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. session 2023-24(In phased manner)

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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							

FIFTH SEMESTER

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**5th**		
Name of the Course	**Economic Botany and Plant Biotechnology**		
Course Code	**B23-BOT-501**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**CC-5/MCC-9**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand origin, distribution, cultivationa and uses of cereals, millets, pulses, fibres and oil yielding crops. 2. Understand cultivationa and uses of spices, condiments, medicinal plants, rubber-yielding plants, beverages and timber yielding plants. 3. Get acquainted with concepts of tissue culture and tissue culture techniques including micro propagation, callus culture 4. Understand different strategies of genetic engineering in plants and its applications 5. *Understand lab techniques of tissue culture; get acquainted with equiments and instruments required for gene transfer techniques; culture media preparation; study of economically important plants.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5

THEORY

Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL

Max. Marks: 30 **Internal Assessment Marks: 10** **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	**Food Plants**: Introduction to Cereals and Millets; Origin, distribution, botanical description, brief idea of cultivation and uses of Rice, Wheat and Maize. Protein Crops (Pulses); Origin, distribution, botanical description, brief idea of cultivation and uses of Gram, Arhar, Peas.	11

	Introduction to Vegetables; Origin, distribution, botanical description, brief idea of cultivation and uses of Potato, Tomato, Onion. **Fibers:** Introduction to natural fibers; Origin, distribution, botanical description, brief idea of cultivation, processing and uses of Cotton, Jute and Flax. **Oil Yielding Crops:** Origin, distribution, botanical description, brief idea of cultivation and uses of Ground nut, Mustard and Coconut.	
II	**Spices and Condiments:** Introduction to spices and condiments; Morphology of plant part used, brief idea of cultivation and uses of Coriander, Black Pepper, Ginger, Turmeric and Cloves. **Medicinal Plants:** Brief idea of Cultivation, botanical features and medicinal importance of *Cinchona*, *Rauwolfia*, *Atropa*, Opium, *Cannabis*, Indian Gooseberry and *Withania*. **Beverages:** Botanical description and processing of Tea and Coffee. **Rubber:** Botanical description and processing of *Hevea* **Sugar:** Botanical description, cultivation and harvesting of Sugarcane: processing of Sugar. **Timber:** Note on important timber yielding plants.	12
III	**Plant Tissue Culture**: Concept, History, Scope and Applications: Totipotency Organogenesis Cryopreservation Types of culture: Seed, Embryo, callus, suspension, organs, Cell and protoplast culture Micro propagation/clonal propagation (different routes of multiplication-axillary bud proliferation, somatic embryogenesis, organogenesis), Synthetic seeds (a brief account) *In vitro* haploid production Androgenic methods: Anther culture, Microspore culture Ando genesis Significance and use of haploids Gynogenic haploids, factors effecting gynogenesis Somatic hybridisation, Cybrids, Somaclonal variations	11
IV	**Genetic Engineering in plants**: Introduction and applications Direct DNA transfer/Physical methods of gene transfer in plants - micro projectile bombardment, electroporation, liposome mediated, Calcium phosphate mediated etc. Restriction Endonucleases: Types and role; brief idea about cloning vectors- Ti plasmid, BAC, Lambda phage, cosmid, shuttle vector, eukaryotic vectors (YAC) Plant transformation by *Agrobacterium tumefaciens* and *A. rhizogenes*. Strategies for gene transfer to plant cells. Binary and co-integrate vectors.	11
V*	• Study of economically important plants: Wheat, Rice, Maize, Gram, Pea, Arhar, Black Pepper, Ginger, Clove, Tea, Coffee, Cotton, Groundnut, Coconut, Mustard and Sugarcane etc. • Study of economically important plants: Potato, Tomato, Onion, fiber-yielding and medicinal plants of the syllabus and different types of woods. • Collection and preparation of reports on various crops and economically important plants being cultivated/wildly available in your area. • Brief introduction to the components and working of the instruments-oven, autoclave, incubator, centrifuge, laminar air flow and spectrophotometer); Familiarization with basic equipments in tissue culture.	30

- Preparation of MS medium.
- To prepare the slants and petri plates for plant tissue culture.
- Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco/*Datura/Brassica* or other available plant
- Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
- Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.

Suggested Evaluation Methods

Internal Assessment:

➢ **Theory**

- Class Participation : 05
- Seminar/presentation/assignment/quiz/class test etc. : 05
- Mid-Term Exam : 10

➢ **Practical**

- Class Participation : NA
- Seminar Demonstration/Viva-voce/Lab records etc. : 10
- Mid-Term Exam : NA

