Scheme A2: Semester 3rd

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A07	Physiology of Plant growth	241/BOT/CC307	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A08	Biology of Reproduction and Anatomy	241/BOT/CC308	03	00	02	03	00	01	04	25	50	05	20	**100**
CC-A09	Bryophytes &Pteridophytes	241/BOT/CC309	03	00	02	03	00	01	04	25	50	05	20	**100**
Discipline Specific Elective Courses (Select any one course from the following)														
DSE-03	Gymnosperms & Ethnobotany OR Advanced Phycology	241/BOT/DS203	02	00	02	02	00	01	03	15	35	05	20	**75**
Multidisciplinary Course(s)														
MD-03	One from the Pool	241/BOT/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**
Skill Enhancement Course(s)														
SEC-02	One from the Pool	241/BOT/SEC302	01	00	02	01	00	01	02	00	50	00	00	**50**
Value added Course(s)														
VA-02	One from the Pool	241/BOT/VA302	02	00	00	02	00	00	02	00	50	00	00	**50**
Seminars														
Seminar	Seminar	241/BOT/SEMINAR301	02	00	00	02	00	00	02	00	50	00	00	**50**
Internship/Field Activity#														
INTRSP	Industrial Visit/ Field Work and Report Writing	241/BOT/INTRSP301	02	00	00	02	00	00	04	00	50	00	00	**50**
Total Credits									**28**					**600**

 # Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Scheme A2: Semester 4th

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Ability Enhancement Course(s)														
AEC-03	Manuscript Writing**/ Pool	241/BOT/AE401	02	00	00	02	00	00	02	00	50	00	00	**50**
Dissertation/Project Work														
Dissertation	Industrial Training/Research Project/ Dissertation	241/BOT/DISSERTATION401	0	0	40	0	0	20	20	00	00	100	400	**500**
Total Credits									**22**					**550**

Scheme A2: Semester 3rd

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of theCourse**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A07 4 credits	241/BOT/CC307	Physiology of plant growth & development	3	3	25	50	75	2 hrs.
		Practical	1	2	5	20	25	2 hrs.

Course Learning Outcomes (CLO)

1. The students will be able to understand the basic concepts of plant growth and development.
2. The students will be learning about abiotic stress tolerance/adaptive physiological changes affecting plant productivity.
3. During the course students will gain in depth knowledge about various plant growth regulators and their role in physiology of growth and development.
4. Students will be acquainted with the knowledge of physiology of flowering and sensory biology.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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 Growth: Growth concepts, Growth curves, Growth analysis. Germination and Dormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors. Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.	12
II	Plant Growth Regulators: Discovery, biosynthetic pathways, transport, influence on plant growth And mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid.	11
III	Senescence and Abscission: Physiological and biochemical changes associated with senescence and abscission. Tropism: Phototropism, nature of receptors, role of hormones, Geotropism and nastism.	11
IV	Sensory Photobiology: Phytochromes: mechanism of phytochrome action, photomorphogenesis and cryptochromes. The Flowering Process: Photoperiodism and its significance, importance of dark periods, role of vernalization. Nature and events during flowering, florigen concept, chemical control of flowering.	11
V Practical	1. Determine the osmotic pressure (potential) and calculate the isotonic coefficient of sugar. 2. Determine the diffusion pressure deficit of plant cells 3. Study the structure of stomata and find out their frequency on the adaxial and abaxial surfaces of leaves 4. Set up wilmott's bubbler and study the effect of varying co2 concentration and different wavelengths of light on the rate of photosynthesis 5. Separate pigments, viz., chlorophyll 'a' and 'b', carotene and xanthophylls from green leaves by paper chromatography and column chromatography 6. Measure the rate of photosynthesis by winkler's method 7. Separation of amino acids by paper chromatography.	30

Learning Resources

1. Audus, L.J. (1972). Plant Growth Substances. Vol.I Chemistry and Physiology. Leonard Hill, London.
2. Bonner, J. And Varner, J.E. (1976). Plant Biochemistry,IIIrd Edition, Academic Press, New York and London.
3. Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4. Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.
5. Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt.Ltd.
6. Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.

7. Hopkins, W.G. 1995 Introduction to Plant Physiology, John Wiley and Sons.
8. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
9. Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East- West Press Pvt Ltd. New Delhi.

BOTANY:
SEMESTER-III

Course Type	Course Code	Name of theCourse	Credit	Contact Hours/ Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
CC-A08 4 credits	241/BOT/CC308	Biology of reproduction and anatomy	3	3	15	50	75	2 hrs.
		Practical	1	2	5	20	25	2 hrs.

