

Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)



Department of Botany

**Scheme of Examination
For**

**B.Sc. Botany
(Semester I to VIII)**

Under Graduate Programmes
as per NEP 2020

**Curriculum and Credit Framework for Undergraduate Programmes
(Multiple Entry-Exit, Internships and Choice Based Credit System LOCF)
With effect from the session 2024-25 (in phased manner)**

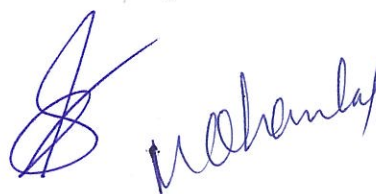
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07/8/2026

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DEPARTMENT OF BOTANY, CHAUDHARY BANSI LAL UNIVERSITY, BHIWANI
Scheme of Examination for Under-Graduate Programme
Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2024-25
(in phased manner)
Subject : Botany

SEMESTER-1									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
Scheme A & C	CC-1 MCC-1 4 credit	24UN-BOT-101	Diversity of Microbes, Algae, Fungi and Archegoniates	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme C only	MCC-2 4 credit	24UN-BOT-102	Conservation Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A	CC-M1 2 credit	24UN-BOT-103	Plant Diversity	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	3 hrs.
Scheme C only	CC-M1 4 credit	From Available CC-M1/ MCC-1 of 4 credits as per NEP							
Scheme A & C	MDC-1 3 credits	From available pool of Multidisciplinary Courses from a subject of different discipline as per NEP							
Scheme A & C	AEC-1 2 credit	From Available AEC-1 of two credits as per NEP							
	SEC-1 3 credit	From Available SEC-1 of three credits as per NEP							
	VAC-1 2 credit	From Available VAC-1 of two credits as per NEP							



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SEMESTER-2									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
Scheme A & C	CC-2 MCC-3 4 credit	24UN-BOT-201	Cell biology & Genetics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme C only	DSEC-2 4 credit	24UN- BOT-202	Floriculture	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A only	CC-M2 2 credit	24UN- BOT-203	Plants for Human Welfare	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	3 hrs.
Scheme C only	CC-M2 4 credit	From Available CC-M2/ MCC-2 of 4 credits as per NEP							
Scheme A & C	MDC-23 credits	From available pool of Multidisciplinary Courses from a subject of different discipline as per NEP							
Scheme A & C	AEC-2 2 credit	From Available AEC-2 of two credits as per NEP							
	SEC-2 3 credit	From Available SEC-2 of three credits as per NEP							
	VAC-2 2 credit	From Available VAC-2 of two credits as per NEP							
Internship of 4 credits of 4-6 weeks duration after 2 nd Semester									

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SEMESTER-3									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/Week	Internal marks	External Marks	Total Marks	Exam Duration
Scheme A, B & C	CC-3	24UN- BOT-301	Gymnosperms & Plant Anatomy	3	3	20	50	70	3 hrs.
	MCC-4 4 credit		Practical	1	2	10	20	30	3 hrs.
Scheme B & C	MCC-5	24UN- BOT-302	Ecology	3	3	20	50	70	3 hrs.
	4 credit		Practical	1	2	10	20	30	3 hrs.
Scheme A & C	CC-M3 4 credits	From Available CC-M3/MCC-3 of 4 credits as per NEP							
Scheme B only	CC-M3(V) 4 credits	From Available CC-M3(V) of 4 credits as per NEP							
Scheme A, B & C	MDC-3 3 credits	From available pool of Multidisciplinary Courses from a subject of different discipline as per NEP							
Scheme A, B & C	AEC-3 2 credit	From Available AEC-3 of two credits as per NEP							
	SEC-3 3 credit	From Available SEC-3 of three credits as per NEP							
Scheme C only	VAC-3 2 credits	From Available VAC-3 of two credits as per NEP							
Scheme B only	MCC-3	MCC-2 FROM SCHEME C OF FIRST SEMESTER							