End Term Examination

Theory: 50
Practical: 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Kocchar, S.L. 1998: Economic Botany in Tropics, 2nd edition, MacMillan India Ltd., New Delhi.
- Kocchar, S.L. 2016. Economic Botany: A Comprehensive Study, 5th Ed, Cambridge India.
- Sambamurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Textbook of Economic Botany, Wiley Eastern Ltd., New Delhi.
- Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill adapted by O.P. Sharma), Tata McGraw Hill Co. Ltd., New Delhi.
- Simpson, B.B. and Conner-Ogorzaly, M. 1986: Economic Botany- Plants in our World, McGraw Hill, New York.
- Singh, B.D. 2021. Biotechnology 4th Edition. Kalyani Publications
- Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Glick, B.R., Pasternak, J.J. 2003. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Stewart Jr. C.N. 2016. Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
- Trehan, K. 1990. Biotechnology, New Age Int. Pvt. Ltrd. New Delhi India.
- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. 2019. Prescott's Microbiology. 11th Edition. McGraw Hill International.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	5th		
Name of the Course	**Reproduction in HigherPlants**		
Course Code	**B23-BOT-502**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**MCC-10**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the structure of flower, microsporangium and process of pollen formation. 2. Get an idea of pollination mechanism, interaction of pollens and pistils and self-incompatibility. 3. Understand the structure of megasporangium, female gametophyte, mature embryo sac and process of double fertilization. 4. Understand the types of endosperms, process of embryogenesis and structure of dicot & monocot seeds. 5. *Understand types of ovules, embryo structure of developing seeds, embryo sac development, types of pollination and pollination mechanism		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Flower-a modified shoot; functions of various floral parts. Microsporangium, its wall and dehiscence mechanism. Microsporogenesis, pollen grains and its structure (pollen wall).	11
II	Pollination (types and agencies); pollen germination (microgametogenesis).	12

	Pollen-pistil interaction; self-incompatibility. Male gametophyte.	
III	Structure of megasporangium (ovule), its curvatures. Megasporogenesis and megagametogenesis. Female gametophyte (monosporic, bisporic and tetrasporic)- organization and ultrastructure of mature embryo sac. Double fertilization.	11
IV	Endosperm types and their biological importance. Embryogenesis in dicot and monocot; Polyembryony and apomixis. Structure of dicot and monocot seed. Fruit types; dispersal mechanisms in fruits and seeds.	11
V*	• Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Permanent Slides). • Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development • (Permanent slides/photographs). • Ultrastructure of mature egg apparatus cells through electron micrographs. • Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens). • Dissection of embryo/endosperm from developing seeds.	30

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination**
➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- B.M. Johri Editor (1984) Embryology of Angiosperms Springer Verlag
- Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Fageri, K. and Van der Pijl1979.The Principles of Pollination Ecology.Pergamon Press, Oxford.
- Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.
- King. J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge, U.K.
- P. Maheshwari (1950) An Introduction to the Embryology of Angiosperms McGraw Hill• Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.
- Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants.5th edition.W.R.Freeman and Co., Worth Publishers, New York.
- Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	5th		
Name of the Course	**Plant Biochemistry and Metabolism**		
Course Code	**B23-BOT-503**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-2**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Students will have a comprehensive understanding of biochemical foundations in plants. 2. Students will be able to understand biomolecule structure and properties. 3. Students will develop comprehensive knowledge about various metabolic processes occurring in plants. 4. Students will develop a comprehensive understanding of biomolecule turnover. 5*. Students will gain knowledge about the tools and techniques used for studying the biochemical and metabolic state of plants. This will be mainly done through estimation and detection of some important metabolites		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Biochemical Foundations: covalent and non-covalent bonds; hydrogen bond; Van der Waal's forces; Structure and properties of water; pH and buffer (inorganic and organic); Handerson-Hasselbalch equation; Isoelectric point.		11
II	Structure, classification and brief concepts of nucleic acids, proteins, carbohydrates and lipids; enzymes and enzyme kinetics; enzyme regulation; mechanism of enzyme catalysis; isozymes.		12

III	Biosynthesis, mechanism of action and uses of brassinosteroids, strigolactones, jasmonates and salicylic acid. Nucleotide biosynthesis and degradation.	11
IV	Secondary metabolites and their roles: terpenes, phenols and nitrogenous compounds; nitrate and ammonium assimilation. Amino acid biosynthesis; lipid biosynthesis, α and β-oxidation.	11
V*	• Qualitative test for reducing and non-reducing sugars. • Qualitative test for proteins. • Qualitative test for oils and fats. • Qualitative test for some common secondary metabolites. • Demonstration/Estimation of catalase activity. • Estimation of free fatty acid by titrimetric method. • Estimation of cell sap chloride ion by titrimetric method. • Estimation of ascorbic acid by titrimetric method	30

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination**
➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry* (8th ed.). W.H. Freeman.
- Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry* (5th ed.). John Wiley & Sons.
- Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry and Molecular Biology of Plants* (2nd ed.). Wiley-Blackwell.
- Berg, J.M., Stryer, L., Tymoczko, J.L. and Gatto, G.J. (2023) *Biochemistry* (10th ed.). WH Freeman.
- Heldt, H.W. (2021). *Plant Biochemistry*. (5th ed.). Elsevier Academic Press.
- Bowber, C., & Tobin, A. (2021). *Plant Biochemistry*. (2nd ed.). CRC Press.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	5th		
Name of the Course	**Modern Plant Systematics**		
Course Code	**B23-BOT-504**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-2**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to 1. Students will have a comprehensive understanding of Plant Taxonomy. 2. Students will be able to understand Plant identification tools 3. Students will develop comprehensive knowledge about taxonomical evidences. 4. Students will develop a comprehensive understanding of Role of APG and economic value of various plant families. 5*. Students will gain knowledge about the tools, techniques, evidences, various system of classification used for the identification of plants.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Aims, principles and practices in taxonomy. Botanical Nomenclature: Brief history, Scientific names, ICN, Principles, typification, Principle of priority, author citation, effective and valid publication, rank of taxa; Floras, monographs, websites. Herbarium and botanical gardens, their role in teaching, research and conservation, Journals; Keys: Single access and Multi-access, important herbaria and botanic gardens of the World. Botanical Survey of India.	11
II	Introduction to Plant systematic; Plant Classification, Nomenclature:	12

