



CURRICULUM BOOK

Ph.D (HORT.) Fruit Science (2025-26)

Ph.D (HORT.) Vegetable Science (2025-26)

Ph.D (HORT.) Floriculture & Landscaping (2025-26)

Department of Horticulture

School of Life Sciences

Central University of Tamil Nadu



Effective from academic year 2025-26 onwards

Ph.D syllabus
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तमिलनाडुकेन्द्रीयविश्वविद्यालय
(संसदद्वारापारितअधिनियम 2009केअंतर्गतस्थापित)
CENTRAL UNIVERSITY OF TAMIL NADU
(Established by an Act of Parliament, 2009)
नीलक्कुडीपरिसर/Neelakudi Campus, कंगलान्चेरी/Kangalancherry,
तिरुवारूर/Thiruvavur- 610 005, Tamilnadu
www.cutn.ac.in

School of Life Sciences
Department of Horticulture
Ph.D syllabus 2025-26

A. Vision

Vision Statement of the Department

Develop world class horticulture hub which can cater to the needs of all stake holders for the ultimate wellbeing of the society, through academic excellence, Innovative research and need based extension.

B. Mission

Mission Statements of the Department

M1	Converging conventional knowledge and frontier research towards enhancing sustainability, food and nutritional security in accordance with regional, national and global priorities.
M2	Conservation, evaluation and development of plant genetic resources for climate resilience and environmental security.
M3	Devising sustainable solutions for major pre and post-production problems and constraints in horticultural crops through innovative approaches.
M4	Appraisal and enhancement of market value through forward and back-end linkages for economic security.
M5	Reaching out to the community through humanity-driven technology.

C. Program Specific Outcomes (PSO)

After five years of successful completion of the program, the students will be able to

PSO1	Handle problems and issues arising in the field of horticulture through research, knowledge and skills acquired.
PSO2	Able to design and conduct independent research in the horticulture and allied sectors and contribute back to the society through academicians.
PSO3	Lead research and development team in strategic and frontier areas of horticulture.
PSO4	Interlink the concepts of horticulture with the multi-disciplinary science arena for innovative outcomes.
PSO5	Advise and advocate policies related to livelihood security through horticultural research.

D. PEO to Mission Statement Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5
M1	3	1	2	3	2
M2	3	3	3	3	3
M3	3	3	3	3	1
M4	3	3	1	2	3
M5	2	3	2	2	3

E. Graduate Attributes of PhD (Horticulture) Program

1. **Disciplinary Knowledge:** Understand the diverse aspects of biotechnology and apply tools and techniques for the industrial advancement, progress and innovation.
2. **Communication Skills:** Develop verbal and written communication skills to convey the mechanistic concepts with clarity.
3. **Critical Thinking:** Capacity to generate hypothesis, design and conduct of experiments, mining, analysis and interpretation of data, and reporting the findings.
4. **Problem-Solving:** Design and execute processes to find solutions for biological problems to meet the needs of the global society.
5. **Cooperation:** Ability to work independently, yet cooperate and function effectively as a member (team player) or leader of a team.
6. **ICT Skills (Modern Tools usage):** Apply biological concepts and appropriate tools (technique) to solve complex biological problems.
7. **Ethics:** Demonstrate and endorse the universal standards of ethics and responsibilities.
8. **Self-Directed Learning:** Establish autonomy and self-regulation in teaching, learning and professional development.
9. **Reasoning:** Develop the ability to critically and systematically analyze scientific data to be able to draw unbiased conclusions for fulfilling the objectives.
10. **Creativity:** Develop the ability to harness out-of-the-box (divergent and convergent) thinking, and by innovative means overcome technical challenges in biotechnology.
11. **Societal and Environmental Concern:** Appreciate and contribute to improvement of the quality of environment and sustainability of life.
12. **Harnessing Longevity of Learning:** Understand the importance of continuous learning and practices it through life.

F. Program Outcomes (PO)

On the successful completion of the program, the student will be able to

PO1	Serve as an academician to disseminate knowledge to the needy audience in the field of horticulture.
PO2	Fit into any research and development endeavor in the field of horticulture and allied sectors.
PO3	Guide student and farming community in the standalone and participatory research to bring meaningful outcomes.
PO4	Able to pursue post- doctoral research in any international arena.
PO5	Emerge as a genuine research manager adhering to legal and moral ethics.

G. PO to PEO Mapping

	PO1	PO2	PO3	PO4	PO5
PSO1	3	3	3	3	3
PSO2	2	3	3	3	3
PSO3	2	3	3	3	3
PSO4	3	3	3	3	2
PSO5	3	3	2	1	3



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School of Life Sciences
Department of Horticulture
Regulation – 2025
Choice Based Credit System Curriculum and syllabi
Ph.D (Hort.) Programme
Course Structure (100 Credits)

Ph.D (Hort.) Fruit Science

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC601	Innovative approaches in fruit breeding*	MC	3	0	0	3	3
2	FSC602	Modern trends in fruit production*	MC	3	0	0	3	3
3	FSC603	Recent developments in growth regulation	MC	3	0	0	3	3
4	FSC606	Abiotic stress management in fruit crops	MC	2	0	1	3	3
5	FSC604 / FSC607	Advanced laboratory techniques	Mi	1	0	2	3	3
		Biodiversity and conservation of fruit crops	Mi	2	0	1	3	3
6	FSC608/ FSC605	Smart fruit production /	Mi	3	0	0	3	3
		Arid and dryland fruit production	Mi	2	0	1	3	3
7	FSC609	Research methodology	SC	3	0	0	3	3
8	CPERPE	Research and publication ethics	SC	1	0	1	2	2
9	FSC691	Seminar 1	S	0	0	1	1	1
10	FSC692	Seminar 2	S	0	0	1	1	1
11	FSC610	Comprehensive Exam Qualifying Viva-voce (Non-Credit Compulsory)	NC	0	0	0	0	0
12	FSC699	Research	R	0	0	75	75	75
Total							100	100

***Compulsory among major courses**

MC- Major Course Mi- Minor course

SC- Supporting course

S- Seminar

R- Research

NC- Non-credit compulsory

Semester wise course allocation for Ph.D (Hort.) Fruit Science**Semester I**

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC601	Innovative approaches in fruit breeding*	MC	3	0	0	3	3
2	FSC602	Modern trends in fruit production*	MC	3	0	0	3	3
3	FSC603	Recent developments in growth regulation	MC	3	0	0	3	3
4	FSC606	Abiotic stress management in fruit crops	MC	2	0	1	3	3
5	FSC609	Research methodology	SC	3	0	0	3	3
6	FSC691	Seminar 1	S	0	0	1	1	1
7	FSC699	Research	R	0	0	2	2	2
Total							18	18

Semester II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC604 / FSC607	Advanced laboratory techniques / Biodiversity and conservation of fruit crops	Mi Mi	1 2	0 0	2 1	3 3	3 3
2	FSC608 / FSC605	Smart fruit production / Arid and dryland fruit production	Mi Mi	3 2	0 0	0 1	3 3	3 3
3	CPERPE	Research and publication ethics	SC	1	0	1	2	2
4	FSC692	Seminar 2	S	0	0	1	1	1
5	FSC610	Comprehensive Exam Qualifying Viva-voce (Non-Credit Compulsory)	NC	0	0	0	0	0
6	FSC699	Research	R	0	0	5	5	5
Total							14	14

Semester III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC699	Research	R	0	0	17	17	17
Total							17	17

Semester IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC699	Research	R	0	0	17	17	17
Total							17	17

Semester V

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC699	Research	R	0	0	17	17	17
Total							17	17

Semester VI

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FSC699	Research	R	0	0	17	17	17
Total							17	17

Ph.D (Hort.) VEGETABLE SCIENCE

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC601	Recent trends in vegetable production*	MC	3	0	0	3	3
2	VSC602	Advances in breeding of vegetable crops*	MC	3	0	0	3	3
3	VSC604	Seed certification, processing and storage of vegetable crops	MC	2	0	1	3	3
4	VSC607	Biotechnological approaches in vegetable crops	MC	2	0	1	3	3
5	VSC608 /	Advanced Laboratory Techniques for Vegetable Crops	Mi	1	0	2	3	3
	VSC606	Biodiversity and conservation of vegetable crops	Mi	2	0	1	3	3
6	VSC605 /	Breeding for special traits in vegetable crops	Mi	3	0	0	3	3
	VSC603	Abiotic stress management in vegetable crops	Mi	2	0	1	3	3
7	VSC609	Research methodology	SC	3	0	0	3	3
8	CPERPE	Research and publication ethics	SC	1	0	1	2	2
9	VSC691	Seminar 1	S	0	0	1	1	1
10	VSC692	Seminar 2	S	0	0	1	1	1
11	VSC610	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC	0	0	0	0	0
12	VSC699	Research	R	0	0	75	75	75
Total							100	100

*Compulsory among major courses MC- Major Course Mi- Minor course

SC- Supporting course S- Seminar R- Research NC- Non-credit compulsory

Semester wise course allocation for Ph.D (Hort.) VEGETABLE SCIENCE**Semester I**

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC601	Recent trends in vegetable production*	MC	3	0	0	3	3
2	VSC602	Advances in breeding of vegetable crops*	MC	3	0	0	3	3
3	VSC604	Seed certification, processing and storage of vegetable crops	MC	2	0	1	3	3
4	VSC607	Biotechnological approaches in vegetable crops	MC	2	0	1	3	3
5	VSC609	Research methodology	SC	3	0	0	3	3
6	VSC691	Seminar 1	S	0	0	1	1	1
7	VSC699	Research	R	0	0	2	2	2
Total							18	18

Semester II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC608 /	Advanced Laboratory Techniques for Vegetable Crops	Mi	1	0	2	3	3
	VSC606	Biodiversity and conservation of vegetable crops	Mi	2	0	1	3	3
2	VSC605 /	Breeding for special traits in vegetable crops	Mi	3	0	0	3	3
	VSC603	Abiotic stress management in vegetable crops	Mi	2	0	1	3	3
3	CPERPE	Research and publication ethics	SC	1	0	1	2	2
4	VSC692	Seminar 2	S	0	0	1	1	1
5	VSC610	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC	0	0	0	0	0
6	VSC699	Research	R	0	0	5	5	5
Total							14	14

Semester III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC699	Research	R	0	0	17	17	17
Total							17	17

Semester IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC699	Research	R	0	0	17	17	17
Total							17	17

Semester V

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC699	Research	R	0	0	17	17	17
Total							17	17

Semester VI

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	VSC699	Research	R	0	0	17	17	17
Total							17	17

Ph.D (Hort.) FLORICULTURE AND LANDSCAPING

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS601	Crop regulation in ornamental crops *	MC	1	0	1	2	2
2	FLS602	Post-harvest biology of floricultural crops*	MC	2	0	1	3	3
3	FLS605	Advances in landscaping*	MC	1	0	1	2	2
4	FLS607	Modern Approaches in Breeding of Floricultural crops	MC	2	0	1	3	3
5	FLS603	Specialty Flowers, Fillers and Cut Greens	MC	1	0	1	2	2
6	FLS604 /	Biotechnological Approaches in Floricultural Crops	Mi	2	0	1	3	3
	FLS608	Current trends in production technology of floricultural crops	Mi	2	0	1	3	3
7	FLS606 /	Vertical Gardening	Mi	1	0	2	3	3
	FLS609	Recent developments in in protected cultivation of floricultural crops	Mi	2	0	1	3	3
8	FLS611	Research methodology	SC	3	0	0	3	3
9	CPERPE	Research and publication ethics	SC	1	0	1	2	2
10	FLS691	Seminar 1	S	0	0	1	1	1
11	FLS692	Seminar 2	S	0	0	1	1	1
12	FLS610	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC	0	0	0	0	0
13	FLS699	Research	R	0	0	75	75	75
Total							100	100