SEMESTER-4

SEMESTER-4									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
Scheme A, B & C	CC-4 MCC-6 4 credit	24UN- BOT-401	Plant Systematics & Embryology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	MCC-7 4 credit	24UN- BOT-402	Plant Molecular Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	MCC-8 4 credit	24UN- BOT-403	Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	DSE-1 4 credit Select one option	24UN- BOT-404	Plant Tissue Culture	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		24UN- BOT-405	Bioethics, Biosafety and IPR	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A, B & C	CC-M4 (V) 4 credits	From Available CC-M4(V) of 4 credits as per NEP							
	AEC-4 2 credit	From Available AEC-3 of two credits as per NEP							
Scheme C only	VAC-4 2 credits	From Available VAC-4 of two credits as per NEP							
Scheme A & B	VAC-3 2 credits	From Available VAC-3 of two credits as per NEP							
Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)									

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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	24UN-BOT-501	Plant Physiology & Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	MCC-10 4 credit	24UN-BOT-502	Reproductive Biology in Plants	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	DSE-2 4 credit Select one Option	24UN-BOT-503	Evolutionary Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		24UN-BOT-504	Modern Plant Systematics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme B & C	DSE-3 4 credit Select one Option	24UN-BOT-505	Natural Plant Products	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
		24UN-BOT-506	Plants and Medicines	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 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 4 th semester							

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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	24UN-BOT-601	Economic Botany & Biotechnology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
SchemeB & C	MCC-12 4 credit	24UN-BOT-602	Plant Pathology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
SchemeB & C	DSE-4 4 credit	24UN-BOT-603	Agroforestry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
	Select one Option	24UN-BOT-604	Post-harvest Technology of Fruits & Vegetables	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
			Plant stress physiology	3	3	20	50	70	3 hrs.
SchemeB & C	DSE-5 4 credit Select one Option	24UN-BOT-605	Practical	1	2	10	20	30	3 hrs.
			Plant propagation	3	3	20	50	70	3 hrs.
		24UN-BOT-606	Practical	1	2	10	20	30	3 hrs.
			Plant stress physiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	3 hrs.
Scheme A only	CC-M6 4 credits	From Available CC-M6 of 4 credits as per NEP							
SchemeA only	CC-M7(V) 4 credits	From Available CC-M7(V) of 4 credits as per NEP							
SchemeB only	CC-M5(V) 4 credits	From Available CC-M5(V) of 4 credits as per NEP							
SchemeC only	CC-M6(V) 4 credits	From Available CC-M6(V) of 4 credits as per NEP							
SchemeC only	SEC-4 2 credit	From Available SEC-4 of two credits as per NEP							

SEMESTER-7 (FOR HONOURS/HONOURS WITH RESEARCH IN BOTANY)

Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hour s/ Wee k	Intern al marks	Exter nal Marks	Tota l Mar ks	Exam Durati on
for Honours in Botany/Honours with Research in Botany (For Scheme B & C)	CC-H1 4 credit	24UN-BOT-701	Algae & Fungi	4	4	30	70	100	3 hrs.
	CC-H2 4 credit	24UN-BOT-702	Bryophytes & Pteridophytes	4	4	30	70	100	3 hrs.
	CC-H3 4 credit	24UN-BOT-703	Cytogenetics & Plant Breeding	4	4	30	70	100	3 hrs.
	DSE-H1 4 credit	24UN-BOT-704	Plant biotechnology	4	4	30	70	100	3 hrs.
	Select one Option	24UN-BOT-705	Basics of Genomics and Proteomics	4	4	30	70	100	3 hrs.
		24UN-BOT-706	Computational Biology	4	4	30	70	100	3 hrs.
	PC-H1 4 credit	24UN-BOT-707	Practical Based on 24UN-BOT-701 TO 704/705/706	4	8	30	70	100	6 hrs.
	CC-HM1 4 credit	From Available Minor of 4 credits as per NEP							