Course Learning Outcomes (CLO)

1. The students will be able to understand the structure and development of reproductive structures and the process of reproduction in angiosperms.
2. Acquire knowledge about in vitro culturing techniques and their applications in human welfare.
3. Learn about the role of anatomy in taxonomy and anomalous secondary structures in plants.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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 plant embryology Male gametophyte: structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; Pollen germination, pollen tube growth and guidance; pollen allergy	11
II	Female gametophyte; ovule development, megasporogenesis; Organization of the embryo sac, structure of the embryo sac cells. Pollination, Pollination mechanisms and vectors,	11
III	Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction, sporophytic and gametophytic incompatibility, double fertilization Endosperm development, polyembryony; apomixis Experimental Embryology: in vitro fertilization Anther, Pollen and embryo culture,	11
IV	Anatomy in relation to taxonomy. Anomalous secondary Structure: Anomalous secondary growth, anomalous position of cambium, abnormal behaviour of normal cambium, accessory cambium formation and its activity, extrastelar cambium, Interxylary and intraxylary phloe, presence of medullary bundles, cortical bundles, presence of exclusive phloem and xylem bundles, secondary growth in monocots.	12
V Practical	1. Study of meristems through permanent slides and photographs. 2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs) 3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides). 5. Leaf: Dicot and Monocot leaf (only Permanent slides). 6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem). 7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). 8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.	30

Learning Resources

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.
2. Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.
3. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, Cambridge. Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin, Esau, K. 1965. Plant Anatomy. John Wiley & Sons New York.
4. Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.
5. Eames, A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New

York.
6. Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of theCourse**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
CC-A09 4 credits	**241/BOT/CC309**	**Bryophytes & Pteridophytes**	**3**	**3**	**15**	**50**	**75**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Identify and classify the major groups of non-flowering plants: Bryophytes and Pteridophytes, based on morphological and reproductive features.
2. Describe the life cycles of Bryophytes and Pteridophytes, emphasizing alternation of generations and the dominance of gametophyte or sporophyte stages.
3. Explain the evolutionary trends and adaptations that distinguish these groups and contribute to their success in terrestrial environments.
4. Compare and contrast the structural complexity, vascular systems, and reproductive strategies among Bryophytes and Pteridophytes,

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	Bryophytes: Systems of classification, distribution, Economic importance. Habitat, external and internal morphology, reproduction,	11
II	Gametophytes and sporophytes in Bryophytes, phylogeny and interrelationships of the orders: Sphaerocarpales, Takakiales, Marchantiales and Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.	11
III	Pteridophyta: Classification, Origin and evolution, Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida-Psilotales and Psilophytales, Lycopsida- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida- Filicales.	11
IV	Sporophyte and gametophyte in Pteridophytes, Stelar organization and evolution, Origin of leaf and Telome concept, Sporocarp, Heterospory and seed habit, Comparison of Pteridophyta with Bryophyt	12
V Practical	1. **Vegetative Organization**: Marchantia, Riccia, Anthoceros, Sphagnum, Polytrichum. 2. **Anatomical Organization**: Marchantia, Cyathodium, Anthoceros, Sphagnum. 3. **Archegonia and Antheridia and their Organization**: Riccia, Marchantia, Anthoceros, Sphagnum. 4. **Sporophytes**: Riccia, Marchantia, Pellia, Anthoceros, Funaria, Sphagnum, Polytrichum. 5. **Pteridophytes**: Morphological and anatomical studies of 1) Psilotum 2) Lycopodium 3) Selaginella, 4) Isoetis, 5) Equisetum,6) Ophioglossum, 7) Osmunda, 8) Gleichenia, 9) Pteris, 10) Adianium,11) Marselia, 12) Salvinia, 13) Azollaand additional forms/species collected during study tour.	30

Learning Resources

1. Bir, S. S. (2005) Pteridophytes their Morphology, Cytology, Taxonomy and Phylogeny. Today & Tomorrow's Printers and Publisher.
2. Biswas, C. and B. M. Johri (2004) The Gymnosperms, Narosa Publishing House, New Delhi
3. Campbell, C. J. (1940) Evolution of land Plants, Stanford University Press.
4. Coulter J. M. and C. J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahabad
5. Eames, A. J. (1974) Morphology of Vascular Plants- lower groups, Tata Me Graw-Hill Publishing Co. New Delhi.
6. Foster, A. S. & F. M. Gifford (1967) Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.
7. Kakkar, R. K. and B. R. Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.
8. Kashyap S. R. (1932) Liverworts of Western Himalayas and the Plains.Vol. I & II, The University of Panjab, Lahore.
9. Parihar, N. S. (1991) Bryophytes, Central Book Dept., Allahabad. Parihar, N. S. (1976) The biology and morphology of the pteridophyta, Central Book Depot, Allahabad.
10. PuriPrem (2005) Bryophytes Morphology, Growth and Differentiation- Pulisher- Atmaram and Sons New Delhi
11. Rashid, A. (1976) An introduction to pteridophyta, Vikas Publishing House Ltd., New Delhi.

12. SambamurtyA. V. S. S, (2005) A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Today & Tomorrow's Printers and Publishers
13. Sharma O. P. (2002) Gymnosperms, PragatiPrakashan, Meerut.
14. Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries PublisherBhishan Singh Mahendra Pal Singh, Dehradun
15. Tewari, Shiv Datt and GiriBala Pant (2005) Bryophytes of Kumaun Himalaya. Publisher-Bhishan Singh Mahendra Pal Singh-Dehradun
16. Siddiqui K. A. (2002) Elements of Paleobotany, KitabMahal, Allahabad.
17. Smith, G. M. (1976) Cryptogamic Botany - Vol. II, Tata Me Graw-Hill Publishing Co. Ltd. New Delhi.
18. Sporne, K. R. (1976) Morphology of Pteridophyta. Hutchinson University Library, London.