*Compulsory among major courses MC- Major Course Mi- Minor course

SC- Supporting course S- Seminar R- Research NC- Non-credit compulsory

Semester wise course allocation for Ph.D (Hort.) FLORICULTURE AND LANDSCAPING**Semester I**

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS601	Crop regulation in ornamental crops *	MC	1	0	1	2	2
2	FLS602	Post-harvest biology of floricultural crops*	MC	2	0	1	3	3
3	FLS605	Advances in landscaping*	MC	1	0	1	2	2
4	FLS607	Modern Approaches in Breeding of Floricultural crops	MC	2	0	1	3	3
5	FLS603	Specialty Flowers, Fillers and Cut Greens	MC	1	0	1	2	2
6	FLS611	Research methodology	SC	3	0	0	3	3
7	FLS691	Seminar 1	S	0	0	1	1	1
8	FLS699	Research	R	0	0	2	2	2
Total							18	18

Semester II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS604 /	Biotechnological Approaches in Floricultural Crops	Mi	2	0	1	3	3
	FLS608	Current trends in production technology of floricultural crops	Mi	2	0	1	3	3
2	FLS606 /	Vertical Gardening	Mi	1	0	2	3	3
	FLS609	Recent developments in protected cultivation of floricultural crops	Mi	2	0	1	3	3
3	CPERPE	Research and publication ethics	SC	1	0	1	2	2
4	FLS692	Seminar 2	S	0	0	1	1	1
5	FLS610	Comprehensive Exam Qualifying Viva (Non-Credit Compulsory)	NC	0	0	0	0	0
6	FLS699	Research	R	0	0	5	5	5
Total							14	14

Semester III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS699	Research	R	0	0	17	17	17
Total							17	17

Semester IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS699	Research	R	0	0	17	17	17
Total							17	17

Semester V

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS699	Research	R	0	0	17	17	17
Total							17	17

Semester VI

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits
				L	T	P		
1	FLS699	Research	R	0	0	17	17	17
Total							17	17

Abstract of course stream

S. No	Career Stream	Total Credits
1.	Major Courses	12
2.	Minor Courses	6
3.	Supporting Courses	5
4.	Seminar	2
5.	Research	75
Total		100

Semester wise credit hours - Abstract

S. No	Semester	Total Credits
1.	I	18
2.	II	14
3.	III	17
4.	IV	17
5.	V	17
6.	VI	17
Total		100

Total credits to be earned for the degree: 100

End Semester Question Paper pattern



CENTRAL UNIVERSITY OF TAMIL NADU
EXAMINATION FOR THE DEGREE OF
Ph.D (Hort.)
Fruit Science/ Vegetable Science/ Floriculture and Landscaping
ACADEMIC SESSION 2025-26
Course code – Course Title
Month Year | TIME: HOURS | TOTAL MARKS: 60

INSTRUCTIONS TO CANDIDATES

1. This paper has Three (3) parts:

Part A: One best answer (OBA) (5 questions)

Fill in the blanks (5 questions)

Or

Match the following (5 questions)

Part B: Descriptive (5 questions)

Part C: Essay (4 questions – Either or Type)

State your matric number clearly on each answer script.

2. The candidates must answer any **FIVE** questions in **Part B descriptive** and FOUR questions in Essay type (Either or Type) in Part C
3. Each question in **Part A** carries 1 (ONE) mark and **Part B** carries 2 (TWO) marks for Descriptive type; and Part C carries 10 (TEN) marks for Essay type.
4. While answering **Part B** questions, **draw neatly labelled diagrams** wherever appropriate.

Registration No.:

(This question paper consists of **20 questions**)

QUESTION PAPER

Time: 3 hours

Maximum Marks: 60

PART – A

OBJECTIVE (10 x 1 = 10 MARKS)

No. of Questions : 10 (Question No.1 to 10)

Nature of Questions

One Best Answer (with four options) (Q.No. 01 to 05) 5 x 1 Marks = 5

1				
	a)	b)	c)	d)
2				
	a)	b)	c)	d)
3				
	a	b	c)	d)
4				
	a)	b)	c	d)
5				
	a)	b)	C	d)

Fill in the blanks (Q.No. 06 to 10) 5 x 1 Marks = 5

6	
7	
8	
9	
10	

Or

Match the following

PART – B

DESCRIPTIVE TYPE (5 x 2 = 10 Marks)

No. of Questions : 6

No. of Questions to be answered : 5

Nature of Questions : Brief answer

11	
12	
13	
14	
15	
16	

PART – C**ESSAY TYPE (4 x 10 = 40 Marks)**

No. of Questions : 2 (Either or type)

Nature of Questions : Detail answer

17	
	or
18	
	or
19	
	or
20	
	or

Ph.D (Hort.) Fruit Science

SEMESTER- I					
Course Code	Course Name	L	T	P	Credits
FSC601	Innovative Approaches in Fruit Breeding	3	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Deep insight on utilization of frontier breeding tools in improvements of fruit crops	Analyze
CO2	Significances of advanced breeding measures on prospecting fruit industry	Understand
CO3	Equip the students with the skills for develop designer crops	Skill
CO4	The students will have in-depth knowledge and hands on training in in-vitro and molecular approaches that can be used in fruit crops	Remember

b. Syllabus

Units	Content
LI	Introduction: Current Trends and Status: Modern trends in fruit breeding – with major emphasis on precocity, low tree volume, suitability for mechanization, health benefits, etc.
LII	Genetic Mechanisms: Inheritance Patterns and Breeding Systems: Genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits.
LIII	Breeding for Specific Traits: Plant Architecture, Stress Tolerance and Fruit Quality: Recent advances in crop improvement efforts- wider adaptation, plant architecture, amenability to mechanization, fruit quality attributes, stress tolerance, crop specific traits; use hybridization (alien genes). omixis gene introgression and wide
LIV	Transgenics, Markers and Genomics: Molecular and transgenic approaches in improvement of selected fruit crops; fast track breeding – marker assisted selection and breeding (MAS and MAB), use of genomics and gene editing technologies. Crops: Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, strawberry, nut crops, Pineapple, Annona, sapota
	References: - Bartholomew DP, Paull RE and Rohrbach KG. eds. 2002. <i>The Pineapple: Botany, Production, and Uses</i>. CAB International. - Bose TK, Mitra SK and Sanyol D. Eds. 2002. <i>Fruits of India – Tropical and Sub- Tropical</i>. 3rd Ed. Vols. I, II. Naya Udyog, Kolkata, India. - Dhillon WS and Bhatt ZA. 2011. <i>Fruit Tree Physiology</i>. Narendra Publishing House, New Delhi. Dhillon WS. 2013. <i>Fruit Production in India</i>. Narendra Publishing House, New Delhi. - Gowen S. 1995. <i>Bananas and Plantains</i>. Chapman & Hall Publication, US. - Litz RE. ed. 2009. <i>The Mango: Botany, Production and Uses</i>. CAB International. Peter KV. 2016. <i>Innovations in Horticulture</i>. NIPA, New Delhi. - Robinson JC and Saúco VG. 2010. <i>Bananas and Plantains</i> (Vol. 19). CAB International. Samson JA. 1980. <i>Tropical Fruits</i>. Longman, USA.

	7. Sharma RR and Krishna H. 2014. <i>Fruit Production: Major Fruits</i>. Daya Publishing House, Delhi. 8. Singh S, Shivankar VJ, Srivastava AK and Singh IP. 2004. <i>Advances in Citriculture</i>. Jagminder Book Agency, New Delhi. 9. Stover RH and Simmonds NW. 1991. <i>Bananas</i>. Longman, USA. 10. Chadha KL, Ahmed N, Singh SK and Kalia P. 2016. <i>Temperate Fruits and Nuts- Way Forward for Enhancing Production and Quality</i>. Daya Publishing House, New Delhi. 11. Childers NF, Morris JR and Sibbett GS. 1995. <i>Modern Fruit Science: Orchard and Small Fruit Culture</i>. Horticultural Publications, USA. 12. Erez A. 2013. <i>Temperate Fruit Crops in Warm Climates</i>. Springer Science. 13. Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. <i>Temperate and Subtropical Fruit Production</i>. CAB International. 14. Ryugo K. 1998. <i>Fruit Culture: Its Science and Art</i>. John Wiley & Sons, USA. 15. Tromp J, Webster AS and Wertheim SJ. 2005. <i>Fundamentals of Temperate Zone Tree Fruit Production</i>. Backhuys Publishers, Lieden, The Netherlands. 16. Westwood MN. 2009. <i>Temperate Zone Pomology: Physiology and Culture</i>. 3rd Edn. Timber Press, USA.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER- I						
Course Code	Course Name	L	T	P	Credits	
FSC602	Modern Trends in Fruit Production	3	-	-	3	

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The boon of advanced techniques to propel the booming fruit industry	Analyze
CO2	The application of the latest techniques in growing and managing fruit crops	Understand
CO3	Well-versed with the application of frontier tools to cause benefit to the fruit industry and to manage effectively a commercial fruit orchards	Skill
CO4	The value of cutting-edge strategies of fruit crop production	Remember

b. Syllabus

Units	Content
LI	Introduction General Concepts and Current Scenario: National and International scenario, national problems.
LII	Advanced Technologies Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting, crop modeling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation.
LIII	Management Practices Overcoming Stress and Integrated Approaches: Effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Physiological disorders, Total quality management (TQM). Crops: Mango, banana, guava, papaya, Citrus, grapes, pomegranate, litchi, apple, pear, strawberry, kiwifruit, plums, peaches, apricot, cherries, nectarines, strawberry, nut crops, Pineapple, Annona, sapota, Jackfruit
	References: 1. Bartholomew DP, Paull RE and Rohrbach KG. eds. 2002. <i>The Pineapple: Botany, Production, and Uses</i>. CAB International. 2. Bose TK, Mitra SK and Sanyal D. Eds. 2002. <i>Fruits of India – Tropical and Sub- Tropical</i>. 3rd 3. Ed. Vols. I, II. Naya Udyog, Kolkata, India. 4. Dhillon WS and Bhatt ZA. 2011. <i>Fruit Tree Physiology</i>. Narendra Publishing House, New Delhi. Dhillon WS. 2013. <i>Fruit Production in India</i>. Narendra Publishing House, New Delhi. 5. Gowen S. 1995. <i>Bananas and Plantains</i>. Chapman & Hall Publication, US. 6. Litz RE. ed. 2009. <i>The Mango: Botany, Production and Uses</i>. CAB International. Peter KV. 2016. <i>Innovations in Horticulture</i>. NIPA, New Delhi. 7. Robinson JC and Saúco VG. 2010. <i>Bananas and Plantains</i> (Vol. 19). CAB International. Samson JA. 1980. <i>Tropical Fruits</i>. Longman, USA.

