) or Plants<br>• Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.<br>• Production of wine from the fruit juice of grapes by fermentation process using yeast. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Stewart C.N. 2016. Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A. 2nd edition.
- Singh. B.D. 2016. Biotechnology. Kalyani Publishers. 5th edition.
- Beyl, C.A. & Trigiano, R.N. 2014. Plant Propagation Concepts and Laboratory Exercises. CRC Press, Boca Raton, FL. 2nd edition.
- MacDonald, P.T. 2014. The Manual of Plant Grafting: Practical Techniques for Ornamentals, Vegetables, and Fruit. Timber Press, Portland, OR.
- Kyte, L., J. Kleyn, H. Scoggins & M. Bridgen. 2013. Plants from Test Tubes: An Introduction to Micropropagation, Timber Press Inc., Portland, OR. 4th edition.
- Smith, R.H. 2013. Plant Tissue culture: techniques and experiments. Elsevier. 3rd edition.
- Glick, B.R., Pasternak, J.J. & Patten C.L. 2010. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. 4th edition.
- Bhojwani, S.S. & Razdan, M.K. 2009. Plant tissue culture: Theory and Practice. Elsevier India Pvt. Ltd.

- George, E.F., Hall, M.A., Klerk, G.J. 2008. Plant Propagation by Tissue Culture. Springer. 3rd edition.


| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A – Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | 4th | | |
| Name of the Course | **Bioethics, Biosafety and IPR** | | |
| Course Code | **B23-BOT-405** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **DSE-1** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will acquire a fundamental understanding of the basics of bioethics and biosafety.<br>2: Students will develop comprehensive knowledge about the ethical issues concerning biotechnology.<br>3: Students will gain knowledge about the safety of modified crops.<br>4: Students will develop a comprehensive understanding of the different forms of IPR.<br>5*. Students will gain the basic knowledge about the various tools and software used for the searching & formatting of scientific articles, plagiarism detection, plant breeders & farmers rights. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Ethical conflicts in biological sciences; bioethics in health care; artificial reproductive technologies; ethics in transplantation and stem cell research; biopiracy; biosafety levels. | 11 |
| II | Ethical issues concerning biotechnology; primary containment for biohazards; recommended biosafety levels for specific microorganisms; biosafety guidelines for industrial operations with GMOs and field trial of GM crops. | 11 |
| III | Environmental risk assessment and food and feed safety assessment; balance of genetically altered and natural population in an ecosystem; safety of modified crops; social and economic effects. | 12 |
| IV | Different forms of IPR; patents, copyrights, designs, trademarks, geographical indication, trade secrets, semiconductor integrated circuit layout designs, plant breeders and farmers rights; general concept of patenting; | 11 |
| V* | • Plagiarism detection tools in scientific literature.<br>• Case studies related to scientific article retraction.<br>• Scientific article search tools; PubMed and Google scholar.<br>• Formatting scientific literature; APA, AMA, MLA and NLM.<br>• Case study: Protection of Plant Varieties and Farmers' Rights Act, 2001.<br>• Case studies related to IPR. | 30 |

| Suggested Evaluation Methods | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Sateesh, M.K. 2020. Bioethics and Biosafety. Wiley India.
- Fleming, D.O. & Hunt, D. L. 2014. Biological Safety: Principles and Practices. ASM Press. 4th Edition.
- Rathore, N.S. Mathur, S.M. Mathur, P. & Rathi, A. 2013. Intellectual Property Rights: Drafting, Interpretation of Patents Specification and claims. New India Publishing Agency-NIPA.
- Parashar, S. & Goel, D. 2013. IPR, Biosafety and Bioethics. Pearson Education, India.
- Poltorak, A.I. & Lerner, P.J. Wiley. 2011. Essentials of Intellectual Property: Law, Economics, and Strategy. John Wiley & Sons Inc. 2nd edition.
- Rallapalli, R. & Bali, G. 2011. Bioethics & Biosafety. APH Publication Corporation.
- Mepham, B. 2008. Bioethics: An introduction for the Biosciences. Oxford University Press. 2nd edition.
- Thomas J.A., Fuch R.L. 2002. Biotechnology and Safety Assessment. Academic Press. 3rd Edition.
- Cutter, S.I. 2003. Environmental Risks and Hazards. Publishers Prentice Hall.
- Donnellan, C. 2002. Cloning. Independent Educational Publication.