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SEMESTER-8 (FOR HONOURS IN BOTANY)									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours / Week	Internal marks	External Marks s	Total Mark s	Exam Durati on
Honours in Botany (For Scheme B & C)	CC-H4 4 credit	24UN- BOT-801	Biostatistics	4	4	30	70	100	3 hrs.
	CC-H5 4 credit	24UN- BOT-802	Natural Resources & Biodiversity	4	4	30	70	100	3 hrs.
	CC-H6 4 credit	24UN- BOT- 803	Gymnosperm & Ethanobotany	4	4	30	70	100	3 hrs.
	DSE-H2 4 credit Select one option	24UN- BOT-804	Molecular Genetics	4	4	30	70	100	3 hrs.
		24UN- BOT-805	Plant Morphogenesis	4	4	30	70	100	3 hrs.
	PC-H2 4 credit	24UN- BOT-806	Practical Based on 24UN-BOT-801 TO 804/805	4	8	30	70	100	6 hrs.
	CC-HM2 4 credit	From Available Minor of 4 credits as per NEP							
OR SEMESTER-8 (FOR HONOURS WITH RESEARCH IN BOTANY)									
Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Mar ks	Exam Duration
Honours with Research in Botany (For Scheme B & C)	CC-H4 4 credit	24UN- BOT- 801	Biostatistics	4	4	30	70	100	3 hrs.
	CC-H5 4 credit	24UN- BOT- 802	Natural Resources & Biodiversity	4	4	30	70	100	3 hrs.
	Project/Di ssert ation 12 credit	24UN- BOT- 807	Project/ Dissertation	8+4	-	-	-	-	-
	CC- HM2 4 credit	From Available Minor of 4 credits as per NEP							

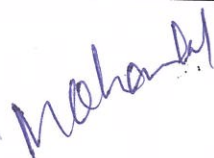
Pool of MDC, VAC, SEC and VOC Courses for scheme A, B, C & D in the subject of Botany to be offered to the University
Pool

Course Type Total Credits	SEM	Course Code	Nomenclature of the Course	Credits	Contact hours per week	Internal Assessment Marks	End term Examination Marks	Total Marks	Examination Hrs.
MDC-1 03 Credits	I	24UN-BOT-MDC101	Fundamentals of Botany	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
MDC-2 03 Credits	II	24UN-BOT-MDC201	Economic Botany	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
MDC-3 03 Credits	III	24UN-BOT-MDC301	Ornamental Plants and Propagation	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
VAC-1	I	24UN-BOT-VAC101	Environmental Sciences	02	02	15	35	50	03
VAC-3	III IV	24UN-BOT-VAC301/401	Medicinal Plants in Everyday Life	02	02	15	35	50	03
VAC-4	IV	24UN-BOT-VAC402	Indian Biodiversity	02	02	15	35	50	03
SEC-2	II	24UN-BOT-SEC201	Organic Farming	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
SEC-3	III	24UN-BOT-SEC301	Herbal Technology	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
SEC-4	VI	24UN-BOT-SEC601	Floriculture	02	02	15	35	50	03
			Practical	01	02	05	15	20	03
CC-M3 (V)	III	24UN-BOT-VOC 301/501	Biofertilizer	02	02	15	35	50	03
CC-M5 (V)	V		Practical	02	04	15	35	50	03
CC-M4 (V)	IV	24UN-BOT-VOC 401	Nursery and Gardening	02	02	15	35	50	03
			Practical	02	04	15	35	50	03
CC-M5 (V)	VI	24UN-BOT-VOC 601	Mushroom Cultivation	02	02	15	35	50	03
CC-M6 (V)									
CC-M7 (V)			Practical	02	02	15	35	50	03