	8. Sharma RR and Krishna H. 2014. <i>Fruit Production: Major Fruits</i> . Daya Publishing House, Delhi. 9. Singh S, Shivankar VJ, Srivastava AK and Singh IP. 2004. <i>Advances in Citriculture</i> . Jagmander Book Agency, New Delhi. 10. Stover RH and Simmonds NW. 1991. <i>Bananas</i> . Longman, USA. 11. Chadha KL, Ahmed N, Singh SK and Kalia P. 2016. <i>Temperate Fruits and Nuts- Way Forward for Enhancing Production and Quality</i> . Daya Publishing House, New Delhi. 12. Childers NF, Morris JR and Sibbett GS. 1995. <i>Modern Fruit Science: Orchard and Small Fruit Culture</i> . Horticultural Publications, USA. 13. Erez A. 2013. <i>Temperate Fruit Crops in Warm Climates</i> . Springer Science. 14. Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. <i>Temperate and Subtropical Fruit Production</i> . CAB International. 15. Ryugo K. 1998. <i>Fruit Culture: Its Science and Art</i> . John Wiley & Sons, USA. 16. Tromp J, Webster AS and Wertheim SJ. 2005. <i>Fundamentals of Temperate Zone Tree Fruit Production</i> . Backhuys Publishers, Lieden, The Netherlands. 17. Westwood MN. 2009. <i>Temperate Zone Pomology: Physiology and Culture</i> . 3 rd Edn. Timber Press, USA.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER- I						
Course Code	Course Name	L	T	P	Credits	
FSC603	Recent Developments in Growth Regulation	3	-	-	3	

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Comprehension of physiological and biochemical basis of crop regulation	Understand
CO2	Cop regulation to improve the profitability of growers	Analyze
CO3	Acquisition of through practical knowledge on crop regulation	Skill
CO4	Advanced programmed production of fruit crops	Apply

b. Syllabus

Units	Content
LI	Introduction Current Concepts and Principles: Eco-physiological influences on growth and development of fruit crops-flowering, fruit set- Crop load and assimilate partitioning and distribution.
LII	Growth Substances Phytohormones and Growth Regulators: Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopymanagement for fertigated orchards.
LIII	Growth and Development Regulation of Developmental Processes: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit-set and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.
	References: 1. Bhatnagar P. 2017. <i>Physiology of Growth and Development of Horticultural Crops</i>. Agrobios (India). 2. Buchanan B, Gruissam W and Jones R. 2002. <i>Biochemistry and Molecular Biology of Plants</i>. 3. John Wiley & Sons, US. 4. Fosket DE. 1994. <i>Plant Growth and Development: A Molecular Approach</i>. Academic Press, USA. 5. Leopold AC and Kriedermann PE. 1985. <i>Plant Growth and Development</i>. 3rd Ed. McGraw-Hill, 6. US. 7. Richard N. Arteca. 1995. <i>Plant Growth Substances – Principles and Applications</i>. Chapman & Hall, USA. 8. Roberts J, Downs S and Parker P. 2002. <i>Plant Growth Development</i>. In: <i>Plants</i> (I. Ridge, Ed.), Oxford University Press.

	9. Salisbury FB and Ross CW. 1992. <i>Plant Physiology</i> . 4 th Ed. Wadsworth Publication.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	2	3	3	3
CO4	3	2	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FSC606	Abiotic Stress Management in Fruit Crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	Detailed understanding of basic principles of abiotic stress in fruit crops.	Understand
CO2	Developing suitable Crop modeling for stress situations in fruit crops.	Skill
CO3	Exploration the interaction between different stresses and fruit crop performance	Apply

b. Syllabus

Units	Content
LI	Introduction Basic Aspects and Principles: Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution – increased level of CO₂, industrial wastes, impact of stress in fruit crop production, stress indices, physiological and biochemical factors associated with stress, fruit crops suitable for different stress situations.
LII	Stress Impact Assessment, Physiology and Performance: Crop modeling for stress situations, cropping systems, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stresses and their impact on crop growth and productivity. Stress Management Mitigation Measures and Conservation Practices: Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, stability and sustainability indices.
PIII	- Seed treatment/ hardening practices (2); - Container seedling production (2); - Analysis of soil moisture estimates (FC, ASM, PWP) (1); - Analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate, etc. under varied stress situations (5); - Biological efficiencies, WUE, solar energy conversion and efficiency (2); - Crop growth sustainability indices and economics of stress management (2);
	- Visit to orchards and watershed locations (2); - Class room Lectures

	• Laboratory/ Field Practicals • Student Seminars/ Presentations • Field Tours/ Demonstrations • Assignments
	Reference: • Blumm A. 1988. <i>Plant Breeding for Stress Environments</i>. CRC Publication, USA. Christiansen, MN and Lewis CF. 1982. <i>Breeding Plants for Less Favourable Environments</i>. Wiley International Science, USA. • Kanayama Y and Kochetor. 2015. <i>Abiotic Stress Biology in Horticultural Plants</i>. Springer. Kramer PJ. 1980. <i>Drought Stress and the Origin of Adaptation</i>. In: <i>Adaptation of Plants to Water and High Temperature Stress</i>. John Wiley & Sons, USA. • Maloo SR. 2003. <i>Abiotic Stress and Crop Productivity</i>. Agrotech Publ. Academy, India. Nickell LG. 1983. <i>Plant Growth Regulating Chemicals</i>. CRC Publication, USA. • Rao NKS, Shivashankar KS and Laxman RH. 2016. <i>Abiotic Stress Physiology of Horticultural Crops</i>. Springer. • Turner NC and Kramer PJ. 1980. <i>Adaptation of Plants to Water and High Temperature Stress</i>. John Wiley & Sons, USA.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	2	1	3
CO2	2	3	3	2
CO3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	Total
Internal	10	15	15	40
External	20	25	15	60
Total	30	40	30	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
FSC609	Research Methodology	3	-	0	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire knowledge of the literature and a ample understanding of methodologies that are directly or indirectly relevant to their own research	Remember
CO2	Create, develop and exchange research knowledge in collaborative manner for the benefit society	Understand
CO3	Ascertain, deduce and link with new idea so as to make a quality publication that is acceptable by a peer review	Apply
CO4	Manage complex ethical concerns and make a vivid verdicts	Analyze

b. Syllabus

Units	Content
LI	Introduction to Research Methodology: Meaning and importance of Research - Types of Research - Selection and formulation of Research Problem; Research Design - Need - Features - Inductive, Deductive and Development of models; Developing a Research Plan - Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs; Hypothesis - Different Types - Significance - Development of Working Hypothesis, Null hypothesis; Research Methods: Scientific method vs. Arbitrary Method; Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive - Inductive logical process - Different types of inductive logical methods; Critical Literature Review: Primary and Secondary Sources, Web sources
LII	Statistics and Computer applications: Introduction to Statistics – Probability Theories - Conditional Probability, Poisson distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi Square Test, Association of Attributes t Test - ANOVA, Standard deviation Coefficient of variations. Correlation and Regression Analysis, Use of excel sheet for research analysis, Data Analysis using statistical packages, SPSS. Data Collection and Analysis: Sources of Data - Primary, Secondary and Tertiary; Types of Data - Categorical, nominal & Ordinal; Methods of Collecting Data - Observation, field investigations; Direct studies - Reports, Records or Experimental observations; Sampling methods - Data Processing and Analysis strategies - Graphical representation - Descriptive Analysis - Inferential Analysis - Correlation analysis - Least square method - Hypothesis - testing - Generalization and Interpretation – Modeling
LIH	Scientific Writing: Structure and components of Scientific Reports; Types of Report - Technical Reports and Thesis - Significance - Different steps in the preparation - Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, Referencing and foot notes –Importance of Effective Communication; Preparing Research papers for journals, Seminars and Conferences - Design of paper using TEMPLATE; Preparation of Project Proposal - Title, Abstract, Introduction - Rationale, Objectives, Methodology -

	Time frame and work plan - Budget and Justification - References; Documentation and scientific writing Results and Conclusions, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography; Importance of Impact factor of a journal and citation Index
	Reference: Kothari, C. R. (2018), Research Methodology-methods and techniques, New Age International. Sahu, P. K. and Das, A. K. (2009). Agriculture and applied statistics, Vol-I, II. Kalyani Publishers, New Delhi. Gomez and Gomez. Statistical Procedures for Agricultural research, 1984. John Wiley & Sons, Inc. Newyork Peter Birmingham and David Wilkinson. Using Research Instruments. 2016. California state university Press. Patton, M. Q. Qualitative research & evaluation methods: Integrating theory and practice (4th ed.). 2015. Thousand Oaks, CA: SAGE Publications. Palys, T., & Atchison, C. Research decisions: Quantitative, qualitative, and mixed methods approaches (5th ed.). 2014. Toronto, Canada: Nelson Education. Michael P Marder, Research Methods for science, 2012. Cambridge university Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	25	25	25	25	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
FSC691	Seminar 1	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – I to VI					
Course Code	Course Name	L	T	P	Credits
FSC699	Research	0	-	75	75

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Design a research plan with proper review of literature	Analyse
CO2	Present a recent advance with critical analysis	Skill
CO3	Conduct the research experiment with critical research appetite	Skill
CO4	Equip with knowledge of conducting research with a high problem solving research appetite.	Analysis
CO5	Interpret the data obtained for the research experiment through statistical tools	Remember
CO6	Equip with knowledge of conducting research with a high problem solving research appetite.	Remember

b. Syllabus

Units	Content
PI	Review collection, documentation, and developing a research plan.
PII	Structuring a scientific report, synopsis preparation, and presentation.
PIII	Selection of crop,
PIV	Preparation of field,
PV	Plotting and experimental design,
PVI	Procurement of chemicals and materials, Preparation of reagents, conduct of lab experiment.
PVII	Recording the results for the parameters and treatments decided
PVIII	Study of relevant research papers
PIX	Writing of 'Introduction' component of dissertation
PX	Writing of 'Review of Literature' part of dissertation
PXI	Development of 'Material' component of experiment
PXII	Development of 'Method' component of experiment
PXIII	Study of relevant research papers
PXIV	Evaluation of appropriateness of experiment-specific statistical analysis
PXV	Analysing the data through appropriate statistical tools
PXVI	Writing results and discussion with critical research interpretation from review of literature, compiling the Introduction, review of literature, Materials and methods, results and discussion with proper summery and conclusion in the form of thesis, Presenting the final research hypothesis to the research advisory committee and audience.

c. Evaluation Scheme: By Research Advisory committee once in 6 months and final thesis evaluation by external examiner followed by viva-voce

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FSC604	Advanced laboratory techniques	1	-	2	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	Understanding the techniques of proximate component analysis.	Understand
CO2	Calibration and standardization of instruments	Analyze
CO3	Acquire the required skill on advanced instrumentation techniques.	Skill
CO4	Learning and application of techniques in textural properties of harvested produce	Apply

b. Syllabus

Units	Content
LI	General Aspects Safety Measures and Laboratory Maintenance: Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.
PII	Destructive and Non-destructive Analysis Methods: Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops.
PIII	Chromatographic and Microscopic Analysis: Basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra-filtration. Application of nuclear techniques in harvested produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce. Sensory Analysis: Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.
	Reference: • AOAC International. 2003. <i>Official Methods of Analysis of AOAC International</i>. 17th Ed. • Gaithersburg, MD, USA, Association of Analytical Communities, USA. • Clifton M and Pomeranz Y. 1988. <i>Food Analysis-Laboratory Experiments</i>. AVI Publication, USA. Leo ML. 2004. <i>Handbook of Food Analysis</i>. 2nd Ed. Vols. I-III, USA. • Linskens HF and Jackson JF. 1995. <i>Fruit Analysis</i>. Springer. • Pomrenz Y and Meloan CE. 1996. <i>Food Analysis – Theory and Practice</i>. CBS, USA. Ranganna S. 2001. <i>Handbook of Analysis and Quality Control for Fruit and Vegetable Products</i>. • 2nd Ed. Tata-McGraw-Hill, New Delhi.