	Evidences from palynology, Cytology, Phytochemistry, Embryology, Morphology, Anatomy, and molecular data, Identification of phytochemicals present in plants.	
III	Major contributions of Theophrastus, Linnaeus, de Candolle, Bessey, Hutchinson, Engler and Prantles, Takhtajan and Cronquist; Types of classification: Artificial; Natural and Phylogenetic; Angiosperm Phylogeny Group (APG I, II, III, IV) classification.	11
IV	Systematic study and economic importance of the following families: Fabaceae, Euphobiaceae, Cucurbitaceae, Malvaceae, Rutaceae, Annonaceae, Brassicaceae, Ranunculaceae & Poaceae; Numerical taxonomy: Characters; Variations; OTUs, character weighting and coding; Phenograms, cladograms (definitions and differences).	11
V*	• Description of specimens from locally available representative families. • Identification of plant specimens using floras and identification keys. • Preparation of identification keys for at least 10 specimens based on morphological features. • Study of herbarium specimens of different families covered in theory course. • Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant. • Use of palynological, chemical methods in taxonomy.	30

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination**
➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Cronquist, A. 1981. An *Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.
- Cronquist, A. 1988. *The Evolution and Classification of Flowering Plants* (2nd ed.) Allen Press, U.S.A.
- Hickey, M. and King, C. 2000. *The Cambridge Illustrated Glossary of Botanical Terms*. Cambridge University Press, UK.
- Hutchinson, J. 1959. *Families of Flowering plants*. Clarendon Press, Oxford.
- Jain S.K. and Rao R.R. 1976. *Handbook of Field and Herbarium Methods*. Today and Tomorrow Publishers, New Delhi.
- Lawrence, G. H. M. 1951. *Taxonomy of Vascular Plants*.Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
- Mabberly, T. J. 2009. *The Plant Book* 2nd ed. Cambridge University Press, Cambridge.

- Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998. A *Handbook of Taxonomic Training*. DST, New Delhi
- Radford A.E. 1986. *Fundamentals of Plant Systematics*. Harper and Row N Y.
- Simpson, M.G. 2010. *Plant Systematics*. Elsevier, Amsterdam.
- Singh, Gurcharan. 2010. *Plant Systematics: An Integrated approach*. 3rd edition. Science Publishers Inc., New Hampshire, USA.
- Singh, Gurcharan. 2012. Plant *Systematics: Theory and Practice*. Completely revised and enlarged 3rdedition. Oxford & IBH, New Delhi.
- Stuessy, Tod F. 2009. *Plant Taxonomy: The Systematic Evaluation of Comparative Data*. Second edition. Columbia University Press.

Session: 2025-26

Part A - Introduction

Subject	**BOTANY**
Semester	**5th**
Name of the Course	**Natural Plant Products**
Course Code	**B23-BOT-505**
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-3**
Level of the course (As per Annexure-I)	300-399
Pre-requisite for the course (if any)	
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Help students to gain knowledge about structure, production, and types of natural plant products. 2. Students will understand wide range of applications including culinary, medicinal, cosmetic, nutritional uses of herbal products. 3. Students will be acquainted with various histochemical tests for screening of different natural plant products. 4. Students will get an insight how natural plant products are important for drug discovery and challenges faced by scientists in recent scenario. 5*. Students will gain knowledge about importance of herbal medicinal plants and theircollection, develop skills in preparation of crude herbal extracts, detect drug adulteration andpropagation methods for conservation of plants.

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

THEORY

Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL

Max. Marks: 30 **Internal Assessment Marks: 10** **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	An overview of secondary metabolism and biosynthesis of natural products: The shikimate pathway for synthesis of phenylpropanoids and aromatic amino acids; The mevalonate and methylerythritol phosphate pathways for synthesis of terpenoids and steroids; The	11