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of theCourse**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03 3 credits	**241/BOT/DS203**	**Gymnosperms & Ethnobotany**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Classify and distinguish gymnosperms from other groups of plants.
2. Trace evolutionary trends in development of male and female gametophytes.
3. Learn about economic importance of gymnosperms and modern methods of their propagation.
4. Explain the ethnobotany, its history, significance, methods and techniques used in ethnobotanical study and research.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	Gymnosperms: Introduction, Classification and distribution of Gymnosperms. Brief account of the following families: Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.	11
II	General account of the following orders: Cycadeoidales(Cycadeoidea), Pentoxylales, Cordiatales Comparative account of Structure and reproduction in the following orders: Cycadales (Cycas), Ginkgoales (Ginkgo).	11
III	Coniferales (Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales, Gnetales Economic importance of gymnosperms, Role of Gymnosperms in Biodiversity. Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and protoplast culture	11
IV	Ethnobotany: History and importance of ethnobotany, ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture Wild edible plants used as emergency food by tribals in India, methods and techniques in ethnobotanical study and research. Traditional plants: Cereals, pulses, vegetables, spices and mushrooms, wild edible fruits and seeds. Plants in folk songs and proverbs. Sacred grooves, Impact of modernization.	12
V Practical	1. **Gymnosperms**: Study of the vegetative and reproductive parts, including anatomy of the following genera: Cycas, Zamia, Pinus, Cedrus, Taxodium, Cryptomeria, Cupressus, Thuja, Juniperus, Podocarpus, Cephalotaxus, Agathis, Araucaria, Taxus, Ginkgo, Gnetum. 2 **Ethnobotany:** Collect plant samples, dry them, and identify them using botanical keys. 3 Conduct interviews with local people to gather information about their traditional knowledge of plant use, including medicinal, food, and other applications. 4 Record the specific parts of the plant used (e.g., leaves, roots, bark), preparation methods, and the traditional uses of each plant. 5 Conduct case studies to explore the ethnobotanical uses of specific gymnosperm species in different regions.	30

Learning Resources

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
2. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publications Pvt. Ltd., New Delhi.
3. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.
4. Cotton, C.M. 1996. Ethnobotany- Principles and Appliations, Centruy School Book by service Film setting Ltd.
5. Dahlgren. R.H., Clifford, T and P.F Yeo 1985.The families of the monocotyledons; structure, Evolution and Taxonomy. SpingeVerag, NY.
6. Gary J, Martin, 2004. Ethnobotany- A Methods Manual, Chapman and Hall. U.K.
7. Jain S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
8. Jain S.K. 1987. A manual of ethnobotany. Scientific publisher Jodhpur.
9. Jain S.K. and Mundgal, 1999. Handbook of ethnobotany, London.
10. Pursrglove, J.W. 1972. Tropical Crops-Monocotyledons and Dicotyledons of ethnobotany, ethnomedicine, ethnoecology, ethnic communities.

11. Rao, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
12. Trivedi, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
13. Yoganarasimhan, S.N. Medicinal Plants of India-Vol-I- Karnataka, Interline Publishing Pvt. Ltd.

BOTANY: SEMESTER-III								
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
DSE-03 3 credits	**241/BOT/DS203**	**Advanced Phycology**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**
		Practical	**1**	**2**	**5**	**20**	**25**	**2 hrs.**

Course Learning Outcomes (CLO)

1. To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous 'Green Revolution' of the nation, thereby making India self-reliant in food grain production.
2. To come out with the trained professionals having the knowledge of nutritional requirements of algae for their mass/ large scale cultivation with particular reference to ecological biodiversity of algae & algal bio-fertilizers in Haryana.
3. The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of algae in terms of their control in water supplies, on ancient monuments and Paddy field algal flora as the N_2-economy builders of the nation.
4. The Course has been conceived to equip the students with the knowledge of various physiological and biochemical aspects on algal flora exposed to pesticides, toxicants and heavy metals to comprehend the mechanisms of adaptation against them in terms of their uptake kinetics.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	Limits to algal growth in natural waters. Dynamics and consequences of freshwater marine & algal blooms; Causative factors for eutrophication and its impact. A brief account of phycological researches in India.	11
II	Mineral nutrition in algae with emphasis on Calcium, Magnesium, Sodium, Iron, Molybdenum, & Silica. Synchronous & continuous cultures and their uses; Physiology of nutrient regulated algal growth. A brief account of culture techniques, media for algal growth and measurement techniques.	11
III	Algae in water supplies, on ancient monuments and bio-fouling of ships. Ecological biodiversity of algae in unusual habitats with suitable examples. Paddy field algal flora as N_2-economy builders of the nation.	11
IV	Physiological and biochemical aspects on algal flora exposed to heavy metals. Kinetics of heavy metal uptake and its bioaccumulation. Mechanisms of adaptation against tolerance to toxicants, pesticides and salt.	12
V Practical	1. To illustrate various methods prescribed for algal culture. 2. To culture any one alga in laboratory (Spirulina/Chlorella/Scenedesmus/Botrycoccus/ Dunaliella) in laboratory. 3. To isolate and maintain any two-nitrogen fixing Blue Green Algae (BGA). 4. To estimate the algal proteins of the cultured alga. 5. To extract DNA/RNA and its quantification by suitable algal material. 6. Biochemical analysis of the cultured alga for food /bio-fuel properties. 7. To separate proteins from cultured alga by using SDS-PAGE Electrophoresis Technique. 8. To study BGA biofertilizer production technology. 9. To prepare culture medium for Algal growth.	30