	Thompson AK. 1995. <i>Post Harvest Technology of Fruits and Vegetables</i>. Blackwell Sciences. USA.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FSC607	Biodiversity and conservation of fruit crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	The student would be expected to learn about the importance, current status of biodiversity conservation, gene centers, and germplasm resources in fruit crops both globally and in India	Understand
CO2	Apply strategies for exploration, collection, characterization, and conservation of germplasm using in situ, ex situ, and cryopreservation methods, addressing issues like recalcitrance and long-term storage	Skill
CO3	Evaluate regulatory frameworks and legal instruments including plant quarantine, phytosanitary certification, IPR, PPV&FR Act, and breeders' and farmers' rights in relation to germplasm exchange and protection.	Analyze
CO4	Utilize modern tools such as GIS, DUS testing, and molecular/biochemical markers for germplasm documentation, biodiversity mapping, and detection of genetic constitution	Apply

b. Syllabus

Units	Content
LI	General Aspects Issues, Goals and Current Status: Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/ database of fruit crops in India. Germplasm Conservation Collection, Maintenance and Characterization: exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Germplasm conservation- <i>in situ</i> and <i>ex situ</i> strategies, on farm conservation; problem of recalcitrancy- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.
LII	Regulatory Horticulture Germplasm exchange, Quarantine and Intellectual Property Rights: Regulatory horticulture, inventory and exchange of fruit and nut germplasm, plant quarantine, phyto-sanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.
PIII	- Documentation of germplasm- maintenance of passport data and other records of accessions (2); - Field exploration trips and sampling procedures (2); - Exercise on <i>ex situ</i> conservation – cold storage, pollen/ seed

	storage (2); • Cryopreservation (2); • Visits to National Gene Bank and other centers of PGR activities (2); • Detection of genetic constitution of germplasm (2); • Germplasm characterization using a standardised DUS test protocol (2); • Special tests with biochemical and molecular markers (2). • Crops: Mango, citrus, guava, banana, papaya, grapes, custard, apple, ber, aonla, malus sp., Prunus sp. and litchi.
	Reference: • Dhillon BS, Tyagi RK, Lal A and Saxena S. 2004. <i>Plant Genetic Resource Management</i>. – • <i>Horticultural Crops</i>. Narosa Publishing House, New Delhi. • Engles JM, Ramanath RV, Brown AHD and Jackson MT. 2002. <i>Managing Plant Genetic Resources</i>, CABI, Wallingford, UK. • Frankel OH and Hawkes JG. 1975. <i>Crop Genetic Resources for Today and Tomorrow</i>. Cambridge University Press, USA. • Hancock J. 2012. <i>Plant Evolution and the Origin of Crops Species</i>. CAB International. Jackson M, Ford-Lloyd B and Parry M. 2014. <i>Plant Genetic Resources and Climate Change</i>. CABI, Wallingford, UK. • Moore JN and Ballington Jr, JR. 1991. <i>Genetic Resources of Temperate Fruit and Nut Crops</i>. • ISHS, Belgium. • Peter KV. 2008. <i>Biodiversity of Horticultural Crops</i>. Vol. II. Daya Publ. House, Delhi. Peter KV. 2011. <i>Biodiversity in Horticultural Crops</i>. Vol. III. Daya Publ. House, Delhi. • Rana JC and Verma VD. 2011. <i>Genetic Resources of Temperate Minor Fruits (Indigenous and Exotic)</i>. NBPGR, New Delhi. • Rajasekharan PE, Rao V and Ramanatha V. 2019. <i>Conservation and Utilization of Horticultural Genetic Resources</i>. Springer. • Sthapit B, et al. 2016. <i>Tropical Fruit Tree Diversity (Good Practices for in situ and ex situ conservation)</i>. Bioversity International. Routledge, Taylor and Francis Group. • Virchow D. 2012. <i>Conservation of Genetic Resources</i>, Springer Verlag, Berlin.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FSC608	Smart Fruit Production	3	-	0	3

b. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	Understanding of concepts of smart fruit production.	Understand
CO2	Drawing a linkage between crop modelling, forecasting in smart fruit production. and maintenance of fresh quality of floricultural produces	Analyze
CO3	Acquire the required skill sets of nanotechnology in smart fruit production.	Skill
CO4	Exploration of the Innovative Approaches for smart fruit production.	Apply

b. Syllabus

Units	Content
LI	.Introduction Importance and Overview: Introduction and importance; concepts and applications of artificial intelligence systems; case studies in horticulture. Crop Modelling and Forecasting GIS, Sensors and Wireless Systems: Application of sensors in fruit production, crop monitoring – crop load and stress incidence forecast modules, remote sensing, Geographical Information System (GIS), Differential Geo-Positioning System (DGPS) hi-tech nursery production of fruit crops under protected conditions, ultra modern wireless based drip irrigation network.
LII	Nanotechnology Concepts and Methods: Nanotechnology for smart nutrient delivery in fruit farming, concepts and methods, practical utility, nano-fertilizers, nano-herbicides; nano-pesticides
LIH	Innovative Approaches Mechanization, Automation and Robotics: Production systems amenable to automation and mechanization; automated protected structures (turn- key systems); hydroponics, aeroponics, bioreactors for large scale plant multiplication; Use of drones and robotics in fruit growing – robotic planters, sprayers, shakers, harvesters, stackers, etc. Visit to Hi-tech facilities.
	Reference: Chadha <i>et al.</i> 2017. <i>Doubling Farmers Incomes through Horticulture</i>. Daya Publishing House, New Delhi. Chadha <i>et al.</i> 2019. <i>Shaping the Future of Horticulture</i>. Kruger Brentt Publishers, UK. Hewett EW. 2013. <i>Automation, Mechanization and Robotics in Horticulture</i>. In: Workshop on Emerging Postharvest Technologies. UC, Davis, USA. Peter KV. 2016. <i>Innovations in Horticulture</i>. NIPA, New Delhi. Prasad S, Singh D and Bhardwaj RL. 2012. <i>Hi-Tech Horticulture</i>. Agrobios (India). Tyagi, S. 2019. <i>Hi- Tech Horticulture</i>. Vols. 1 to 7. NIPA, New Delhi.

	Zhang Q. 2017. <i>Automation in Tree Fruit production – Principles and Practice</i> . CABI. http://horticulture.ucdavis.edu - Innovative Technology for Horticultural Department.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FSC605	Arid and dryland fruit production	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyse the pros and cons of fruit production in arid and dryland conditions. to propel the booming fruit industry	Analyze
CO2	The application of the latest techniques in growing and managing fruit crops in arid and dryland situations.	Understand
CO3	Well-versed with the approaches for efficient input management in in arid and dryland conditions	Skill
CO4	Malady diagnosis in fruit crop production in arid zones and project preparation for commercialization.	Remember

b. Syllabus

Units	Content
LI	Introduction General Concepts and Current Scenario: Characteristics features and major constraints of the arid and dryland region, distinguishing features of the fruit species trees for adaptation in adapting to the region, nutritional and pharmaceutical importance, national problems. Propagation, Planting Systems and Crop Regulation: Recent advances in propagation – root stocks, planting systems, High density planting,
LII	Crop modelling, Precision farming, decision support systems – aspects of crop regulation- physical and chemical regulation, effects on physiology and development, influence of stress factors. Stress Mitigation and Integrated Approaches: Strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, total quality management (TQM). Crops Aonla, Annonas, ber, woodapple, bael, jamun, date palm, Dragon fruit, khejri, kair, pilu, lasoda, manila tamarind, tamarind, mahua, khirni, seabuckthorn, chironji, phalsa, karonda, Fig, and other minor fruits of regional importance.
PI	Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to arid zone orchards, Project preparation for establishing commercial orchards. Visit of ICAR institute like IIHR, Bengaluru, TNAU, Coimbatore, CRIDA, CIAH, Bikaner, SAUs like MPUAT, Udaipur, NDUAT, Faizabad, UP.
	Reference: - Hiwale S. 2015. <i>Sustainable Horticulture in Semiarid Drylands</i>. Springer. - Krishna H and Sharma RR. 2017. <i>Fruit Production – Minor Fruits</i>. Daya Publishing House, Delhi. - More T A, Singh RS, Bhargava R and Sharma BD. 2012. <i>Arid Horticulture for Nutrition and Livelihood</i>. Agrotech Publishing Academy, Udaipur (Rajasthan).

	• Pareek OP, Sharma S and Arora RK. 2007. <i>Underutilised Edible Fruits and Nuts</i>, IPGRI, Rome. • Peter K.V. 2010. <i>Underutilized and Underexploited Horticultural Crops</i>. NIPA, New Delhi. Saroj PL, Dhandar DG and Vashishta BB. 2004. <i>Advances in Arid Horticulture</i>, Vol.-1 Present • <i>Status</i>. IBDC, Lucknow. • Saroj P L and Awasthi OP. 2005. <i>Advances in Arid Horticulture</i>, Vol: II: <i>Production Technology of Arid and Semiarid Fruits</i>. IBDC, Lucknow. • Sontakke MB. 2014. <i>Production and Management of Fruit crops in Arid/ Drylands</i>. AgrotechPublishing Academy, Udaipur (Rajasthan).
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
CPERPE	Research and Publication Ethics	1	-	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire the knowledge on Philosophy and ethics, Scientific conduct, Publication ethics.	Understand
CO2	Acquire the knowledge on Open access publishing, Publication misconduct, data base and plagiarism	Apply

b. Syllabus

Units	Content
LI	Philosophy and ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and relations. Scientific conduct: Ethics with respect to science and research, Intellectual honest and research integrity. Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Publication ethics: Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
PI	Open access publishing: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Publication misconduct: A. Group Discussions, Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad. B. Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools. Databases and research metrics: A. Databases, Indexing databases, Citation databases: Web of Science, Scopus, etc. B. Research Metrics, Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.
	Reference: 1. https://www.ugc.ac.in/pdfnews/9836633_Research-and-Publication-Ethics.pdf .

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	2	0
CO2	2	3	1	1	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	Total
Internal	20	20	40
External	30	30	60
Total	50	50	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
FSC692	Seminar 2	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
FSC610	Comprehensive Exam, Qualifying Viva-voce (Non- Credit Compulsory)	-	-	-	-

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquiring overall knowledge on specialized courses undergone in the respective specializations of students.	Analyse

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	Total	Result
Internal	0	0	Satisfactory/ non- satisfactory
External	100	100	
Total	100	100	

VEGETABLE SCIENCE

SEMESTER- I					
Course Code	Course Name	L	T	P	Credits
VSC601	Recent Trends in Vegetable Production	3	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The students are exposed to acquire the knowledge about recent trends in production technology of vegetable crops	Understand
CO2	To keep abreast with latest developments and trends in production technology of vegetable crops.	Skill
CO3	Modern technologies such as hi-tech nursery management, protected cultivation (polyhouse, net house), and crop modeling for year-round and sustainable vegetable production	Analyze
CO4	Diagnose and manage the physiological disorders, nutrient deficiencies, and develop suitable cropping systems for export, processing, and organic gardening purposes	Apply

b. Syllabus

Units	Content
LI	Present status and prospects of vegetable cultivation; nutritional, antioxidant and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; Hi-tech nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies/ disorders and correction methods; different cropping systems; mulching; Protected cultivation of vegetables, containerized culture for year-round vegetable production; low-cost polyhouse; net house production; crop modelling, organic gardening; vegetable production for pigments, export and processing of: <i>Solanaceous crops</i> : Tomato, brinjal, chilli, sweet pepper and potato.
LII	<i>Cole crops</i> : Cabbage, cauliflower and knol-khol, sprouting broccoli.
LIII	Okra, onion, peas and beans, amaranth and drumstick.
LIV	<i>Root crops and cucurbits</i> : Carrot, beet root, turnip and radish and cucurbits
LV	<i>Tuber crops</i> : Sweet potato, Cassava, elephant foot yam, Dioscorea and taro.
	<i>References</i> 1. Bose TK and Som NG. 1986. <i>Vegetable crops of India</i>. Naya prokash. 2. Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. <i>Vegetable crops</i>. Vols. I-III. Naya Udyog. 3. Brewster JL. 1994. <i>Onions and other vegetable alliums</i>. CABI. 4. Chadha KL and Kalloo G (Eds.). 1993-94. <i>Advances in horticulture</i> Vols. V-X. Malhotra Publ.House. 5. Chadha KL (Ed.). 2002. <i>Hand book of horticulture</i>. ICAR. 6. Chauhan DVS (Ed.). 1986. <i>Vegetable production in India</i>. Ram prasad and Sons.