	acetate pathway for synthesis of polyketides and fatty acids; Factors affecting synthesis of secondary metabolites	
II	Structure elucidation of natural products: General strategies for structure elucidation of natural products with few examples; Phytochemical screening and histochemical tests for alkaloids, saponins, cardenolides, flavonoids, leucoanthocyanidins, tannins, polyphenols, anthraquinones, cyanogenic glycosides, volatile oils in plant extracts. Important therapeutic classes: antimicrobial, antidiabetics, hepatoprotectives, immunomodulators, anti-cancer.	12
III	Herbal cosmetics: Importance of herbals as shampoos (soapnut), conditioners and coloring agents (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver); Flavouring agents from plants; Utilization of aromatic plants and derived products (sandalwood oil, mentha oil, lemon grass oil, eucalyptus oil); Nutraceuticals and Health Foods: Classification of Nutraceuticals; Sources and uses of health foods; Chamomile, Corn oil, Fenugreek, Ferverfew, Garlic, Ginseng, Ginkgo, Honey etc.	11
IV	Role of Natural Products (NP) in Drug Discovery: Case studies of taxol, artemisinin, etc.; Challenges associated with NP drug discovery; Multidisciplinary approach to natural products drug discovery using innovative technologies; Quality control of herbal drugs as per WHO, AYUSH; Conservation and sustainable use of medicinal plants; in-situ and ex-situ conservation methods. Centres for conservation of medicinal plants – CIMAP (Central institute of medicinal and aromatic plants) and FRLHT (Foundation for revitalization of local health traditions); TKDL (Traditional Knowledge Digital Library)	11
V*	• Collection of locally used ethanobotanicals and preparation of herbarium • To study the propagation and nursery techniques of medicinal and aromatic plants • Preparation of crude herbal extract • Microscopic evaluation and chemical tests (Metanil yellow test and chalk powder test). • To detect adulteration of turmeric powder. • Preparation of herbal formulation for common cold • Detection of alkaloids (Datura / Sadafuli / Tirphal), flavonoids (Green Tea / Onion) and • Saponins (Karando / Godekashtha) or from other suitable plant materials.	30

Suggested Evaluation Methods

Internal Assessment: **➢Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 **➢Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Medicinal Natural Products: A Biosynthetic Approach, 3rd Edition, Paul M. Dewick, 2009, Wiley.
- From Biosynthesis to Total Synthesis: Strategies and Tactics for Natural Products, Alexandros L. Zografos, 2016, Wiley.
- Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery, Christopher T Walsh and Yi Tang, 2017, RSC.
- Trease and Evan's Pharmacognosy, 16th Edition, W.C. Evans, 2009, Elsevier.
- Influence of abiotic stress signals on secondary metabolites in plants. Plant signaling&behavior. Akula R, Ravishankar GA, 2011, 6(11), 1720-31.
- Natural Products and Drug Discovery An Integrated Approach, 1st edition, Subhash C. Mandal, Vivekananda Mandal and Tetsuya Konishi, 2018, Academic Press is an imprint of Elsevier.
- Integrated Approach to Nature as Source of New Drug Lead, Open access peer-reviewed chapter, In book: Molecular Insight of Drug Design, Seema Kohli, 2018, Intechopen.
- Lead Generation Approaches in Drug Discovery, Chapter 7: Role of Natural Products in Drug Discovery, Hugo Lachance, Stefan Wetzel, Herbert Waldmann, 2010, Wiley online library.
- Khandelwal, K.R. 2002. Practical Pharmacognosy: Techniques and Experiments. 9th edition. Nirali Prakashan, Pune.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**5th**		
Name of the Course	**Plants and Medicines**		
Course Code	**B23-BOT-506**		
Course Type: (CC/MCC MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-3**		
Level of the course (As per Annexure-1)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Student will get understanding of traditional and present medicinal systems as well as herbal industries. 2. Student will have a comprehensive understanding of propagation methods of plants and significance of green house technologies. 3. Students will get knowledge of various medicinal plants and their significant contribution to pharma industry. 4. Students will acquire knowledge about the principles of conservation laws; conceptual understanding of classifications used by IUCN and understanding of international legislation. 5. *Get acquainted with distribution of medicinal plants, methods of vegetative propagation and plant-based medicines.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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 to medicinal plants and scope of medicinal botany.		11

	Brief account of traditional medicinal systems- Ayurveda, siddha, unani, and homeopathy. Medicinal plants- past and present status in world and India. Demand and supply of medicinal plants. Herbal industries.	
II	Agro and cultivation techniques i.e., nursery raising, cultivation, inter culture and fertilizers, pests and diseases, harvesting and profits for some economically important medicinal plants- Aloe vera, *Withaniasomnifera, Rauvolfia Serpentina.* Green house technology- principles, methodology and applications. Propagation of medicinal plants through cuttings, rhizomes, bulbs and seeds.	12
III	Important medicinal plants of India with their systematics, geographical distribution and uses, morphology, active principles and medicinal value- *Glycyrrhiza, Cinchona, Belladona,* Aloe, *Rauvolfia,* Neem, Ashwagandha, Amla, Bahera, Bhringraj. Plant's secondary metabolite of medicinal importance- Alkaloid, Glycosides and Sterols (brief account).	11
IV	Contribution of medicinal plants to alternative and modern medicine. Concept of IUCN, red list criteria, threat categories, concept of endemism, threatened and endemic medicinal plants. Conservation, in-situ (national parks, sanctuaries, biosphere reserves and sacred grooves), ex-situ (botanical gardens, ethno medicinal herbal gardens and seed banks). Conservation through tissue culture and cryopreservation. Wildlife act. National medicinal plant board and state medicinal plant board- objectives and functions. Future of medicinal plants.	11
V*	• To study different methods of vegetative propagation. • Identification and description of various medicinal plants. • To test the presence of various secondary metabolite in extracts of various medicinal plants. • To study various plant-based medicines. • Preparation of survey/collection report.	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Indian Medicinal Plants by P.C. Trivedi (2009).
- Medicinal Plants of Uttrakhand by C.P. Kala (2010).
- Medicinal Plants of Indian Himalaya by S.S. Samant and U. Dhar.
- Recent progress in Medicinal Plants Vol. 12, Globalization of Herbal Health by A.K. Sharma

(2006).