Learning Resources

1. Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
6. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.
7. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
8. Graham, L.E. & Wilcox, L.W. (1999): Algae, Benjamin Cummings, USA.
9. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing

BOTANY: SEMESTER-IV							
Course Type	**Course Code**	**Name of the Course**	**Credit**	**Contact Hours/ Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**
Dissertation	241/BOT/DISSERTATION401	**Dissertation**	**20**	**40**	**100**	**400**	**500**

Course Learning Outcomes (CLO)

1. **Demonstrate advanced knowledge and understanding** of a specialized area within the field of botany, integrating current research and scientific literature.
2. **Formulate a clear research question or hypothesis** and design a methodologically sound investigation to address it.
3. **Apply appropriate experimental, analytical, or field techniques** to collect, analyse, and interpret botanical data.
4. **Critically evaluate scientific data** and discuss its implications in the context of existing botanical theories and research.
5. **Present research findings clearly and effectively** in a well-structured scientific dissertation, adhering to academic standards of writing and referencing.
6. **Defend research outcomes** and methodology in an oral or written format, demonstrating a thorough understanding of the research topic and its broader scientific context.
7. **Work independently and manage time effectively** over an extended research project, showing initiative, problem-solving ability, and scientific integrity.

COURSE DESCRIPTION:

***Industrial Training/Research Project/ Dissertation*:** Every student will be required to undertakeIndustrial Training or a research project based on related areas of Botany. The training/research project report will be submitted in the form of dissertation and will be presented forevaluation at the end of semester by an external expert. The internal and external assessment of training and project work will be carried out as following.

Internal Assessment:

- Synopsis
- One Mid-semester progress report/presentation

External Assessment:

- Final project report and viva-voce presentation.

Dissertation Report Submission Guidelines:

The dissertation report should be contained followings:

1. Dissertation report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
   - The paper size to be used should be A-4 size.
   - The font size should be 12 with Times New Roman.
   - The text of the dissertation may be typed in 1.5 (one and a half) space.
   - The print out of the dissertation shall be done on both sides of the paper (instead of singleside printing)
   - The total no. of written pages in dissertation report should be 40 to 60.
2. The candidate shall be required to submit three hard bound copies of dissertation along with aCD in the department as per the date announced.
3. Plagiarism should be below 20% (with filter of 5 words in a line from the same source) andstudents are required to produce letter of undertaking regarding plagiarism.
4. The candidate will defend her/his dissertation/project work through presentation before theExternal examiner at the end of semester and will be awarded marks.

Multidisciplinary Course from the department for pool of the Courses in the University

(These courses are to be offered to students of different discipline/Subject)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-01	Principles of Plant Pathology	241/BOT/MD101	02	00	02	02	00	01	03	15	35	05	20	**75**

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-02	Conservation Biology	241/BOT/MD202	02	00	02	02	00	01	03	15	35	05	20	**75**

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-03	Biophysical & biochemical techniques	241/BOT/MD303	02	00	02	02	00	01	03	15	35	05	20	**75**

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-04	Plant Tissue Culture	241/BOT/MD404	02	00	02	02	00	01	03	15	35	05	20	**75**

Multidisciplinary Course

BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-01	241/BOT/MD101	**Principles of Plant Pathology**	2	2	15	35	50	2 hrs
			1	1	5	20	**25**	

Course Learning Outcomes (CLO)

1. Imparts knowledge regarding the various mechanisms involved during pathogenesis.
2. Students will be able to understand plant disease epidemiology, forecasting and management
3. Students gets familiar with applications of biotechnology in plant pathology
4. Students will form concepts about host-pathogen interactions and mycotoxins

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	How pathogens attack plants : chemical weapons of pathogens (enzymes and toxins) How plants defend themselves against pathogens: structural defense and biochemical defense.	12
II	Plant disease epidemiology and plant disease forecasting: Importance of disease forecasting services, methods used in plant disease forecasting. Management of plant pathogens: cultural, chemical and biological methods.	11
III	Applications of biotechnology in Plant Pathology: The use of tissue culture techniques (callus culture, apical meristem culture and protoplast fusion), Recombinant DNA technology, use of monoclonal antibodies in plant pathology. Effect of environmental factors on disease development.	11
IV	. Mycotoxin producing fungi during storage and major mycotoxins produced by them. Host-pathogen interaction of population level: transmission and spread of plant pathogens.	11
	Practical List: A) To study the symptoms and diagnostic features of causal organisms of the following plant diseases. 1. Downy mildew of grapes 2. Karnal bunt of wheat 3. Smut of bajra 4. Late and early blight of potato 5. Yellow vein mosaic of Bhindi 6. Tikka disease of groundnut 7. Bacterial blight of paddy 8. Black rust of wheat 9. Sandal spike B). Collection and submission of plant diseases samples.	