7. Fageria MS, Choudhary BR and Dhaka RS. 2000. *Vegetable crops: production technology*. Vol.II. Kalyani.
8. FFTC. *Improved vegetable production in Asia*. Book Series No. 36.
9. Ghosh SP, Ramanujam T, Jos JS, Moorthy SN and Nair RG. 1988. *Tuber crops*. Oxford and IBH.
10. Gopalakrishanan TR. 2007. *Vegetable crops*. New India Publ. Agency.
11. Hazra P and Som MG. 2015. *Seed production and hybrid technology of vegetable crops*. Kalyani publishers, Ludhiana.
12. Hazra P. 2016. *Vegetable science*. 2nd edn, Kalyani publishers, Ludhiana.
13. Hazra P. 2019. *Vegetable production and technology*. New India publishing agency, New Delhi.
14. Kallo G and Singh K. (Ed.). 2001. *Emerging scenario in vegetable research and development*. Research periodicals and Book Publ. House.
15. Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S and Pallai SV. 1996. *Tropical*
16. *tuber crops, problems, prospects and future strategies*. Oxford and IBH.
17. Rana MK. 2008. *Olericulture in India*. Kalyani Publishers, New Delhi.
18. Rana MK. 2008. *Scientific cultivation of vegetables*. Kalyani Publishers, New Delhi.
19. Rubatzky VE and Yamaguchi M. (Eds.). 1997. *World vegetables: principles, production and nutritive values*. Chapman and Hall.
20. Saini GS. 2001. *A Text Book of oleri and floriculture*. Aman Publishing House.
21. Salunkhe DK and Kadam SS. (Ed.). 1998. *Hand book of vegetable science and technology: production, composition, storage and processing*. Marcel Dekker.
22. Shanmugavelu KG. 1989. *Production technology of vegetable crops*. Oxford and IBH.
23. Sin MT and Onwueme IC. 1978. *The tropical tuber crops*. John Wiley and Sons.
24. Singh DK. 2007. *Modern vegetable varieties and production technology*. International book distributing Co.
25. Singh NP, Bhardwaj AK, Kumar A and Singh KM. 2004. *Modern technology on Vegetable production*. International book distr. Co.
26. Singh PK, Dasgupta SK and Tripathi SK. 2006. *Hybrid vegetable development*. International book distr. Co.
27. Singh SP. (Ed.). 1989. *Production technology of vegetable crops*. Agril. Comm. Res. Centre.
28. Thamburaj S and Singh N. (Eds.). 2004. *Vegetables, tuber crops and spices*. ICAR.
29. Thompson HC and Kelly WC. (Eds.). 1978. *Vegetable crops*. Tata McGraw-Hill.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER- I					
Course Code	Course Name	L	T	P	Credits
VSC602	Advances in Breeding of Vegetable Crops	3	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The evolution, distribution, cytogenetics, and genetic diversity of crop plants, including wild relatives and genetic resources for breeding programs	Understand
CO2	Inheritance patterns of qualitative and quantitative traits, and apply concepts such as genetic divergence, heterosis, plant ideotype, and selection indices in crop improvement.	Analyze
CO3	Advanced breeding techniques including hybridization, mutation breeding, ploidy manipulation, and pre-breeding to develop varieties resistant to biotic and abiotic stresses with improved quality and processing traits	Skill
CO4	Modern tools such as in-vitro breeding, marker-assisted selection, haploid breeding, biofortification, and transgenic technology for accelerating crop improvement	Apply

b. Syllabus

Units	Content
LI	Evolution, distribution, cytogenetics, Genetics and genetic resources, wild relatives, genetic divergence, hybridization, inheritance of qualitative and quantitative traits, heterosis breeding, plant ideotype concept and selection indices, breeding mechanisms, pre breeding, mutation breeding, ploidy breeding, breeding for biotic and abiotic stresses, breeding techniques for improving quality and processing characters, biofortification, <i>in-vitro</i> breeding, marker assisted breeding, haploidy, development of transgenic: <i>Solanaceous crops</i> : Tomato, brinjal, chilli, sweet pepper and potato.
LII	Cucurbits and Cole crops
LIII	<i>Legumes and leafy vegetables</i> —Peas and Beans, Amaranth, Palak, Chenopods and Lettuce
LIV	<i>Root crops and onion</i> —Carrot, Beetroot, Radish, Turnip, Onion
LV	<i>Tuber crops</i> —Sweet potato, Tapioca, Elephant foot yam, Colocasia, Dioscorea
	<i>References</i> - Allard RW. 1999. <i>Principle of plant breeding</i>. John Willey and Sons, USA. - Basset MJ. (Ed.). 1986. <i>Breeding vegetable crops</i>. AVI Publ. - Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. <i>Plant genetic resources: horticultural crops</i>. Narosa Publ. House. - Fageria MS, Arya PS and Choudhary AK. 2000. <i>Vegetable crops: Breeding and seed production</i>. Vol. I. Kalyani. - Gardner EJ. 1975. <i>Principles of genetics</i>. John Wiley and Sons. - Hayes HK, Immer FR and Smith DC. 1955. <i>Methods of plant breeding</i>. McGraw-Hill.

7. Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. *Plant Breeding-principles and prospects*. Chapman and Hall.
8. Hazra P and Som MG. 2015. *Vegetable science* (Second revised edition), Kalyani publishers, Ludhiana, 598 p
9. Hazra P and Som MG. 2016. *Vegetable seed production and hybrid technology* (Second revised edition), Kalyani Publishers, Ludhiana, 459 p
10. Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.
11. Kalloo G. 1998. *Vegetable breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
12. Kumar JC and Dhaliwal MS. 1990. *Techniques of developing hybrids in vegetable crops*. Agro Botanical Publ.
13. Paroda RS and Kalloo G. (Eds.). 1995. *Vegetable research with special reference to hybrid technology in Asia-Pacific Region*. FAO.
14. Peter KV and Pradeepkumar T. 2008. *Genetics and breeding of vegetables*. Revised, ICAR.
15. Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
16. Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume II. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p.
17. Peter KV and Hazra P. (Eds). 2015. *Hand book of vegetables* Volume III. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p.
18. Rai N and Rai M. 2006. *Heterosis breeding in vegetable crops*. New India Publ. Agency.
19. Ram HH. 1998. *Vegetable breeding: principles and practices*. Kalyani Publishers, New Delhi.
20. Simmonds NW. 1978. *Principles of crop improvement*. Longman. Singh BD. 1983. *Plant Breeding*. Kalyani Publishers, New Delhi.
21. Kalyani Publishers, New Delhi.
22. Singh BD. 1983. *Plant breeding*. Kalyani Publishers, New Delhi.
23. Singh PK, Dasgupta SK and Tripathi SK. 2004. *Hybrid vegetable development*. International Book Distributing Co.
24. Swarup V. 1976. *Breeding procedure for cross-pollinated vegetable crops*. ICAR.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER- I					
Course Code	Course Name	L	T	P	Credits
VSC604	Seed Certification, Processing and Storage of Vegetable Seeds	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	After successful completion of this course, the students are expected to Acquire the knowledge on seed certification	Understand
CO2	The students are expected to Acquire the knowledge on field inspection, sampling, isolation, rouging, and certification procedures across seed production stages	Skill
CO3	Planning and management of seed processing operations	Apply
CO4	Marketing and storage strategies by addressing viability, longevity, transport	Analyze

b. Syllabus

Units	Content
LI	Seed certification, history, concepts and objectives, seed certification agency, phases of seed certification, Indian Minimum seed Certification standards, Planning and management of seed certification programmes. Principles and procedures of field inspection, seed sampling, testing and granting certification, OECD certification Schemes.
LII	Principles of seed processing, Methods of seed drying and cleaning, seed processing plant- Layout and design, seed treatment, seed quality enhancement, packaging and marketing. Principles of Seed Storage, orthodox/ recalcitrant seeds, types of storage (open, bulk, controlled, germplasm, cryopreservation), factors affecting seed longevity in storage (Pre and post harvest factors). Seed aging and deterioration, maintenance of seed viability and vigor during storage, storage methods, storage structures, transportation and marketing of seeds.
PI	General procedures of seed certification; • Field inspection and standards; • Isolation and rouging; • Inspection and sampling at harvesting, threshing and processing; • Testing physical purity, germination and moisture, grow-out test; • Visit to regulatory seed testing and plant quarantine laboratories; • Seed processing plants and commercial seed stores.
	<i>References</i> 1. Agarwal PK and Anuradha V. 2018. <i>Fundamentals of seed science and technology</i>. Brilliant publications, New Delhi. 2. Basra AS. 2000. <i>Hybrid seed production in vegetables</i>. CRC press, Florida, USA. 3. Bench ALR and Sanchez RA. 2004. <i>Handbook of seed physiology</i>. Food products press, NY/ London.

	4. Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. <i>Testing of distinctiveness, uniformity and stability for plant variety protection</i>. IARI, New Delhi 5. Copland LO and McDonald MB. 2004. <i>Seed science and technology</i>, Kluwer academic press. 6. Fageria MS, Arya PS and Choudhry AK. 2000. <i>Vegetable crops: breeding and seed production</i> Vol 1. Kalyani publishers, New Delhi. 7. George RAT. 1999. <i>Vegetable seed production</i> (2nd Edition). CAB International. 8. Hazra P and Som MG. 2016. <i>Vegetable seed production and hybrid technology</i> (Second revised edition), Kalyani publishers, Ludhiana, 459p 9. Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. <i>Seed: A global perspective</i>. Associated publishing company, New Delhi.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	2	3	3	3
CO4	3	2	3	3

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER- I					
Course Code	Course Name	L	T	P	Credits
VSC607	Biotechnological Approaches in Vegetable Crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The student would be expected to learn different biotechnological tools for vegetable crop improvement	Understand
CO2	Advanced cellular and molecular techniques like somatic embryogenesis, protoplast fusion, synthetic seed production, haploid and cybrid technology for genetic enhancement of vegetable crops.	Skill
CO3	Utilize molecular marker technologies (RFLP, AFLP, RAPD, SSR, SNPs), QTL mapping, MAS, allele mining (TILLING, Eco-TILLING), and DNA fingerprinting to identify, characterize, and improve desirable traits in vegetable crops	Utilize
CO4	The student would be expected to learn genomic tools including, NGS, genetic engineering, gene cloning, RNAi, genome editing (ZFN, TALENs, CRISPR)	Apply

b. Syllabus

Units	Content
LI	<i>Importance and scope of biotechnology</i> – in vegetable crop improvement. <i>In-vitro</i> culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture. Crops: Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables. <i>Somatic embryogenesis</i> – somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Haploids, Somatic hybrids and cybrids and their application in vegetable improvement programme. Crops: Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables
LII	<i>Blotting techniques, DNA finger printing</i> – Molecular markers/ DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allele mining by TILLING and Eco-TILLING. Crops: Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables. <i>Plant genetic engineering</i> – Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Biosafety issue, regulatory issues for commercial approval. Crops: Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables. <i>Concepts and methods of next generation sequencing</i> (NGS)- Genome sequencing, transcriptomics, proteomics, metabolomics. Genome editing (ZFN, TALENs and CRISPR). Crops: Solanaceous crops, cole crops, cucurbitaceous crops, root vegetables, garden pea, onion, potato and leafy vegetables ¹
PI	. Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production