- Handbook of Ayurvedic Medicinal Plants by L. D. Kapoor (2005)
- Indian Medicinal Plants (vol. 1-4) by K.R. Kirtikar and B.D. Basu (2006).
- IUCN Red List Categories by IUCN.
- Medicinal Plant Cultivation: A Scientific Approach by S.S. Purohit (2004).
- Medicinal Plants: Conservation, Cultivation & utilization by A.K. Chopra, Daya publishing house, Trinagar, Delhi (2007).

Sixth Semester

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**Plant Anatomy and Embryology**		
Course Code	**B23-BOT-601**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**CC-6/MCC-11**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Describe and differentiate various categories of plant tissues, their functions and anatomical features of plant parts and their applications in various branches of botany; general mechanism of secondary growth in plants. 2. Develop their competency on understanding morphology and anatomy of leaves and root system of plants. 3. Understand self incompatibility, pollen-pistil interaction, microsporogenesis, pollination and palynology. 4. Understand concepts of megasporogenesis, double fertilisation, embryo development, fruit types, embryo culture and anther culture. 5. *Get acquainted with practical aspects of permanent tisuues, types of ovules, pollination mechanism and embryo development.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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, objective and scope of plant anatomy, meristematic andpermanent tissues, complex tissues, plant secretory tissues, mechanicaltissues and their distribution. Tissue systems (epidermal, ground and vascular), cambium, types of vascular bundles, vascular skeleton at nodes and internodes.	11
II	SAM anatomy, theories of histological organization of shoot apex, anatomy of monocot and dicot stem, secondary growth, anomaloussecondary growth (Dracaena, Boerhaavia, and Mirabilis). Phyllotaxy, anatomy of dicot and monocot leaf. Kranz anatomy. RAM anatomy, types of roots in monocots and dicots, quiescent centre, root-stem transition, secondary growth in dicot root, structuralmodifications in respiratory (Rhizophora) storage (Beta) and epiphytic(Vanda) roots.	12
III	History and scope of plant embryology, flower-a modified shoot, floralorgans. Microsporangium, its wall and dehiscence mechanism, microsporogenesis, pollen grains and its structure (pollen wall), scopeof palynology. Pollen-pistil interaction, self-incompatibility. Pollination types and agencies, pollen germination and development.	11
IV	Structure of megasporangium, megasporogenesis and megagametogenesis, types of female gametophyte. Double fertilization, endosperm types, embryogenesis in dicots andmonocots; polyembryony, apomixis. Structure of dicot and monocot seed, dispersal mechanisms in fruitsand seeds.	11
V*	• Study of meristems through permanent slides and photographs. • Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs) • Preparation/observation of permanent Slides of Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Boerhaavia*. • Preparation/observation of permanent Slides of Root: Monocot: *Zea mays*; Dicot: *Helianthus*. • Leaf: Dicot and Monocot leaf (Permanent slides). • Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides). • Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Permanent slides). • Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs). • Ultrastructure of mature egg apparatus cells through electron micrographs (images/photographs). • Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens). • Dissection of embryo/endosperm from developing seeds.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Bryan G. Bowes 1999. A Colour Atlas of Plant Structure. Manson Publishing
- Cutter, E.G. 1969. Plant Anatomy Part-I, Cells and Tissues. Edward Arnold, London.
- Cutter, E.G. 1971. Plant Anatomy: Experiment and Interpretation. Part-II Organs, Edward Arnold London.
- Esau, K. 1977. Anatomy of Seed Plants, 2nd Edition. John Wiley & Sons, New York.
- Fahn, A. 1974. Plant Anatomy, 2nd Edition. Pergamon Press, Oxford.
- Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.
- King, J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge, U.K.
- Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing Company Inc., Menlo Park, California, USA.
- Pandey, B.P. 2012. Plant Anatomy. S. Chand & Co. Publisher
- Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants. 5th edition.W.R. Freeman and Co., Worth Publishers, New York.
- Sharma MK. Plant Structure (An Introduction To Plant Anatomy) JBC Press
- William C. Dickison 2015. Integrative Plant Anatomy. Academic Press
- Johri, B.M. (Ed.) 1984. Embryology of Angiosperms. Springer Verlag
- Bhojwani, S.S. & Bhatnagar, S.P. 2011. Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Fagen, K and Van der Pijl 1979.The Principles of Pollination Ecology.Pergamon Press, Oxford.
- Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rd Edition. Prentice Hall of India Pvt. Ltd. New Delhi.
- King, J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge, U.K.
- Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms. McGraw Hill
- Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.
- Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants. 5th Edition. W.R.Freeman and Co., Worth Publishers, New York.
- Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**Plant Pathology**		
Course Code	**B23-BOT-602**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC-12		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the fundamental basis of plant-microbe interaction that leads to plant diseasesand measures to be adopted for plant health management. 2. Help the students to properly understand pathogen behavior, their interaction with host to develop resistant cultivars. 3. To understand disease cycle and management of microbial diseases. 4. To help the students for isolation, inoculation, culturing, preservation, maintenance of microorganisms and handling of different instruments. 5*. Students will be acquainted with methods for cultivation, preservation, and maintenance of microbial cultures; different sterilization methods; skills in isolation and handling of microbes.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5