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FIFTH SEMESTER

Session: 2024-25			
Part A - Introduction			
Subject	BOTANY		
Semester	5 th		
Name of the Course	Plant physiology and Biochemistry		
Course Code	24UN-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. Students will acquire an understanding of various physiological process in plants. 2. Students will develop a comprehensive knowledge of biochemical pathways of photosynthesis 3. Students will learn major metabolic pathways in plants. 4. Students will gain a conceptual understanding of plant growth and senescence 5*. Students will be able to demonstrate practical aspects and learn the basic concepts of various physiological and biochemical process of plant		
	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: 3 Hours	
Part B- Contents of the Course			
Instructions for Paper- Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.			
Unit	Topics		Contact Hours



I	Plant-water relations and mineral nutrition Diffusion, Osmosis; Imbibition, water potential and its components; Absorption and transport of water (Root pressure and Transpiration pull theory), Transpiration (Malate-K ⁺ ion theory) and its significance, Brief Account of Guttation & Wilting	11
II	Unit 2: Photosynthesis Photosynthetic Pigments (chlorophyll and carotenoids), Photosynthetic unit, enhancement effect and red drop, Photosystem 1 and II, Cyclic and non-cyclic photophosphorylation, C ₃ , C ₄ and CAM pathways of carbon fixation, Photorespiration, factors affecting photosynthesis	12
III	Unit 3: Plant metabolism Aerobic and anaerobic respiration, Glycolysis, Kreb's cycle; Oxidative phosphorylation, Oxidative Pentose Phosphate Pathway Lipid biosynthesis, β -oxidation, Glyoxylate cycle; Biological nitrogen fixation, Nitrate and ammonia assimilation.	11
IV	Unit 4: Plant growth & development Plant growth regulators: Discovery and physiological roles of auxin, gibberellin, cytokinin, ABA and ethylene. Photoperiodism (SDP, LDP, Day neutral plants), Phytochrome and photomorphogenesis, Physiology of senescence	11
V*	• Demonstration of imbibition by plaster of Paris method. • Demonstration of Osmosis by potato osmoscope method. • To study the Osmotic pressure of onion scale/ Rhoeo leaf peel by plasmolytic method. • To demonstrate Ascent of sap • To study and compare cuticular and stomatal transpiration by leaves • To study rate of transpiration by Ganong's potometer • To study the effect of two environmental factors (light and wind) on transpiration by excised twig • To separate photosynthetic pigments by thin layer/paper chromatography. • To study evolution of oxygen during photosynthesis by Wilmott's bubbler • To demonstrate Aerobic respiration • To demonstrate Anaerobic respiration by Kuhne's tube • Biochemical tests for carbohydrates, proteins and lipids • To study phototropism and geotropism • Project work on any topic based on syllabus	30

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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:

- Pandey, S.N & Sinha BK. 2018. Plant Physiology .Vikas Publishing House Pvt. Ltd. 4th edition
- Jain, V. K. 2017. Fundamentals of Plant Physiology. S. Chand publishing. 20th edition
- Gupta, N.K. Bala, MKSM. Gupta, M. 2016. Practical in Plant Physiology and Biochemistry. Scientific Publishers, India
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. 2015. Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Lehninger Principles of Biochemistry – David L. Nelson & Michael M. Cox, Publisher: W.H. Freeman
- Fundamentals of Biochemistry – J.L. Jain, Sunjay Jain & Nitin Jain, Publisher: S. Chand
- Plant Physiology and Biochemistry by HS Srivastava, Rastogi Publications.
- Hopkins, W.G. and Huner, A. 2008. Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
- Salisbury, F.B. and Ross, C.W. 2002. Plant Physiology. Wordsworth Publishing Co. Belmont CA. 7th edition.
- 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.