	• <i>In-vitro</i> mutation induction, <i>in-vitro</i> rooting – hardening at primary and secondary nurseries • DNA isolation from economic vegetable crop varieties – Quantification and amplification • DNA and Protein profiling – molecular markers, PCR Handling • Vectors for cloning and particle bombardment • DNA fingerprinting of flower crop varieties • Project preparation for establishment of low, medium and high cost tissue culture
	References 1. Bajaj YPS. (Ed.). 1987. <i>Biotechnology in agriculture and forestry</i>. Vol. XIX. Hitech and Micropropagation. Springer. 2. Chadha KL, Ravindran PN and Sahijram L. (Eds.). 2000. <i>Biotechnology of horticulture and plantation crops</i>. Malhotra Publ. House. 3. Debnath M. 2005. <i>Tools and techniques of biotechnology</i>. Pointer publication, New Delhi. 4. Glover MD. 1984. <i>Gene cloning: the mechanics of DNA manipulation</i>. Chapman and Hall. 5. Gorden H and Rubsell S. 1960. <i>Hormones and cell culture</i>. AB Book Publ. 6. Keshavachandran R. 2007. <i>Recent trends in biotechnology of horticultural crops</i>. New India Publ. Agency. 7. Keshavachandran R and Peter KV. 2008. <i>Plant biotechnology; tissue culture and gene transfer</i>. Orient and Longman, USA. 8. Keshavachandran R. 2007. <i>Recent trends in biotechnology of horticultural crops</i>. New-India Publication Agency, New Delhi. 9. Panopoulos NJ. (Ed.). 1981. <i>Genetic engineering in plant sciences</i>. Praeger Publ. 10. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. <i>Biotechnology of horticultural crops</i>. Vols. I-III. Naya Prokash. 11. Pierik RLM. 1987. <i>In-vitro culture of higher plants</i>. Martinus Nijhoff Publ. 12. Prasad S. 1999. <i>Impact of plant biotechnology on horticulture</i>. 2nd Ed. Agro Botanica. 13. Rout GR and Peter KV. 2018. <i>Genetic engineering of horticultural crops</i>. Academic Press Elsevier, USA. 14. USA. 15. Sharma R. 2000. <i>Plant tissue culture</i>. Campus Books. 16. Singh BD. 2010. <i>Biotechnology- expanding horizons</i>. Kalyani Publishers, New Delhi. 17. Skoog Y and Miller CO. 1957. <i>Chemical regulation of growth and formation in plant tissue cultured in-vitro</i>. Attidel. II Symp. On biotechnology action of growth substance. 18. Vasil TK, Vasi M, While DNR and Bery HR. 1979. <i>Somatic hybridization and genetic manipulation in plants, plant regulation and world agriculture</i>. Planum Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
VSC609	Research Methodology	3	-	0	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire knowledge of the literature and a ample understanding of methodologies that are directly or indirectly relevant to their own research	Remember
CO2	Create, develop and exchange research knowledge in collaborative manner for the benefit society	Understand
CO3	Ascertain, deduce and link with new idea so as to make a quality publication that is acceptable by a peer review	Apply
CO4	Manage complex ethical concerns and make a vivid verdicts	Analyze

b. Syllabus

Units	Content
LI	Introduction to Research Methodology: Meaning and importance of Research - Types of Research - Selection and formulation of Research Problem; Research Design - Need - Features - Inductive, Deductive and Development of models; Developing a Research Plan - Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs; Hypothesis - Different Types - Significance - Development of Working Hypothesis, Null hypothesis; Research Methods: Scientific method vs. Arbitrary Method; Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive - Inductive logical process - Different types of inductive logical methods; Critical Literature Review: Primary and Secondary Sources, Web sources
LII	Statistics and Computer applications: Introduction to Statistics – Probability Theories - Conditional Probability, Poisson distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi Square Test, Association of Attributes t Test - ANOVA, Standard deviation Coefficient of variations. Correlation and Regression Analysis, Use of excel sheet for research analysis, Data Analysis using statistical packages, SPSS. Data Collection and Analysis: Sources of Data - Primary, Secondary and Tertiary; Types of Data - Categorical, nominal & Ordinal; Methods of Collecting Data - Observation, field investigations; Direct studies - Reports, Records or Experimental observations; Sampling methods - Data Processing and Analysis strategies - Graphical representation - Descriptive Analysis - Inferential Analysis - Correlation analysis - Least square method - Hypothesis - testing - Generalization and Interpretation – Modeling
LIII	Scientific Writing: Structure and components of Scientific Reports; Types of Report - Technical Reports and Thesis - Significance - Different steps in the preparation - Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, Referencing and foot notes –Importance of Effective Communication; Preparing Research papers for journals, Seminars and Conferences - Design of paper using TEMPLATE; Preparation of Project Proposal

	- Title, Abstract, Introduction - Rationale, Objectives, Methodology - Time frame and work plan - Budget and Justification - References; Documentation and scientific writing Results and Conclusions, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography; Importance of Impact factor of a journal and citation Index
	Reference: Kothari, C. R. (2018), Research Methodology-methods and techniques, New Age International. Sahu, P. K. and Das, A. K. (2009). Agriculture and applied statistics, Vol-I, II. Kalyani Publishers, New Delhi. Gomez and Gomez. Statistical Procedures for Agricultural research, 1984. John Wiley & Sons, Inc. Newyork Peter Birmingham and David Wilkinson. Using Research Instruments. 2016. California state university Press. Patton, M. Q. Qualitative research & evaluation methods: Integrating theory and practice (4th ed.). 2015. Thousand Oaks, CA: SAGE Publications. Palys, T., & Atchison, C. Research decisions: Quantitative, qualitative, and mixed methods approaches (5th ed.). 2014. Toronto, Canada: Nelson Education. Michael P Marder, Research Methods for science, 2012. Cambridge university Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	25	25	25	25	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
VSC691	Seminar 1	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – I to VI					
Course Code	Course Name	L	T	P	Credits
VSC699	Research	0	-	75	75

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Design a research plan with proper review of literature	Analyse
CO2	Present a recent advance with critical analysis	Skill
CO3	Conduct the research experiment with critical research appetite	Skill
CO4	Equip with knowledge of conducting research with a high problem solving research appetite.	Analysis
CO5	Interpret the data obtained for the research experiment through statistical tools	Remember
CO6	Equip with knowledge of conducting research with a high problem solving research appetite.	Remember

b. Syllabus

Units	Content
PI	Review collection, documentation, and developing a research plan.
PII	Structuring a scientific report, synopsis preparation, and presentation.
PIII	Selection of crop,
PIV	Preparation of field,
PV	Plotting and experimental design,
PVI	Procurement of chemicals and materials, Preparation of reagents, conduct of lab experiment.
PVII	Recording the results for the parameters and treatments decided
PVIII	Study of relevant research papers
PIX	Writing of 'Introduction' component of dissertation
PX	Writing of 'Review of Literature' part of dissertation
PXI	Development of 'Material' component of experiment
PXII	Development of 'Method' component of experiment
PXIII	Study of relevant research papers
PXIV	Evaluation of appropriateness of experiment-specific statistical analysis
PXV	Analysing the data through appropriate statistical tools
PXVI	Writing results and discussion with critical research interpretation from review of literature, compiling the Introduction, review of literature, Materials and methods, results and discussion with proper summery and conclusion in the form of thesis, Presenting the final research hypothesis to the research advisory committee and audience.

c. Evaluation Scheme: By Research Advisory committee once in 6 months and final thesis evaluation by external examiner followed by viva-voce

SEMESTER- II					
Course Code	Course Name	L	T	P	Credits
VSC608	Advanced Laboratory Techniques for Vegetable Crops	1	-	2	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Demonstrate proper safety measures, laboratory maintenance, and sampling procedures for quantitative and qualitative analysis of vegetable crops	Understand
CO2	Acquire the required skill on physical and biochemical properties.	Skill
CO3	Apply advanced analytical tools including chromatographic (GC, HPLC, GC-MS), electrophoretic, and microscopic techniques (fluorescent, SEM, phase-contrast) for quality evaluation and adulteration detection.	Apply
CO4	Learning and application of techniques in textural properties of harvested vegetable produce	Analyze

b. Syllabus

Units	Content
LI	<i>Safety measures and laboratory maintenance</i> – Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solutions, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.
PI	<i>Destructive and non-destructive analysis methods</i> – Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops. <i>Chromatographic and microscopic analysis</i> - basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques in harvested produce. Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce. <i>Sensory analysis</i> – Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.
PII	• Determination of moisture, relative water content and physiological loss in weight; • Determination of biochemical components in horticultural produce; • Calibration and standardization of instruments; • Textural properties of harvested produce; • Determination of starch index (SI); • Specific gravity for determination of maturity assessment, and pH of produce; • Detection of adulterations in fresh as well as processed products; • Non-destructive determination of colour, ascorbic acid, vitamins, carotenoids, sugars and starch;

	• Estimation of rate of ethylene evolution using gas chromatograph (GC); • Use of advanced microscopes (fluorescent, scanning electron microscope, phase contrast, etc.).
	<i>References</i> 1. AOAC International. 2003. <i>Official methods of analysis of AOAC international</i>. 17th Ed. Gaithersburg, MD, USA, association of analytical communities, USA. 2. Clifton M and Pomeranz Y. 1988. <i>Food analysis – laboratory experiments</i>. AVI publication, USA. 3. Linskens HF and Jackson JF. 1995. <i>Fruit analysis</i>. Springer. 4. Leo ML. 2004. <i>Handbook of food analysis</i>, 2nd Ed. Vols. I-III, USA. 5. Pomrenz Y and Meloan CE. 1996. <i>Food analysis – theory and practice</i>. CBS, USA. 6. Ranganna S. 2001. <i>Handbook of analysis and quality control for fruit and vegetable products</i>. 2nd Ed. Tata-McGraw-Hill, New Delhi. 7. Thompson AK. 1995, <i>Postharvest technology of fruits and vegetables</i>. Blackwell sciences, USA.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
VSC606	Biodiversity and conservation of vegetable crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	The student would be expected to learn about the importance, current status of biodiversity conservation, gene centers, and germplasm resources in vegetable crops both globally and in India	Understand
CO2	Apply strategies for exploration, collection, characterization, and conservation of germplasm using in situ, ex situ, and cryopreservation methods, addressing issues like recalcitrance and long-term storage	Skill
CO3	Evaluate regulatory frameworks and legal instruments including plant quarantine, phytosanitary certification, IPR, PPV&FR Act, and breeders' and farmers' rights in relation to germplasm exchange and protection.	Analyze
CO4	Utilize modern tools such as GIS, DUS testing, and molecular/biochemical markers for germplasm documentation, biodiversity mapping, and detection of genetic constitution	Apply

b. Syllabus

Units	Content
LI	<i>General aspects: issues, goals and current status:</i> Biodiversity and conservation; issues and goals- needs and challenges; present status of gene centres; world's major centres of fruit crop domestication; current status of germplasm availability/ database of fruit crops in India <i>Germplasm conservation: collection, maintenance and characterization:</i> Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections. Germplasm conservation- insitu and ex situ strategies, on farm conservation; problem of recalcitrance- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.
LII	<i>Regulatory horticulture:</i> Germplasm exchange, quarantine and intellectual property rights germplasm exchange, quarantine and intellectual property rights regulatory horticulture, inventory and exchange of fruit and nut germplasm, plant quarantine, phytosanitary certification, detection of genetic constitution of germplasm and maintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. GIS and documentation of local biodiversity, Geographical indications, GIS application in horticultural mapping and spatial analyses of field data; benefits of GI protection; GI tagged fruit varieties in India.
PI	- Documentation of germplasm- maintenance of passport data and other records of accessions; - Field exploration trips and sampling procedures; - Exercise on <i>ex situ</i> conservation – cold storage, pollen/ seed storage - Cryopreservation;