THEORY

Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL

Max. Marks: 30 **Internal Assessment Marks: 10** **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	Disease concept; symptoms, etiology and causal complex; primary and secondary inoculation; infection, pathogenecity and pathogenesis; necrotroph and biotroph; Koch's postulates; endemic, epidemic, pandemic and sporadic disease; disease triangle; disease	11

	cycle (monocyclic, polycyclic and polyetic).	
II	Mechanism of infection, role ofenvironment and host nutrition on disease development, defence mechanism with special reference to phytoalexin, Local acquired resistance (LAR), Induced systemic resistance (ISR) and systemic acquired resistance (SAR); RNAi as a defence mechanism; Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecularbasis for resistance.	12
III	Symptoms, causal organism, disease cycle and control measures of: late and early blight of potato, brown spot of rice, black stem rust of wheat, red rot of sugarcane, loose smut of wheat, downy mildew of grapes, apple scab, karnal bunt of wheat, green ear disease of bajra (Sorghum), tikka disease of ground nut, bacterial blight of rice, tungro disease of rice, leaf curl of tomato, root knot.	11
IV	Plant disease management-quarantine, chemical, biological and integrated management; applications of biotechnology in plant pathology; recombinant DNA technology, use of monoclonal antibodies in plant pathology; Concepts in epidemiology, Monocyclic and polycyclic pathogens; Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases.	11
V*	• Working and handling of equipment used in microbiology laboratory. • Preparation of liquid and solid (plates and slants) culture media – Nutrient Broth, NutrientAgar and Potato Dextrose Agar for growth of microbes by steam sterilization • Demonstration of Koch's postulates for a bacterial/fungal pathogen. • To study anatomy/mounting of spores of fungus infected specimens (rust, blight and rot). • To study Gram staining of bacteria. • Isolation of microorganisms from soil; study of colony characteristics of bacteria and fungi; preparation of pure culture of bacteria by streak plate method to obtain isolated colonies; streaking on slants. • Testing quality of milk by methylene blue dye reduction test.	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation : 05 • Seminar presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
- Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.

- Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
- Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH. New Delhi.
- Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH. NewDelhi.
- Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and EvolvingBiotechnology. Oxford & IBH, New Delhi.
- Chakravarti BP. 2005. Methods of Bacterial Plant Pathology. Agrotech, Udaipur.
- Jayaraman J & Verma JP. 2002. Fundamentals of Plant Bacteriology. Kalyani Publ., Ludhiana.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**Agroforestry**		
Course Code	**B23-BOT-603**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-4**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Students will have a comprehensive understanding of concepts of agroforestry and geographical distribution of crop plants. 2. Students will be able to learn about sustainable agriculture parameters. 3. Students will develop comprehensive knowledge about the cultivation of fruits crops. 4. Students will develop a comprehensive understanding of forest management. 5*. Students will gain knowledge about the tools and techniques used for agroforestry and forest management.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Principles of crop ecology and crop adaptation, climate shift and its ecological implications, Argo-ecological regions in India, Geographical distribution of crop plants, Greenhouse effect, Climatic factors and their effect on plant processes and crop productivity, Role of GIS and GPS in agriculture. Basis of classification of agroforestry systems and principles, indigenous vs. exotic, intraspecific variations, crown architecture of tropical/temperate trees; organizational set up of agricultural research, education and extension in India.	11
II	Essential plant nutrients and their deficiency symptoms, concept of essentiality of plant nutrients, Indicators of soil fertility and productivity; Sustainable agriculture: parameters and indicators, Conservation agriculture, safe disposal of Agri-industrial waste for crop production, Argo-forestry.	11
III	Layout and establishment of orchards: Pruning and training; propagation, climatic requirement and cultivation of fruits like mango, banana, citrus, guava, grape, pineapple, papaya, apple, pear, peach and plum; cultivation of plantation crops like coconut and cashew nut and spices like black pepper, coriander, turmeric, important physiological disorders.	12
IV	Forest: Importance, types, classification, forest management, silvicultural practices, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, silvopastoral systems tree diseases, wood decay and discoloration, tree pests, integrated pest and disease management, biological and chemical wood preservation, forest conservation, Indian forest policies, Indian forest act, forest engineering, forest economics, joint forest management and tribology.	11
V*	• Study of quantification interactions from tree–Crop Yield Performance • Study of quantification from tree–Crop Interaction Models • Study of allelopathic Interference from mulches of plant residue • Study of allelopathic Interference from leaching and root exudation • Study of microclimate modifications in agroforestry systems • Study of effect of different plant mixtures in agroforestry systems. • Study of tree-soil-crop interactions in agroforestry systems. • Study of estimation of Land Equivalent Ratio of agroforestry systems. • Study of estimation of competition indices in agroforestry systems. • Study of measurement and interpretation of light interception in agroforestry systems • Study of soil water and drainage measurement in agroforestry systems. • Study of transpiration measurement in agroforestry systems. • Study of quantification of root distribution in agroforestry systems. • Study of use of line quantum sensor in agroforestry systems. • Study of use of SPAD chlorophyll meter in agroforestry systems	30