Session: 2024-25

Part A – Introduction

Subject	BOTANY
Semester	5th
Name of the Course	Reproductive biology in Plants
Course Code	24UN-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)	

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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: 3 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 onequestion 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
III	Pollen-pistil interaction; self-incompatibility. Male gametophyte. Structure of megasporangium (ovule), its curvatures. Megasporeogenesis 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 and their germination. Fruit types; dispersal mechanisms in fruits and seeds.	11
V*	- Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Permanent Slides). - Female gametophyte: <i>Polygonum</i> (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:

> 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:

- 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 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.
- 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: 2024-25

Part A - Introduction

Subject

BOTANY

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Semester	5 th		
Name of the Course	Evolutionary Biology		
Course Code	24-UN-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 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: 3 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 selection, reciprocal altruism; biological clocks; development of behaviour; use of space and territoriality; mating systems, parental		12

	investment and reproductive success; parental care.	
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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 quadrat method. • To calculate biodiversity indices of herbaceous vegetations.	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:

- 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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Session: 2024-25			
Part A – Introduction			
Subject	BOTANY		
Semester	5 th		
Name of the Course	Modern Plant Systematics		
Course Code	24UN-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: 3 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, Journals Herbarium and botanical gardens, their role in teaching, research and conservation,; important herbaria and botanic gardens of the World. Botanical Survey of India. Keys: Single access and Multi-access.		11






II	Role of palynology, Cytology, Phytochemistry, Embryology, Morphology, Anatomy and numerical taxonomy	12
	in relation to taxonomy	
III	Types of Classification: Artificial (Theophrastus, Parashara, Linnaeus), Natural (Bentham and Hooker) and Phylogenetic (Engler and Prantl, Brief idea of Angiosperm Phylogeny Group classification).	11
IV	Systematic study and economic importance of the following families: Ranunculaceae, Fabaceae, Malvaceae, Brassicaceae, Solanaceae, Asteraceae, Apiaceae, Lamiaceae, Euphorbiaceae, Cucurbitaceae, Liliaceae & Poaceae	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: > 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		

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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.

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- 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 3rd edition. Oxford & IBH, New Delhi.
- Stuessy, Tod F. 2009. *Plant Taxonomy: The Systematic Evaluation of Comparative Data*. Second edition. Columbia University Press.

Session: 2024-25			
Part A - Introduction			
Subject	BOTANY		
Semester	5 th		
Name of the Course	Natural Plant Products		
Course Code	24UN-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 their collection, develop skills in preparation of crude herbal extracts, detect drug adulteration and propagation methods for conservation of plants.		
	Theory	Practical	Total
Credits	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70	Time: 3 Hours		
Internal Assessment Marks: 20			
End Term Exam Marks: 50			
PRACTICAL			

Max. Marks: 30 Internal Assessment Marks: 10 End Term Exam Marks: 20	Time: 3 Hours
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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 acetate pathway for synthesis of polyketides and fatty acids; Factors affecting synthesis of secondary metabolites	11
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	30
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	Saponins (Karando / Godekashtha) or from other suitable plant materials.	
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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: 2024-25

Part A – Introduction

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Subject	BOTANY
Semester	5th
Name of the Course	Medicinal Plants and its Applications
Course Code	24UN-BOT-506
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. 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.
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	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: 3 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
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I	Introduction to medicinal plants and scope of medicinal botany. Brief account of traditional medicinal systems- Ayurveda, siddha, unani, and homeopathy. Medicinal plants- past and present status in world and India. Herbal industries.	11
II	Agro and cultivation techniques i.e., nursery raising, cultivation, pests and diseases, harvesting and profits for some economically important medicinal plants- Aloe vera, <i>Withania somnifera</i> , <i>Rauvolfia serpentina</i> . 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- <i>Glycyrrhiza</i> , <i>Cinchona</i> , <i>Belladonna</i> , Aloe, <i>Rauvolfia</i> , Neem,	11