| Session: 2023-24 | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |
| Semester | **3rd** |
| Name of the Course | **Organic Farming** |
| Course Code | **B23-BOT-109** |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **VOC-1** |

| | |
|---|---|
| Level of the course (As per Annexure-I | |
| Pre-requisite for the course (if any) | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1: Students will be able to understand the need and concept of organic and integrated farming system.<br>2: Students will develop a conceptual understanding of plant nutrients, utilization of biofertilizers.<br>3: Students will gain knowledge about the disease and pest management<br>4: Students will learn about the use of plant products in organic farming, quality control and certification procedures of organic products.<br>---<br>5*. Students will gain the knowledge of practical aspects of organic and integrated farming system, role of nutrient in plant growth, utilization of plant and animal waste in organic farming, and also learn about the standardization procedures. |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Basics of organic farming – Concept and components of organic farming, aims and objectives; Need of organic farming; Historical development of organic farming in India; Status of organic farming in India; Advantages and disadvantages of organic farming. Organic farming process- Concept of farming | 11 |

| | | |
|---|---|---|
| | system, Developing organic farms, Important steps & methods; Pure organic farming and integrated farming system (combination of organic and inorganic). | |
| II | Plant nutrients: Essential plant nutrients, their role in plant growth and development, Nutrient uptake and utilization by plant. Nutrient management in organic farming: Balanced nutrients supply for organic farming system using nutrients from organic sources. Preparation, nutrient content and methods of use of following- FYM/Rural compost, mulching, city compost, oil cakes, animal wastes, vermicomposts, vermiwash, jeevamrit, beejamrit, green manures, biofertilizers. | 11 |
| III | Bio fertilizers and their method of use – Nitrogenous, Phosphatic, Potassic, availability of nutrients from above sources. Recycling of organic matter in organic agriculture-Transformation of organic substances in soil. Disease and pest management in organic farming-Integrated pest & disease managements; Organic pesticides, bio-pesticides; Inorganic pesticides, disadvantages of their use;Seed, seedling and soil treatment measures; Feasibility of complete dependence on organic sources.Weed management inorganic farming | 12 |
| IV | Use of Neem and other plant products in organic farming; Organic agri-horticulture in urban & semi urban areas. Certification, Standardization, Marketing - Quality control and certification procedures of organic products. Organic standards In India. Govt. schemes related to organic farming in India. Potential demand and Marketing of organic products. Organic farming and food security in India. | 11 |
| V* | • Preparation of compost by open air composting.<br>• Preparation of vermicompost.<br>• Comparative analysis of plants grown in compost prepared in 1 and 2.<br>• Determining the effectiveness of neem extract in pest control.<br>• Comparative analysis of plants grown in the presence of organic and inorganic fertilizers.<br>• Comparative analysis of nitrogen content in organic and inorganic fertilizers.<br>• Comparative analysis of phosphorous content in organic and inorganic fertilizers. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.: | **End Term Examination:** |

| | |
|---|---|
| • Mid-Term Exam: | |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Chandran, S., Unni M.R., Thomas, S. Meena, D.K. 2023. Organic Farming: Global Perspectives and Methods. Elsevier.
- Somasundaram, E. Udhaya Nandhini, D., Meyyappan, M. 2021. Principles of Organic Farming. CRC Press.
- Chandran, S., Thomas, S., Unni M.R. 2019. Organic Farming: New Advances Towards Sustainable Agricultural Systems. Springer.
- Giri b, Prasad, R. Qiang-Sheng, W. & Varma A. 2019. Biofertilizers for sustainable agriculture and environment (Soil Biology Book 55). Springer.
- Chandran, S., Unni M.R., Thomas, S. 2018. Organic Farming: Global Perspectives and Methods. Elsevier.
- Subbarao, N.S. 2017. Bio-fertilizers in Agriculture and Forestry. MedTech Publishers. 4th edition.
- Hermary, H. 2007. Working with nature. Gaia College Inc.


| Session: 2023-24 | |
|---|---|
| **Part A – Introduction** | |
| Subject | **BOTANY** |
| Semester | **4th** |
| Name of the Course | **Floriculture** |
| Course Code | **B23-BOT-209** |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **VOC-2** |
| Level of the course (As per Annexure-I | |
| Pre-requisite for the course (if any) | |

| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will be able to understand the importance and scope of floriculture, management of nursery and gardens, methods of plant propagation.<br>2: Students will develop a conceptual understanding of different types of ornamental plants.<br>3: Students will gain knowledge about the various types of gardens and importance of landscaping.<br>4: Students will learn about commercial floriculture and cultivation of important cut flowers.<br>5*. Students will gain the knowledge of practical aspects of floriculutre, management of nursery, maintinance of gardens, vase life of cut flowers,various methods used for the propagation of ornamental plants,hydroponics, and disease management. |
|---|---|