Learning Resources

Agrios, G.N. (2005): Plant Pathology, Acad. Press, Inc. California.
Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.
Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.
Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.
Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, New Delhi.
Mehrotra, R.S. and Ashok Aggarwal (2003): Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi.
Michael J. Pelezar, E.C.S. Shan & N.R. Krieg (1993): Microbiology. Tata Mc Graw Hill Publ. New Delhi.
Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
Singh, R.S. (1990): Plant Disease, 6th Edition, Oxford, IBH Publ., New Delhi.
Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.
Webster, J. (1985): Introduction of Fungi. Cambridge University, Press.

BOTANY: SEMESTER-II								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-02	**241/BOT/MD202**	**Conservation Biology**	2	2	15	35	50	**2 hrs.**
3 credit			1	2	5	20	25	

Course Learning Outcomes (CLO)

1. Students will become aware and understand the concept and significance of different conventions and Protected Area Networks in relation to conservation of Biodiversity.
2. Students will be able to develop own conservation values and ethics and appreciate the importance of biodiversity services.
3. Student will be able to develop the skills necessary to work efficiently in areas like conservation, EIA, environment management and monitoring.
4. After completion of the course, the student be able to formulate one's own scientific and realistic approach towards Conservation Biology.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	Principles, characteristics and importance of conservation biology Conservation values and ethics, Role of species in conservation	12
II	Global biodiversity I: Patterns and Processes Global biodiversity II: Losses, Pattern of species vulnerability, Habitat fragmentation and degradation, Synergistic interactions Biodiversity and ecosystem services	11
III	Biodiversity of wetlands, mangroves and coral reefs- A general account Biosphere reserves and RAMSAR sites in India, The Design of Conservation Reserves Major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere Reserves)	11
IV	Importance of genetic resources and conservation of crop genetic resources International and National efforts to conserve biodiversity: Convention on biological diversity, CITES, Ramsar convention; National Biodiversity strategy Role of remote sensing and GIS and biodiversity conservation	11
	List of Practical: 1. To determine the Calcium content of soil samples using titration method. 2. To estimate available N2 in a given soil sample. 3. To determine the role of CO2 evolution from the given soil sample. 4. To calculate their phosphorous content of the given soil sample. 5. To interpret the Annual Forest report with reference to Haryana. 6. To study the Biosphere reserves of India - National park, wildlife sanctuaries in Haryana	

Learning Resources

1. Chape, S., Fish, L., Fox, P. And Spalding, M. 2003. United Nations list of protected areas. IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge
2. Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.
3. Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.
4. Hunter (Jr.) M.L. (1996); Fundamentals of Conservation Biology, Blackwell Science. Meffe G.K. and C. Ronals Corroll (1994) Principles of Conservation Biology, Sinaur Associates, Inc., Sunderland. Massachusetts.
5. Huston, M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
6. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
7. Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
8. Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.
9. Turner, M.G., Gadner,R.H. and O,Neill, R.V. 2001. Landscape Ecology: In theory and Practice, Pattern and Processes. Spinger Verlag, New York.

BOTANY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-03	241/BOT/MD303	Biophysical & biochemical techniques	2	2	15	35	50	2 hrs
			1	1	5	20	**25**	

Course Learning Outcomes (CLO)

1. **Students will be able to demonstrate an understanding of fundamental biochemical concepts,**
2. **Students will be proficient in various laboratory techniques for analyzing biological samples,**
3. **Students will be able to apply biophysical principles to biological systems.**
4. **Students will be able to collect, analyze, and interpret data from various experimental techniques.**

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	**Microscopy:** Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. Fixation and staining; cytophotometry and flow cytometry.	12
II	**Chromatographic techniques:** Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high-pressure liquid chromatography (HPLC). **Electrophoresis and centrifugation:** Principles and applications of agarose and polyacrylamide gel	11
III	**Spectrometry:** Introduction; Theory; Mass spectrometer; Ionization of molecules; Mass analyzers-MALDI; Detectors and Applications **Spectroscopy:** Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction.	11
IV	**Molecular biology techniques:** southern, northern and western blotting techniques, polymerase chain reaction (PCR), ELISA. Methods for measuring nucleic acid and protein interactions; DNA fingerprinting; Molecular markers (RFLP, AFLP, RAPD). **Tracer Biology:** Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography.	11
	List of Practical: 1. Demonstration of working of different types of microscopes. 2. Demonstration of Chromatography i.e. TLC, HPLC, GC. 3. To demonstrate the separation of proteins with the help of electrophoresis. 4. To study various molecular biology techniques i.e. PCR, ELISA. 5. To demonstrate the use of spectrophotometer. 6. Purification of protein by column chromatography. 7. Visit of various laboratories in the university, preparation and submission of report. 8. Principles of Calorimetry, Spectrophotometry and Fluorimetry	

Learning Resources

Hegyi, G., Kardos, J., Kovacs, M., Csizmadia, A.M., Nyitray, L., Pal, G., Radnai, L., Remenyi, A.,Venekei, I., 2013,Introduction to Practical Biochemistry, Eotvos Lorand University, Hungary.