	Ashwagandha, Amla, Bahera, Bhringraj. Plant's secondary metabolite of medicinal importance- Alkaloid, Glycosides and Sterols (brief account).	
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, ethnomedicinal 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
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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: 2024-25			
Part A – Introduction			
Subject	BOTANY		
Semester	6 th		
Name of the Course	Economic Botany and Biotechnology		
Course Code	24UN-BOT-601		
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 micropropagation, callus culture 4. Understanddifferent strategies of genetic engineering in plants and its applications 5. *Understand lab techniques of tissue culture; get acquainted with equipments 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	Time: 3 Hours		
Internal Assessment Marks: 20			
End Term Exam Marks: 50			
PRACTICAL			
Max. Marks: 30	Time: 3 Hours		
Internal Assessment Marks: 10			
End Term Exam Marks: 20			
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





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I	Economic Botany-I Vavilo's, center of origin; Food Plants: Origin, botanical description, brief idea of cultivation and uses of Rice, Wheat Protein Crops (Pulses): Origin, botanical description, brief idea of cultivation and uses of Gram, Arhar. Fibers: Origin, botanical description, brief idea of cultivation, processing and uses of Cotton, Jute Oil Yielding Crops: Origin, botanical description, brief idea of cultivation and uses of Groundnut, Mustard	11
II	Economic Botany-II Spices and Condiments: Introduction to spices and condiments; Morphology, plant part used and uses of Coriander, Black Pepper, Ginger, Turmeric. Medicinal Plants: Morphology, plant part used, medicinal importance of Cinchona, Rauwolfia, Opium, Cannabis, and Withania. Beverages: Botanical description and processing of Tea and coffee Sugar: Botanical description, cultivation and processing of Sugarcane	12
III	Recombinant DNA Techniques: General account of recombinant DNA Technology, Enzymes (Restriction endonuclease, DNA ligase, polynucleotide kinase, reverse transcriptase, alkaline phosphatase, DNA polymerase-I) Overview of Cloning Vectors (Plasmid, Cosmid, Bacteriophage), Gene Transfer Techniques: Physical, Chemical and Biological methods	11
IV	Plant Tissue Culture: Concept of Totipotency, explant culture, micropropagation and somaclonal variation, protoplast culture, and somatic hybridization, anther culture, embryo culture, somatic embryogenesis and synthetic seeds	11
V*	- Study of economically important plants: Wheat, Rice, Gram, Arhar, Black Pepper, Ginger, Coriander, Turmeric, Tea, Coffee, Cotton, Jute, Groundnut, Mustard and Sugarcane etc. - Study of medicinal plants important plants: Cinchona, Rauwolfia, Opium, Cannabis, and Withania. - Collection and preparation of reports on various crops and economically and medicinally 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

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• Preparation of MS medium. • To prepare the slants and petri plates for plant tissue culture. • Demonstration of <i>in vitro</i> sterilization and inoculation methods using leaf and nodal explants of tobacco/<i>Datura/Brassica</i> 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. • Study different types of vectors with the help of photographs: Plasmid, Cosmid, Bacteriophage • Collection of economically important plants • Lab Visit	
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. • Sambammurthy, 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: 2026-27
Part A - Introduction

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Subject	BOTANY		
Semester	6 th		
Name of the Course	Plant Pathology		
Course Code	24U-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 diseases and 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: 3 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 cycle (monocyclic, polycyclic and polyetic).		11

II	Mechanism of infection, role of environment 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; molecular basis 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, Nutrient Agar 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, New Delhi.
- Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. 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: 2024-25			
Part A - Introduction			
Subject	BOTANY		
Semester	6 th		
Name of the Course	Agroforestry		
Course Code	24U-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.		
Credits	Theory	Practical	Total
Contact Hours	3	1	4
	3	2	5
THEORY			
Max. Marks: 70		Time: 3 Hours	
Internal Assessment Marks: 20			
End Term Exam Marks: 50			
PRACTICAL			
Max. Marks: 30		Time: 3 Hours	
Internal Assessment Marks: 10			
End Term Exam Marks: 20			
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

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

Session: 2024-25	
Part A - Introduction	
Subject	BOTANY
Semester	6 th
Name of the Course	Post-harvest Technology of Fruits & Vegetables
Course Code	24U-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)	