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Introduction:History, importance andscope of floriculture and landscape gardening. Nursery management and routine garden operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators | 11 |

| | | |
|---|---|---|
| II | Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai. | 11 |
| III | Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (garden wall, fencing, steps, hedge, edging, lawn, flower beds, shrubbery, borders, water garden. Some famous gardens of India. Landscaping of places of public importance: Landscaping highways and educational institutions. | 12 |
| IV | Commercial floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life. Cultivation of Important cut flowers- Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium). Diseases and Pests of Ornamental Plants. | 11 |
| V* | • Plant propagation by cutting.<br>• Plant propagation by grafting.<br>• Plant propagation by air-layering.<br>• Investigating the effect of different flower preservatives on the vase life of common ornamental flowers.<br>• Setting up a laboratory scale hydroponics setup.<br>• Preparation of different types of floral arrangements.<br>• Morpho-anatomical study of different types of flowers.<br>• Study of different diseases in ornamental plants. | 30 |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, A.K. & Kumar A. 2023. Plant Propagation and Nursery management. S.K. Kataria and sons.
- Arora, J.S. 2016. Introductory Ornamental Horticulture. Kalyani Publishers. 8th edition.
- Jain, S.M. & Ochatt, S.J. 2009. Protocols for in vitro propagation of ornamental plants: 598 (Methods in Molecular Biology). Humana Press.
- Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios
- Lauria A & Victor HR. 2001. Floriculture – Fundamentals and Practices Agrobios.

| Session: 2023-24 | | | |
|---|---|---|---|
| **Part A - Introduction** | | | |
| Subject | **BOTANY** | | |
| Semester | **5th** | | |
| Name of the Course | **Nursery and Gardening** | | |
| Course Code | **B23-VOC-217** | | |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **VOC-3** | | |
| Level of the course (As per Annexure-I | | | |
| Pre-requisite for the course (if any) | | | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will be able to understand the infrastructure of nursery,seed production technology<br>2: Students will develop a conceptual understanding the gardening procedure and ,management of pest and diseases.<br>3: Students will gain knowledge about the vegetative propagation methods.<br>4: Students will learn about cultivation of different vegetables and flowers.<br>5*. Students will gain the knowledge of practical aspects of management of nursery,gardens, vegetative propagation methods,and cultivation of different vegetables and flowers. | | |
| Credits | Theory | Practical | Total |
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |
| **THEORY** | | | |
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | | **Time: 3 Hours** | |
| **PRACTICAL** | | | |

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Nursery: Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities – planting, direct seeding and transplants.<br>Seed: Structure and types -Seed dormancy; causes and methods of breaking dormancy<br>Seed storage: Seed banks, factors affecting seed viability, genetic erosion.<br>Seed production technology: Seed testing and certification. | 11 |
| II | Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design.<br>Gardening operations: Soil laying, manuring, watering, management of pests and diseases and harvesting, sowing/raising of seeds and seedlings, transplanting of seedlings.<br>Computer applications in landscaping. | 11 |
| III | Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings.<br>Hardening of plants - greenhouse - mist chamber, shed root, shade house and glass house. | 12 |
| IV | Cultivation of different vegetables: Cabbage, Brinjal, Lady's finger, Onion, Tomatoes and carrots<br>Cultivation of different flowers: Marigold, Lilium, Rose, Gerbera, Gladiolus, Chrysanthemum and Carnation.<br>Storage and marketing procedures. | 11 |
| V* | • Study of seed dormancy breakage by scarification and stratification.<br>• Investigating the effect of different environmental conditions on seed germination. | 30 |

| | | |
|---|---|---|
| | • Study of different tools used in gardening.<br>• Bed preparation for growth of seedlings.<br>• Raising of seedlings and transplantation.<br>• Comparing the effects of different pruning methods, such as topping, thinning, or pinching, on plant growth, branching patterns, and flower production.<br>• Study of different methods of vegetative propagation. | |

**Suggested Evaluation Methods**

| | |
|---|---|
| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Singh, A.K. & Kumar A. 2023. Plant Propagation and Nursery management. S.K. Kataria and sons.
- Ray, P.K. 2021. Essentials of Plant nursery management. Scientific publishers, India. 2nd edition.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. 2015. Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Ray, P.K. 2012. Plant nursery management: how to start and operate a plant nursery. Scientific publishers, India.
- Sinha, N.K., Hui, Y.H. 2011. Handbook of vegetables & vegetable processing. Wiley-Blac, A John Wiley & SOns, Ltd.
- Jain, S.M. & Ochatt, S.J. 2009. Protocols for in vitro propagation of ornamental plants: 598 (Methods in Molecular Biology). Humana Press.
- Hopkins, W.G. and Huner, A. 2008. Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
- Mason, J. 2004. Nursery management. Landlinks Press.