Suggested Evaluation Methods	End Term Examination
Internal Assessment: ➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.
- Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.
- Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.
- Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture Applied Forest Ecology*. John Wiley & Sons.
- Ram Parkash 1983. *Forest Surveying*. International Book Distr.
- Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.
- Huxley P. 1999. *Tropical Agroforestry*. Blackwell.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**Post-harvest Technology of Fruits & Vegetables**		
Course Code	**B23-BOT-604**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-4**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To acquire knowledge about basichorticultural techniques and simple technologies used in reducing post-harvest losses and add value to horticultural products. 2. To have knowledge of use of phytohormones & postharvest practices like handling of fruits and vegetables, their storage andpreservation. 3. To understand the marketing qualities of fruits and vegetables for export and local use. 4. To understand various factors that cause post-harvest damage and strategies/methods to minimize the loss. 5*. Students will gain knowledge about mechanism of ripening and maturity in differentfruits and vegetables; reasons for loss, marketing quality and packaging methods for saleof fruits and vegetables		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5

THEORY	
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL	
Max. Marks: 30 **Internal Assessment Marks: 10** **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	**Post-harvest technology of vegetable crops:** scope and importance of post-harvest management, causes of post-harvest loss, Methods of assessment of maturity, physiological and biochemical changes	11

	during maturity and ripening, enzymatic changes; ethylene evolution and management, change in texture; Influence of pre-harvest practices on shelf life and post-harvest quality.	
II	**Post-harvest technology of fruit crops:** scope and importance of post-harvest management, causes of post-harvest loss, Methods of assessment of maturity, physiological and biochemical changes during maturity and ripening, enzymatic changes; ethylene evolution and management, respiration, change in texture; Influence of pre-harvest practices on shelf life and post-harvest quality.	12
III	Climacteric and non-climacteric fruits and vegetables; harvesting methods and practices for specific market requirements; pre-cooling methods, grading, washing, wax coating, edible coating, packaging method and materials used; Maturity indices of fruits and vegetables; Factors responsible for deterioration of harvested fruits and vegetables; Artificial ripening of fruits and vegetables; Preparation of processed products of fruits and vegetables.	11
IV	Storage methods: cold storage, CA storage, zero energy cool chamber, hypobaric storage etc. Storage disorders: physical injury, chilling injury, post-harvest diseases and pests; principles of transport; food containers; food safety standards and export standards; Processing waste management; Importance of post-harvest management technology	11

V*	1. Determination of maturity of fruits and vegetables by different methods- visual, physical, and chemical. 2. Chemical analysis of fruits and vegetables at different stages of maturity and ripening 3. Chemical analysis of nutritive value of fresh and processed fruits and vegetables 4. To study microbial load on samples. 5. Sensory analysis of fruits and vegetables: identification of basic taste, odor, texture, color. 6. Study of different packaging materials and systems for fruits and vegetables. 7. To study respiration rate and ethylene production in different fruits and vegetables.	30

Suggested Evaluation Methods

Internal Assessment: **➢Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 **➢Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Mir, Shabir Ahmad, Manzoor Ahmad Shah, and Mohammad Maqbool Mir, eds. Postharvest Biology and Technology of Temperate Fruits. Cham: Springer International Publishing, 2018. http://dx.doi.org/10.1007/978-3-319-76843-4.
2. Valero, Daniel. Postharvest biology and technology for preserving fruit quality. Boca Raton, FL: Taylor & Francis Group, 2010.
3. Florkowski, Wojciech J. Postharvest handling: A systems approach. 2nd ed. Amsterdam: Elsevier/Academic Press, 2009.
4. Paliyath, Gopinadhan. Postharvest biology and technology of fruits, vegetables, and flowers. Ames, Iowa: Wiley-Blackwell, 2008.
5. Chattopadhya SK. 2007. Handling, transportation, and storage of fruits and vegetables Gene-Tech books, New Delhi.
6. Sudheer, K. P. Indira, V. 2007: Postharvest Technology of Horticultural Crops, New India Publishing, Delhi.
7. Verma, L. R & Joshi, V. K. 2000: Postharvest Technology of Fruits and Vegetables. Indus Publishing House, Delhi.
8. Ramaswamy, Hosahalli, G. Vijaya Raghavan, AmalenduChakraverty, and Arun Mujumdar, eds. Handbook of Postharvest Technology. CRC Press, 2003. http://dx.doi.org/10.1201/9780203911310.