Plummer, D.T., 1990, An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.

Prescott, L., Harley, J., Klein, D., 2005, Microbiology (6th Ed) Mc Graw-Hill.

Ranade, R. and Deshmukh, S., 2013, Handbook of Techniques in Biotechnology, StudiumPress (India) Pvt. Ltd. New Delhi.

Sawhney, S.K. and Singh, R., 2000, Introductory Practical Biochemistry (Ed.), NarosaPublishing House Pvt. Ltd., New Delhi.

Wilson, K., and Walker, J., 2010, Principles and Techniques of Biochemistry and Molecular Biology (7th Ed.), Cambridge University Press, New Delhi.

BOTANY: SEMESTER-IV								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
MDC-04	241/BOT/MD404	Plant Tissue Culture	2	2	15	35	50	2 hrs
			1	1	5	20	**25**	

Course Learning Outcomes (CLO)
Students will be able to:

1. **Acquire knowledge about the non - conventional methods of plant propagation.**
2. **Learn about regeneration of complete plants from plant organs/cell other than seeds**
3. **Apply knowledge regarding in vitro techniques in Agriculture and forestry.**
4. **Attain practical knowledge of preparing artificial seeds. Develop curiosity about use of non - conventional methods in storage and conservation of germplasm.**

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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:** History of Plant Tissue Culture, Basic concept, principles and scopeof plant cell and tissue culture, concepts of cellular differentiation; Totipotency; basic techniques of plant tissue culture; callus formation, organogenesis and embryogenesis. Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.	12
II	*In vitro* haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture Production of triploids through endosperm culture. **Micropropagation:** meristem culture and virus-free plants; Cryopreservation of plant cell and tissue cultures and establishment of gene banks Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement.	11
III	**Plant Secondary Metabolites:** Sources and production of secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; biotransformation.	11
IV	Somatic embryogenesis, production of synthetic seeds, importance, limitation and their utilization. Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India edible vaccines, and their prospects.	11
	List of Practical: 1. Preparation of different types of standard tissue culture media. 2. Establishment of aseptic cultures following appropriate sterilization procedures using seeds. 3. Preparation of competent cells and Agrobacterium transformation by electroporation. 4. Agrobacterium tumefaciens-mediated transformation of tobacco. 5. Visualization of GFP or YFP in transgenic Arabidopsis. 6. Morphological and histochemical features of major cereals, oilseeds, legumes, forest trees, non-alcoholic beverages and medicinal plants. 7. Analysis of crude extracts from medicinal plants using HPLC. 8. Evaluation of a transgenic phenotype (viz., Herbicide resistance) under containment conditions in	

Learning Resources

Bhojwani, S.S. and Razdan, M.K., 1996, Plant Tissue Culture: Theory and Practice (Arevised Edition), Elsevier Science Pub., New York, USA.

Chawla, H.S., 2020, Introduction to Plant Biotechnology (3rdEdition), Oxford and IBHPub. Co., New Delhi.

Collins, H.A. and Edwards, S. 1998, Plant Cell Culture, Bios Scientific Pub., Oxford,U.K.

Glick, B.R., and Pasternak, J.J., 1998, Molecular Biotechnology: Principles andApplications, ASM Press, Washington, DC.

Razadan, M.K., 1993, An introduction to Plant Culture, Oxford & IBH Pub., Co., NewDelhi, India.

Skill Enhancement Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Genomics	241/BOT/SEC201	01	00	02	01	00	01	02	05	20	05	20	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-2	Restoration Ecology	241/BOT/SEC302	01	00	02	01	00	01	02	05	20	05	20	50

Skill Enhancement Course

BOTANY: SEMESTER-II								
Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
SEC-01 2 credit	241/BOT/SEC201	Genomics	2	1 2	05 05	20 20	50	2 hrs.

Course Learning Outcomes (CLO)

1. The students get acquainted about the basic principles of DNA sequencing and evolution of DNA sequencing techniques.
2. Help the students to understand methods/techniques employed in proteome and genome analysis.
3. This course will enable the students to learn about the various databases utilize for the storage and analysis of proteome/genome information.
4. The students will learn about the various computational tools used for analysis of genome sequence data.