	• Visits to national gene bank and other centers of PGR activities; • Detection of genetic constitution of germplasm; • Germplasm characterization using a standardised DUS test protocol; • Special tests with biochemical and molecular markers.
	Reference: ▪ Dhillon BS, Tyagi RK, Lal A and Saxena S. 2005. <i>Plant genetic resource management. – horticultural crops</i>. Narosa publishing house, New Delhi. ▪ Engles JM, Ramanath RV, Brown AHD and Jackson MT. 2002. <i>Managing plant genetic resources</i>, CABI, Wallingford, UK. University Press, USA. ▪ Hancock J. 2012. <i>Plant evolution and the origin of crops species</i>. CAB International. ▪ Jackson M, Ford-Lloyd B and Parry M. 2014, <i>Plant genetic resources and climate change</i>. CABI, Wallingford, UK ▪ Peter KV. 2008. <i>Biodiversity of horticultural crops</i>. Vol. II. Daya Publ. House, Delhi. Peter KV. 2011. <i>Biodiversity in horticultural crops</i>. Vol.III. Daya Publ. House, Delhi. ▪ Rajasekharan PE, Rao V and Ramanatha V. 2019. <i>Conservation and utilization of horticultural genetic resources</i>. Springer. ▪ Rana JC and Verma VD. 2011. <i>Genetic resources of temperate minor fruits (indigenous and exotic)</i>. NBPGR, New Delhi. ▪ Sthapit et al. 2016. <i>Tropical fruit tree diversity (good practices for in situ and ex situ conservation)</i>. ▪ Bioversity international. routledge, Taylor and Francis Group. ▪ Virchow D. 2012. <i>Conservation of genetic resources</i>, Springer Verlag, Berlin

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER- II					
Course Code	Course Name	L	T	P	Credits
VSC605	Breeding for Special Traits in Vegetable Crops	3	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	After successful completion of this course, the students are expected to understand the nutritional constituents, genetics of vegetables, their role in human health in different vegetable crops	Understand
CO2	Apply breeding strategies to develop nutrient-rich vegetable varieties for both market and industrial applications	Skill
CO3	Apply molecular and biotechnological approaches, including biofortification and genetic engineering, to improve micronutrient content and color traits in key vegetable groups	Apply
CO4	Bioavailability and their impact on malnutrition, incorporating them into future breeding program for quality improvements	Analyze

b. Syllabus

Units	Content
LI	Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and color content. Brassica group, carrot and beetroot, Tomato, brinjal, peppers and potato. Molecular markers, QTL mapping, SNPs discoveries, for novel traits in vegetable crops.
LII	Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and color content. Green leafy vegetables, Legume crops and okra, Cucurbitaceous vegetable crops and edible Alliums. Molecular markers, QTL mapping, SNPs discoveries, for novel traits in vegetable crops.
LIII	Biofortification in vegetable crops, genetic engineering for improvement of quality traits in vegetable crops, bioavailability of dietary nutrients from improved vegetable crops and impact on micronutrient malnutrition, achievements and future prospects in breeding for quality traits in vegetables.
	<i>References</i> - Allard RW. 1999. <i>Principle of plant breeding</i>. John Willey and Sons, USA. - Basset MJ. (Ed.). 1986. <i>Breeding vegetable crops</i>. AVI Publ. - Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. <i>Plant genetic resources: horticultural crops</i>. Narosa Publ. House. - Fageria MS, Arya PS and Choudhary AK. 2000. <i>Vegetable crops: Breeding and seed production</i>. Vol. I. Kalyani. - Gardner EJ. 1975. <i>Principles of genetics</i>. John Wiley and Sons. - Hayes HK, Immer FR and Smith DC. 1955. <i>Methods of plant breeding</i>. McGraw-Hill.

	7. Hayward MD, Bosemark NO and Romagosa I. (Eds.). 1993. <i>Plant Breeding-principles and prospects</i>. Chapman and Hall. 8. Hazra P and Som MG. 2015. <i>Vegetable science</i> (Second revised edition), Kalyani publishers, Ludhiana, 598 p 9. Hazra P and Som MG. 2016. <i>Vegetable seed production and hybrid technology</i> (Second revised edition), Kalyani Publishers, Ludhiana, 459 p 10. Kalloo G. 1988. <i>Vegetable breeding</i> (Vol. I, II, III). CRC Press, Fl, USA. 11. Kalloo G. 1998. <i>Vegetable breeding</i>. Vols. I-III (Combined Ed.). Panima Edu. Book Agency. 12. Kumar JC and Dhaliwal MS. 1990. <i>Techniques of developing hybrids in vegetable crops</i>. Agro Botanical Publ. 13. Paroda RS and Kalloo G. (Eds.). 1995. <i>Vegetable research with special reference to hybrid technology in Asia-Pacific Region</i>. FAO. 14. Peter KV and Pradeepkumar T. 2008. <i>Genetics and breeding of vegetables</i>. Revised, ICAR. 15. Peter KV and Hazra P. (Eds). 2012. <i>Hand book of vegetables</i>. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p. 16. Peter KV and Hazra P. (Eds). 2015. <i>Hand book of vegetables</i> Volume II.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p. 17. Peter KV and Hazra P. (Eds). 2015. <i>Hand book of vegetables</i> Volume III.Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p. 18. Rai N and Rai M. 2006. <i>Heterosis breeding in vegetable crops</i>. New India Publ. Agency. 19. Ram HH. 1998. <i>Vegetable breeding: principles and practices</i>. Kalyani Publishers, New Delhi. 20. Simmonds NW. 1978. <i>Principles of crop improvement</i>. Longman. Singh BD. 1983. <i>Plant Breeding</i>. Kalyani Publishers, New Delhi. 21. Kalyani Publishers, New Delhi. 22. Singh BD. 1983. <i>Plant breeding</i>. Kalyani Publishers, New Delhi. 23. Singh PK, Dasgupta SK and Tripathi SK. 2004. <i>Hybrid vegetable development</i>. International Book Distributing Co. 24. Swarup V. 1976. <i>Breeding procedure for cross-pollinated vegetable crops</i>. ICAR.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
VSC603	Abiotic Stress Management in vegetable crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	Understand the types of environmental stresses and soil-plant-water relationships in various vegetable crops	Understand
CO2	Experiments to measure stress responses in vegetables under simulated stress environments for developing adaptive cultivation strategies	Skill
CO3	Management techniques to mitigate the effects of abiotic stresses on vegetable production.	Apply

b. Syllabus

Units	Content
LI	<i>Environmental stress</i> —its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress. <i>Mechanism and measurements</i> —tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.
LII	<i>Soil-plant-water relations</i> —under different stress conditions in vegetable crops production and their management practices. Techniques of vegetable growing under water deficit, water logging, salinity and sodicity. Use of chemicals—techniques of vegetable growing under high and low temperature conditions, use of chemicals and antitranspirants in alleviation of different stresses.
PI	• Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops; • Measurement of tolerance to various stresses in vegetable crops; • Short term experiments on growing vegetable under water deficit, water logging, salinity and sodicity, high and low temperature conditions; • Use of chemicals for alleviation of different stresses.
	Reference: ▪ Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa Publ. House. ▪ Dwivedi P and Dwivedi RS. 2005. Physiology of abiotic stress in plants. Agrobios. Janick JJ. 1986. Horticultural science. 4th Ed. WH Freeman and Co. ▪ Kaloo G and Singh K. 2001. Emerging scenario in vegetable research and development. Research periodicals and book publ. house. ▪ Kaloo G. 1994. Vegetable breeding. Vols. I-III. Vedams eBooks. ▪ Lerner HR. (Eds.). 1999. Plant responses to environmental stresses. Marcel Dekker. ▪ Maloo SR. 2003. Abiotic stresses and crop productivity. Agrotech

	Publ. Academy. ▪ Narendra T. et al. 2012. Improving crops resistance to abiotic stress. Wiley and Sons.US. ▪ Peter KV and Pradeep Kumar T. 2008. Genetics and breeding of vegetables. (Revised Ed.). ICAR. ▪ Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume II.Studium Press LLC, ▪ P.O. Box 722200, Houston, Texas 77072, USA, 509p. ▪ Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables volume III. Studium Press LLC, ▪ P.O. Box 722200, Houston, Texas 77072, USA, 634p. Ram HH. 2001. Vegetable breeding. Kalyani. ▪ Rao NK. (Eds.). 2016. Abiotic stress physiology of horticultural crops. Springer publication.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	2	1	3
CO2	2	3	3	2
CO3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	Total
Internal	10	15	15	40
External	20	25	15	60
Total	30	40	30	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
CPERPE	Research and Publication Ethics	1	-	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire the knowledge on Philosophy and ethics, Scientific conduct, Publication ethics.	Understand
CO2	Acquire the knowledge on Open access publishing, Publication misconduct, data base and plagiarism	Apply

b. Syllabus

Units	Content
LI	Philosophy and ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and relations. Scientific conduct: Ethics with respect to science and research, Intellectual honest and research integrity. Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Publication ethics: Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-verse, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
PI	Open access publishing: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Publication misconduct: A. Group Discussions, Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad. B. Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools. Databases and research metrics: A. Databases, Indexing databases, Citation databases: Web of Science, Scopus, etc. B. Research Metrics, Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.
	Reference: 1. https://www.ugc.ac.in/pdfnews/9836633_Research-and-Publication-Ethics.pdf .

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	2	0
CO2	2	3	1	1	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	Total
Internal	20	20	40
External	30	30	60
Total	50	50	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
VSC692	Seminar 2	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
VSC610	Comprehensive Exam, Qualifying Viva-voce (Non-Credit Compulsory)	-	-	-	-

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquiring overall knowledge on specialized courses undergone in the respective specializations of students.	Analyse

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	Total	Result
Internal	0	0	Satisfactory/ non- satisfactory
External	100	100	
Total	100	100	

FLORICULTURE AND LANDSCAPING

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FLS601	Crop Regulation in Ornamentals Crops	1	-	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Comprehension of physiological and biochemical basis of crop regulation and programmed production of flower crops	Understand
CO2	Crop regulation to improve the profitability of growers	Analyze
CO3	Acquisition of thorough practical knowledge on crop regulation	Skill
CO4	Advanced programmed production of flower crops	Apply

b. Syllabus

Units	Content
LI	Basis of crop regulation, Basis of flowering: Eco-physiological influences on growth and development of flower crops for flowering, Crop load and assimilate partitioning and distribution. Root and canopy regulation. Growth regulators: Study of plant growth regulators including bio-stimulants and polyamines in floriculture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants. Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, Plant architecture management for flower crops and ornamental plants, molecular approaches in crop growth regulation, Growth regulation: Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, flower bud initiation, regulation of flowering, photo and thermo periodism, off season production, bulb forcing techniques, Programmed production: Programmed production of important flower crops like chrysanthemum, tulips, lily, daffodils, poinsettia, kalanchoe, gypsophila.
PII	Plant architecture studies in important flower crops; Bioassay and isolation through chromatographic analysis for auxins, gibberellins, cytokinins, ABA; Growth regulation during propagation, dormancy, flowering; Photoperiod regulation in short day and long day crops; Off season production in important crops; Bulb forcing in bulbous ornamental crops; Exposure visits
	Reference: 1. T. K. Bose, V. Bhargava, Debmala Mukherjee and K. Dutta. Tropical and Subtropical Garden Plants. 2022. Astral International Pvt. Ltd. New Delhi. 2. Buchanan B, Gruissem W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. 2015. Wiley Blackwell Publ. 2nd Edition, pp. 1280. 3. De Hertagh A and Le Nard M. 1993. The Physiology of Flower Bulbs. Elsevier, London, UK. 4. Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley & Sons.