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**GIS and Remote Sensing**		
Course Code	**B23-BOT-605**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-5**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Understand the history, development, and characteristics of various remote sensing satellites and their sensors. 2. Acquire skills in procuring and analyzing remote sensing data, ground truth collection, and digital photogrammetry. 3. Learn cartography basics, map projections, GPS system elements, and interpretation of IRS satellite images. 4. Grasp GIS concepts, integration with RS data, and applications in groundwater exploration, agriculture, and environmental assessment. 5*. Students will gain knowledge about the interpretation of biologically relevant data usingGIS and remote sensing.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5

THEORY	
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL	
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Remote sensing; history & development, satellites and their characteristics; LANDSAT; SPOT; IRS; IKONOS satellite series, Meteorological satellites; INSAT; NOAA; GOES, sensors; MSS; TM; LISS; WiFS; PAN, techniques and instruments for visual	12

	interpretation and interpretation keys.	
II	Remote sensing data products and their procurement; ground truth collection, display forms; computer printouts; thematic maps: dot density maps, digital photogrammetry; orthophotos, digital orthophotography, theory of orientation relationship between image and corresponding ground coordinates, collinearity and coplanarity of aerial photographs, aerial mosaics.	11
III	Cartography; nature and scope, relation between digital cartography, RS & GIS, map projection; azimuthal, cylindrical, conical and rectangular projection system, GPS system elements, classification and signals, interpretation of different resolution IRS satellite images; LISS III, PAN and WiFS.	11
IV	GIS; definition, concept and history, computer fundamentals, hardware and software requirements for GIS, integration of RS and GIS data, types of GIS modelling, remote sensing in ground water exploration, agriculture, agro-meteorology, soil erosion hazard assessment and forest density mapping.	11
V*	• Land use / land cover mapping • Identification of degraded lands • Land utilization mapping • Soil mapping • Crop estimation studies • Identification of forest species from aerial photographs • Vegetation mapping from satellite images • Digital image enhancements for vegetation/forest • NDVI analysis • Digital classification for forest cover mapping • Forest change detection studies	30

Suggested Evaluation Methods

Internal Assessment: **➢Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 **➢Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	**End Term Examination** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Campbell, J.B.2002: Introduction to Remote Sensing. Taylor Publications
- Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin
- Gupta, R.P., 1990: Remote Sensing Geology. Springer Verlag
- Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall.
- Anji Reddy, M. 2004: Geoinformatics for Environmental Management.B.S. Publications
- Mishra R.P and Ramesh A. 1989: Fundamentals of Cartography. Concept Publishing Company
- Nag P. and Kudrat M. 1998: Digital Remote Sensing. Concept Publication

Session: 2025-26			
Part A - Introduction			
Subject	**BOTANY**		
Semester	**6th**		
Name of the Course	**Evolutionary and Behavioural Biology**		
Course Code	**B23-BOT-606**		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	**DSE-5**		
Level of the course (As per Annexure-I)	300-399		
Pre-requisite for the course (if any)			
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Students will have a comprehensive understanding of concepts of evolution. 2. Students will be able to understand molecular basis of evolution. 3. Students will develop comprehensive knowledge about population genetics. 4. Students will develop a comprehensive understanding of behavioural biology. 5*. Students will gain knowledge about the tools and techniques used for studying evolutionary and behavioural biology.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5

THEORY	
Max. Marks: 70 **Internal Assessment Marks: 20** **End Term Exam Marks: 50**	**Time: 3 Hours**

PRACTICAL	
Max. Marks: 30 **Internal Assessment Marks: 10** **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	Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis; the evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multi cellular organisms; stages in plant evolution.	11
II	Approaches and methods in study of behaviour; proximate and ultimate causation; altruism and evolution, group selection, kin	12

	selection, reciprocal altruism; biological clocks; development of behaviour; use of space and territoriality; mating systems, parental investment and reproductive success; parental care.	
III	Concept of environment; biotic and abiotic interactions, concept of habitat and niche; characteristics of a population; population growth curves; r and K selection; concepts of species interactions.	11
IV	Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones; ecological succession and concept of climax; energy flow and mineral cycling (C, N, P); biogeographical zones of India; hotpots and Ramsar sites.	11
V*	• Study of convergence and divergence. • Construction of phylogenetic trees. • Study of floral-pollinator relationship. • Study of territoriality in animals. • Study of interaction between native and invasive plant species. • Study of interaction between native and invasive plant species. • Study of different seed dispersal mechanisms. • To measure pH, EC and TDS of different soil samples. • To measure pH, EC and TDS of different water samples. • Study of NTFPs in surrounding area. • To study density and abundance of plants by quadrate method. • To calculate biodiversity indices of herbaceous vegetations.	30

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination**
➢ **Theory** • Class Participation : 05 • Seminar/presentation/assignment/quiz/class test etc. : 05 • Mid-Term Exam : 10 ➢ **Practical** • Class Participation : NA • Seminar/Demonstration/Viva-voce/Lab records etc. : 10 • Mid-Term Exam : NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Hall, B.K., & Hallgrímsson, B. (2013). *Strickberger's Evolution* (5th ed.). Jones and Bartlett Publishers.
- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., & Killian, D. (2019). *Concepts of Genetics* (11th ed.). Pearson publishers.
- Russel, P.J. (2016). *iGenetics: A Molecular Approach* (3rd ed.). Pearson publishers.
- Snustad, D.P, & Simmons, M.J. (2015). *Principles of Genetics* (7th ed.). Wiley, Hoboken.
- Brown, T.A. (2011). *Introduction to Genetics: A Molecular Approach*. (1st ed.). Garland Science.
- Davies, N.B., Krebs, J.R., & West, S.A. (2012). An Introduction to Behavioural Ecology (4th ed.). Wiley-Blackwell.

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