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	**Genome**: Completely sequenced prokaryotic and eukaryotic genomes; Mitochondrial and Chloroplast genomes. **Mapping of Genome**: Genetic mapping- using DNA markers and Linkage analysis; Physical mapping- restriction mapping, Fluorescent *in-situ* hybridization and Sequence Tagged Sites (STSs) mapping.	8
II	**Genome sequencing**: Chain termination and chemical degradation methods; Next generation sequencing (NGS)- Human Genome Project. **Understanding a Genome Sequence**: Gene location using 1.) ORF scanning, Automatic annotation, Homology searches and comparative genomics. 2.) Experimental techniques- northern hybridization, cDNA sequencing and RACE.	8
III	**Identification of a Gene Function**: Using computer analysis; Experimental analysis- gene inactivation and overexpression; Directed mutagenesis; Reporter genes and Immunocytochemistry. **Analysis of the Transcriptome**: Expressed Sequence Tags (ESTs); Serial analysis of gene expression (SAGE); Differential Display (DD); Representational Difference Analysis (RDA) and DNA Microarrays. **Proteome Analysis:** Using 2-D; Protein identification; Protein-DNA and Protein- Protein interactions and Biochips.	7
IV	**Biological Databases**: Introduction; Primary and Specialized Databases; Database Scheme; Database Annotation; Retrieval System; Nucleotide Databases; Protein Databases; Genomic Databases and Resources; Gene Databases and Resources; Transcriptome Databases; Mutation Databases; Mitochondrial Databases and Resources.	7
	Practical List: 1. Use of SNP databases at NCBI and other sites 2. Use of OMIM database 3. Detection of Open Reading Frames using ORF Finder 4. Proteomics 2D PAGE database 5. Software for Protein localization. 6. Software for protein secondary sequencing prediction 7. Hydropathy plots 8. Native PAGE 9. SDS-PAGE	

Learning Resources

1. Birren B, Green ED, Klapholz S, Myers RM and Roskams J (1997) Genome Analysis, CSHL Press.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Brown TA (2002) Genomes 2, Wiley-Liss, New York
4. Brown TA (2007) Genomes 3, Garland Science Publishing New York, London.
5. Chawla HS (2009) Introduction to Plant Biotechnology (3rd Ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Dale JW, Schantz MV and Plant N (2012) From Genes to Genomes (3rd Ed.), John Wiley and Sons, Ltd. UK.
7. Dawson, MT, Powell R and L Gannon F (1996) Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK. DNA Amplification, Stockton Press, New York, USA.
8. Glick B and Pasternak JJ (2003), Molecular Biotechnology (3rd Ed), ASM Press, Washington.
9. Hartl DL and Ruvolo M (2011) Genetics- Analysis of Genes and Genomes (8th Ed.), Jones and Bartlett Publishers, Inc., USA.
10. Hunt SP and Livesey FJ (2000) Functional Genomics, Oxford University Press, New York. London.
11. Lewin B (2005) Genes VIII, Oxford University Press, Oxford, UK.

BOTANY: SEMESTER-III								
Course Code	Course ID	Course Title	Credit	Contact Hours/Week	Internal Assessment marks	End Term Marks	Max. Marks	Exam Duration
SEC-02 2 credit	241/BOT/SEC302	Restoration Ecology	2	1 2	05 05	20 20	50	2 hrs.

Course Learning Outcomes (CLO)

1. Describe the ecological, economic and social factors that lead to ecosystem degradation
2. Evaluate and select appropriate ecological restoration techniques for different types of ecosystems
3. Design ecological restoration projects and identify appropriate methods to monitor and evaluate the restoration practices
4. Undertake collaborative programmes to understand and solve ecological restoration problems

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	**Fundamentals of Restoration Ecology:** Definition and history of restoration ecology, Principles of restoration ecology, Restoration process: planning, implementation, and monitoring; Ecosystem services and the importance of restoration ecology; Challenges and limitations of restoration ecology; Case studies in restoration ecology; Ethics and values in restoration ecology; Restoration ecology and environmental policy	8
II	**Ecological Foundations for Restoration Ecology:** Role of ecological concepts in restoration ecology: ecological succession. Biodiversity, ecological interactions, and habitat fragmentation and ecosystems; Climate change and its impact on restoration ecology, Invasive species and their role in ecosystem degradation and restoration, Ecological thresholds, and their relevance to restoration ecology	8
III	**Techniques and Tools for Restoration Ecology:** Ecological site assessment and inventory, Restoration planning and design, Techniques for soil and water conservation in restoration ecology, Seed collection, propagation, and planting techniques for restoration, Wildlife management in restoration ecology, Restoring aquatic ecosystems: techniques and challenges, Biomimicry and ecological engineering in restoration ecology. Evaluating and monitoring restoration outcomes	7
IV	**Ecosystem Restoration:** Restoration of: grasslands, forests, wetlands, agricultural and urban landscapes, mining and industrial sites; Restoration of ecosystem services in aquatic ecosystems	7
	Practical List: 1. Field visits to assess the magnitude of degradation in selected ecosystems 2. Analyse the success of ecosystem restoration case studies in Haryana and identify the underlying principles 3. Assess the current status of a degraded ecosystem and identify potential areas for restoration 4. Learn techniques for collecting and propagating native plant species for use in restoration projects 5. Design methods for reducing erosion and managing nutrient runoff in restored ecosystems 6. Examine techniques for planting and establishing native plant species in a restored ecosystem 7. Evaluate methods for assessing and managing wildlife habitat in a restored ecosystem. 8. Assess efficacy of different methods for monitoring and evaluating restoration outcomes in a restored ecosystem. 9. Learn techniques for managing invasive species in a restored ecosystem 13-14. Design and implement a restoration plan for selected degraded ecosystems (terrestrial and aquatic) to improve the quality of habitat	