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Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To acquire knowledge about basic horticultural 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 and preservation. 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 different fruits and vegetables; reasons for loss, marketing quality and packaging methods for sale of fruits and vegetables
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	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: 3 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 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.	11
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
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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. Chattopadhyaya 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: 2024-25			
Part A - Introduction			
Subject	BOTANY		
Semester	6 th		
Name of the Course	Plant Stress Physiology		
Course Code	24UN- 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. Students will acquire an understanding of how plants respond physiologically to biotic stress. 2: Students will develop a comprehensive knowledge of the genetic mechanisms plants employ to defend against biotic stress. 3: Students will learn about the effects of environmental factors on plants. 4: Students will gain a conceptual understanding of how plants sense and respond to abiotic stress. 5*. Students will be able to demonstrate the practical approach of plant responses under biotic and abiotic stress, and the biochemical test for secondary metabolites.		
	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: 3 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

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

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

Session: 2026-27			
Part A – Introduction			
Subject	BOTANY		
Semester	6 th		
Name of the Course	Plant Propagation		
Course Code	24UN- 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 acquire an understanding of the history of gardens in India and other countries. 2: Students will develop comprehensive knowledge about different groups of plants used as ornamentals. 3: Students will learn about flower and seed production. 4: Students will gain a deep understanding of vegetative propagation methods for ornamental plants. 5*. Students will be able to learn various types of gardens & their significance, management, and methods of propagation of valuable plants.		
Credits	Theory	Practical	Total
Contact Hours	3	1	4
	3	2	5
THEORY			
Max. Marks: 70	Time: 3 Hours		
Internal Assessment Marks: 20			
End Term Exam Marks: 50			
PRACTICAL			

Max. Marks: 30 Internal Assessment Marks: 10 End Term Exam Marks: 20		Time: 3 Hours
Part B- Contents of the Course		
Instructions for Paper- Setter 1. Nine questions will be set in all. All questions will carry equal marks. 2. Question No.1 will be short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.		
Unit	Topics	Contact Hours
I	History of gardens in India; terrace gardening; popular gardens of India; Types of gardens: Formal and Informal gardens; Styles of gardens: Mughal gardens, Persian gardens, Italian gardens, French gardens, English gardens, Japanese gardens.	11
II	Significance of Shrubs, trees, palms, ferns, cycads, cacti and succulents, climbers, creepers, indoor plants, water plants, bonsai plants as ornamentals.	12
III	Flower and seed production; protected cultivation of ornamentals; present position and scope of floriculture in India.	11
IV	Vegetative propagation-principles and practices of clone selection; techniques of cutting, budding, grafting and layering; propagation by specialized stems and roots.	11
V*	- Preparation of nursery beds – flat, raised and sunken beds - Identification and description of various plants grown in ornamental gardens. - Tools, implements and containers used in ornamental gardening. - Planning, designing and establishment of garden features viz. lawn, hedge and edge, rockery etc. - To study propagation by separation and division technique. - Preparation of land for lawn and planting. - To study propagation by cuttings, layering, grafting and budding - Flower arrangement practices. - Preparation of bouquets, garland.	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: • Singh, A.K. & Kumar A. 2023. Plant Propagation and Nursery management. S.K. Kataria and sons. • Arora, J.S. 2016. Introductory Ornamental Horticulture. Kalyani Publishers. 8th edition. • Sachdeva, P. & Tongbram, V. 2014. A Naturalist's guide to the trees & Shrubs of India. Prakash Books. • Jain, S.M. & Ochatt, S.J. 2009. Protocols for in vitro propagation of ornamental plants: 598 (Methods in Molecular Biology). Humana Press. • Sabina, GT and Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency. • Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi. • Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. • Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi • Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios • Lauria A & Victor HR. 2001. Floriculture – Fundamentals and Practices Agrobios.	

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