| **Session: 2023-24** | |
|---|---|
| **Part A - Introduction** | |
| Subject | **BOTANY** |

| | |
|---|---|
| Semester | 6th |
| Name of the Course | **Mushroom Cultivation** |
| Course Code | **B23-VOC-309** |
| Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC) | **VOC-4** |
| Level of the course (As per Annexure-I | |
| Pre-requisite for the course (if any) | |
| Course Learning Outcomes(CLO): | After completing this course, the learner will be able to:<br>1. Students will be able to understand the nutritional and medicinal value of edible mushrooms.<br>2: Students will develop a conceptual understanding of various procedure and techniques used for mushroom cultivation.<br>3: Students will gain knowledge about the storage procedure of different types of edible mushrooms.<br>4: Students will learn about different types of food prepared from mushrooms and their medicinal value.<br>5*. Students will gain the knowledge of practical aspects of mushroom cultivation |

| Credits | Theory | Practical | Total |
|---|---|---|---|
| | 3 | 1 | 4 |
| Contact Hours | 3 | 2 | 5 |

**THEORY**

| | |
|---|---|
| **Max. Marks: 70**<br>**Internal Assessment Marks: 20**<br>**End Term Exam Marks: 50** | **Time: 3 Hours** |

**PRACTICAL**

| | |
|---|---|
| **Max. Marks: 30**<br>**Internal Assessment Marks: 10**<br>**End Term Exam Marks: 20** | **Time: 4 Hours** |

**Part B- Contents of the Course**

**Instructions for Paper- Setter**

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit . The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

| Unit | Topics | Contact Hours |
|---|---|---|
| I | Introduction, nutritional and medicinal value of edible mushrooms; poisonous mushrooms, types of edible mushrooms available in India- *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.<br>Required infrastructure: substrates (locally available), polythene bags, vessels, inoculation hook, inoculation loop, low cost stoves, sieves, culture racks, mushroom unit (thatched house), water sprayer, tray, etc. | 11 |
| II | Pure culture: medium, sterilization, preparation of spawn, multiplication.<br>Mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves, Factors affecting the mushroom bed preparation- low cost technology, composting technology in mushroom production | 11 |
| III | Storage: short term storage, long term storage (canning, pickels, papads), drying, storage in salt solutions.<br>Nutritional value of some common commercially available mushrooms: proteins, amino acids, mineral elements nutrition, carbohydrates, crude fibre content and vitamins. | 12 |
| IV | Food preparation: type of foods prepared from mushrooms.<br>Medicinal value of edible mushrooms.<br>Research centres: National level and regional level. Cost benefit ratio: marketing in India and abroad. Export value. | 11 |
| V* | 1. Sterilization of media for spawn preparation.<br>2. Preparation of spawn and multiplication.<br>3. Preparation of mushroom bed with different substrates.<br>4. Cultivation of *Pleurotus* sp.<br>5. Cultivation of *Agaricus* sp.<br>6. Evaluation of total soluble sugar content of commonly available mushrooms.<br>7. Evaluation of total protein content of commonly available mushrooms.<br>8. Preparation of dried mushroom powder for long term storage and its nutrient evaluation. | 30 |
| **Suggested Evaluation Methods** | | |

| **Internal Assessment:**<br>➢ **Theory**<br>• Class Participation:<br>• Seminar/presentation/assignment/quiz/class test etc.:<br>• Mid-Term Exam:<br>➢ **Practicum**<br>• Class Participation:<br>• Seminar/Demonstration/Viva-voce/Lab records etc.:<br>• Mid-Term Exam: | **End Term Examination:** |
|---|---|

**Part C-Learning Resources**

**Recommended Books/e-resources/LMS:**


- Bray, R. 2019. Mushroom cultivation: 12 ways to become the MacGyver of Mushrooms. Urban Homesteading.
- Kumaresan, V. 2018. Mushroom cultivation. Saras Publication.
- Russell, S. 2014. The essential guide to cultivating mushrooms: Simple and advanced techniques for growing Shiitake, Oyster, Lion's mane and Maitake mushrooms at home. Storey publishing LLC.
- Gour, P.Y. 2010. Mushroom Production and Processing Technology. Agrobios India.
- Powell, M. 2010. Medicinal mushrooms: A clinical guide. Mycology Press.
- Cheung, P.C. 2008. Mushrooms as Functional foods. Willey-Interscience.
- Tripathi, D.P. 2005. Mushroom Cultivation. Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
- Paul Stamets, J.S. & Chilton, J.S. 2004. Mushroom cultivation: A practical guide to growing mushrooms at home, Agarikon Press.
- Chang, S.F. Miles, P.G. & Chang, S.T. 2004. Mushrooms Cultivation, nutritional value, medicinal effect and environmental impact. CRC press. 2nd edition.
- Bahl, N. 2000. Handbook on Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.