Learning Resources

Clewell, A. F., & Aronson, J. (Eds.). (2013). Ecological restoration: Principles, values, and structure of an emerging profession (2nd ed.). Island Press.
Erickson, A. L., Ryan, C. M., & Jones, T. A. (Eds.). (2021). The science of ecological restoration: Creating resilience in a changing world. Island Press.
Hobbs, R. J., & Suding, K. N. (2018). New models for ecosystem dynamics and restoration. CRC Press.
Palmer, M. A. (2016). Restoration: The science of restoring ecosystems and the human spirit. Island Press.
Temperton, V. M., Hobbs, R. J., Nuttle, T., Halle, S., & Tonev, C. (Eds.). (2020). Novel ecosystems: Intervening in the new ecological world order. John Wiley & Sons.
Yaffee, S. L., & Wondolleck, J. M. (2019). Ecosystem management in the United States: An assessment of current experience. Routledge.

Value Added Course from the department for pool of the Courses in the University

(All the departments will offer value added course for the students of same or different departments)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-1	Plants for human welfare	241/BOT/VA101	02	00	00	02	00	00	02	15	35	00	00	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-2	Mushroom cultivation technology	241/BOT/VA302	02	00	00	02	00	00	02	15	35	00	00	50

Value Added Course

BOTANY: SEMESTER-I								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
VAC-01 **2 credit**	**241/BOT/VA101**	**Plants for Human Welfare**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**

Course Learning Outcomes (CLO)

1. Explain the origin of agriculture and centres of origin of various crops
2. Identify the plant sources of foods, modern and traditional medicines, spices, oil, fibres, dyes, gum and timbers.
3. Learn about plant sources of psychoactive compounds, ornamental plants and identification of common food adulterants

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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	**Plants and Civilization:** Origin of agriculture **Origin crop plants:** Idea about centre of origin of common crop plants **Minor Cereals, Major cereals Pseudocereals and pulses** **Spices and condiments** (Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafetida, Coriander, Fennel, Fenugreek)	8
II	**Medicinal plants:** Importance of medicinal plants – role in human health care 24 **Traditional knowledge and utility of some common medicinal plants-***Sarpgandha, Isabgol, Vasaka, Neem, Bhiringraj, Amla, Harrad, Bahera, Arjun, Punarnava, Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus* **Psychoactive plants – general account and classification**	8
III	**Nutritive and medicinal value of some fruits and vegetables** (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage) **Beverages** (Coffee, Tea, Chocolate, Cola) **Common ornamental plants** **Common food adulterants**	7
IV	**Common timber yielding plants and minor forest products** **General account of Fibers, dyes, tannins, gums and resins** **Insecticides from plants** Pyrethrum and Rotenone	7

Learning Resources

1. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
2. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
3. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
4. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
5. SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi
6. Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
7. Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

BOTANY: SEMESTER-III								
Course Code	**Course ID**	**Course Title**	**Credit**	**Contact Hours/Week**	**Internal Assessment marks**	**End Term Marks**	**Max. Marks**	**Exam Duration**
VAC-02 2 credits	**241/BOT/VA302**	**Mushroom Cultivation Technology**	**2**	**2**	**15**	**35**	**50**	**2 hrs.**

Course Learning Outcomes (CLO)

1. To impart knowledge about mushroom farming to the students.
2. To be knowledgeable of the preparations for culture.
3. To comprehend technology used in mushroom growing

Instructions for Paper-Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. 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 - scope of edible mushroom cultivation - Types of edible mushrooms available in India – Agaricusbisporus, Plerotus citrinopileatus and Volvariellavolvacea	8
II	Pure culture – preparation of medium (PDA and Oatmeal agar medium) sterilization – preparation of test tube slants to store mother culture – culturing of Pleurotus mycelium on petriplates, preparation of mother spawn in saline bottle and polypropylene bag and their multiplication.	8
III	Cultivation technology: Infrastructure: Sibstates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low-cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag, Mushroom bed preparation - paddy straw, sugarcane trash, #maize straw, banana leaves.	7
IV	Storage and nutrition: Short – term storage (Refrigeration – up to 24 hours) Long term Storage (Canning, pickles, papas), drying, storage in salt solutions. Nutrition – Proteins – amino acids, mineral elements nutrition – *Carbohydrates, Crude fibre content – Vitamins. Diseases of mushroom.	7

Learning Resources

1. Nita Bahl (1984 – 1988). Hand book of Mushrooms, II Edition, I & II. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi
2. Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No.88, Mysore Road, Bangalore – 560018.
3. Tewari and Pankaj K. (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. T. Lynch (2018). Mushroom cultivation: An illustrated guide to growing your own mushrooms at home. Quarry Books, III Ed.