	5. Fosket DE. 1994. Plant Growth and Development: A Molecular Approach. Academic Press. pp. 580. 6. Leopold AC and Kriedemann PE. 1985. Plant Growth and Development. McGraw-Hill, New York. 3rd Edition. 7. Peter KV. 2008. Basics of Horticulture. New India Publ. Agency, New Delhi, India. 8. Roberts J, Downs S and Parker P. 2002. Plant Growth Development: In Plant. Oxford University Press. pp. 221-274. 9. Salisbury FB. and Ross CW. 1992. Plant Physiology, Hormones and Plant Regulators: Auxins and Gibberellins. Wadsworth Publ., Belmont. 4th Edition, pp. 357-381.
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c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	3
CO3	3	3	3	3	3
CO4	3	2	3	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FLS602	Post-harvest Biology of Floricultural Crops	2	-	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcomes	Level
CO1	Detailed understanding of physiological and biochemical basis of senescence in flower crops.	Understand
CO2	Draw a linkage between the importance(s) of improved post-harvest physiology and maintenance of fresh quality of floricultural produces	Analyze
CO3	acquire the required skill sets of managing the storage and packaging methods to be followed in case of flowers	Skill
CO4	Exploration of the entrepreneurial options in post-harvest management.	Apply

b. Syllabus

Units	Content
LI	Pre harvest physiology: Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and other biochemical changes, respiration, transpiration in important flower crops, Senescence: Physiology and biochemistry of flowering, enzymatic changes, Ethylene sensitivity, ethylene evolution and management, factors leading to post-harvest loss, pre-cooling. Petal senescence at molecular level, functional gene analysis for postharvest flower quality in important flower crops, etc., Pigments and secondary metabolites: Biosynthetic pathways of chlorophyll, xanthophyll, carotenoids, flavonoids and anthocyanins and betalains. Chemistry and importance of secondary metabolites. Biochemistry and utilization for commercial products in important flower crops.
LII	Storage of flowers: Treatments prior to shipment, viz., pre-cooling, pulsing, impregnation, chemicals, Irradiation, bio-control agents and natural plant products. Methods of storage: ventilated, refrigerated, Modified atmosphere, Controlled atmosphere storage, cool chain management, physical injuries and disorders in important flower crops, Packaging: Packing methods and transport, Smart technologies in packaging and storage, advanced tools like nanotechnology application for quality parameters and post harvest treatments for export in important flower crops, packaging standards, flower labels value chain in floriculture, Recent trends: Recent trends- extraction of bio-colours from flowers conventional as well as in-vitro methods and their value addition uses in food and textile industries. Molecular techniques for enhancing postharvest flower quality, trans-genetics in ornamental plants for enhanced postharvest life, Dried ornamental crops: Post harvest handling of dried ornamental crops including packing, storage and shipment. Storage pest and mould problems in dried ornamental produce, colour retention, physiological and biochemical changes, etc.
PIII	Improved packaging and storage of important flowers; Physiological loss in weight of flowers, estimation of transpiration, respiration rate, ethylene release and study of vase life; Extension in cut flower vase life using chemicals; Estimation of quality

	characteristics in stored flowers; Estimation of biochemical changes like enzymatic changes, lipids and electrolyte leakage; Extraction of flower pigments – Chlorophyll, xanthophylls, carotenoids and anthocyanins; Cold chain management – visit to cold storage, MA and CA storage units; Project preparation
	Reference: 1. Buchanan B, Gruissem W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. 2015. Wiley Blackwell Publ. 2nd edition, pp. 1280. 2. Dey PM and Harborne JB. 1997. Plant Biochemistry. Academic Press. 2nd Edition. 3. Glover MD. 1984. Gene Cloning: The Mechanics of DNA Manipulation. Chapman & Hall Publ. 4. Goodwin TW and Mercer EI. 2003. Introduction to Plant Biochemistry. CBS Publ.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FLS605	Advances in Landscaping	1	0	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The connection between green landscaping and sustainability	Analyze
CO2	Understand the recent advances in landscape gardening	Understand
CO3	Acquire the skills to independently handle landscape projects	Skill
CO4	Landscape design principles	Remember

b. Syllabus

Units	Content
LI	Landscape design: Commercial landscape gardening- History, Plant identification and ecology, Materials of garden design, Design making by different garden styles and types. Design principles in ancient and modern landscape. Principles of designing a commercial landscape project. Role of landscaping in environment improvement, ecology conservation (birds, butterflies, animals). Plant wealth for edges, hedges, herbaceous borders, trees, floral beds, water plants, cacti, ferns, palms, etc.; Site analysis: Assessing site and plants adaptability for different locations, Landscape engineering (Topographical survey and designing concept including GIS,GPS, Remote sensing), special techniques in garden landscaping (Burlapping, water-scaping, xeriscaping, hardscaping, lawn establishment, topiary styles specializing, bio-aesthetic planning); Software in landscaping: Preparation and drawing of site plan, Learning the basics in computer aided design (CAD) for developing a garden landscape plan, Handling soft landscape materials (AUTOCAD and ARCHICAD), GIS as a tool for spatial designing; Landscaping for different situations: Contemporary landscaping, Urban landscaping, Environmental landscaping, Industrial and institutional landscaping, Public and private garden making, play ground landscaping, Inventory management, Landscape restoration, Assessing a successful design in site; Maintenance: Maintenance of different types of gardens, waste water utilisation, historical and archaeological garden sites, Permissions required for bigger projects, carbon sequestration, carbon credits etc.
PII	Plant identification; Materials of garden design, Design making by different garden styles and types; Assessing site and plants adaptability for different locations; Way of designing a commercial landscape project; Landscape engineering (Topographical survey and designing concept); Preparation and drawing of site plan; Learning the basics in computer aided design (CAD) for developing a garden landscape plan; Exposure visits.
	Reference: 1. Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India. 2. Nambisan KMP.1992. Design Elements of Landscape Gardening. Oxford & IBH Publ. Co., New Delhi, India.

	3. Ozayuvuz M. 2013. Advances in Landscape Architecture. In Tech Open Publ. 4. Woodrow MG. 1999. Gardening in India. Biotech Books, New Delhi, India.
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b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FLS607	Modern Approaches in Breeding of Floricultural Crops	2	0	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Deep insight on utilization of frontier breeding tools in further improvements of ornamentals	Analyze
CO2	Significances of advanced breeding measures on prospecting floriculture industry	Understand
CO3	Equip the students with the skills for develop designer crops	Skill
CO4	The students will have in-depth knowledge and hands on training in in-vitro and molecular approaches that can be used in flower crops	Remember

b. Syllabus

Units	Content
LI	In-vitro techniques and biosynthetic pathways; In-vitro techniques: Role of biotechnology in improvement of flower crops; in-vitro mutagenesis, embryo culture, somaclonal variation, transformation, in-vitro cryopreservation, somatic hybridization, anther and ovule culture including somatic embryogenesis; Biosynthetic pathways: Biosynthetic pathways of pigment, fragrance and senescence, flower form; chemistry and importance of secondary metabolites, genomics, proteomics, metabolomics.
LII	Molecular techniques; Molecular breeding: Molecular breeding and Marker assisted selection; molecular characterization; construction of c-DNA library; High throughput sequencing; Genome editing: Genome editing, CRISPER CAS, gene pyramiding, allele mining; Advances in flower crops: Breeding for biotic and abiotic stresses using biotechnological means; designer flower crops. Advancements in important flower crops like rose, chrysanthemum, carnation, orchids, anthuriums, liliun, gerbera, etc.
PII	In-vitro mutagenesis, embryo culture, somaclonal variation; Somatic hybridization, anther and ovule culture and somatic embryogenesis; Genetic transformation; Genetic fingerprinting, Genome editing techniques; PCR, genomics, blotting techniques; Cloning, marker assisted selection; Bioinformatics.
	Reference: 1. Anderson NO. 2007. Flower Breeding and Genetics Issues, Challenges and Opportunities for the 21st Century. Springer Publ., The Netherlands. 2. Arthur ML. 2013. Introduction to Bioinformatics. Oxford University Press, U.K. 400 p. 3. Chadha KL and Chaudhury B. 1992. Ornamental Horticulture in India. ICAR, New Delhi, India. 4. Nelson DL and Cox MM. 2000. Principles of Biochemistry. 4th Edition, Lehninger Publ.

	5. Panopoulos NJ (Ed.). 1981. Genetic Engineering in Plant Sciences. Praeger Publ. 6. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vol. I-III. Naya Prokash, Kolkata, India. 7. Pierik RLM. 1987. In-vitro Culture of Higher Plants. MartinusNijhoff Publ. Amsterdam. 8. Primrose SB and Twyman R. 2006. Principles of Gene manipulation and Genomics. Blackwell Publ., USA. 9. Srivastava PS, Narula A and Srivastava S. 2005. Plant Biotechnology and Molecular Markers. Anamaya Publ., New Delhi, India. 10. Vainstein A. (Ed.) 2002. Breeding for Ornamental crops: Classical and Molecular Approaches. Springer-Science-Business Media, B.V. 1st Edition. 11. Wilson K and Walker J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition, Cambridge University Press, UK.
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b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	20	10	10	60
Total	30	30	20	20	100

SEMESTER –I					
Course Code	Course Name	L	T	P	Credits
FLS603	Specialty Flowers, Fillers and Cut Greens	1	0	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Contribution of Specialty Cut Flowers towards various dimensions of Sustainability	Analyze
CO2	The students will gain knowledge on different specialty flowers, cut greens, fillers their cultivation practices and post-harvest management	Understand
CO3	Infuse confidence to take up cultivation as an enterprise	Skill
CO4	Importance(s) and cultivation of specialty flowers, fillers and cut green crops.	Remember

b. Syllabus

Units	Content
LI	Scope, Importance, national and international scenario: Introduction, present status, scope, importance and avenues for specialty flowers and cut greens; Avenues, Specialty flowers, Cultivation practices of specialty flower crops like Heliconia, red ginger, Bird of Paradise, Ornamental banana, ornamental curcuma, gingers, wax flower, kangaroo paw, limonium, rice flower, etc., Fillers, Cultivation practices of fillers like gypsophila, solidago, Mollucella, lupins, etc., Cut greens: Cultivation practices of cut greens like anthurium, ferns, asparagus, cycas, thuja, bottle brush, ornamental palms, dracaena, eucalyptus, ruscus, dianella, alpinia, etc., Trade and Marketing, Post harvest management: Pre and post harvest factors influencing the vase life of the flowers and fillers, Post harvest management including pulsing, holding, packing, storing, forward and backward linkages, value chain management, Standards, Quality standards, Packaging standards, marketing and trade in important flower, filler and foliage crops.
PII	Identification of specialty flowers, fillers and cut greens; Media and bed preparation for cultivation; Propagation of important crops; Integrated disease and pest management in important crops; Post harvest handling of specialty flowers, fillers and cut greens; Preparation of value added products from important specialty flowers, fillers and foliages; Exposure visits; Economics and Project preparation.
	References: 1. Armitage AM and Laushman JM. 2008. Speciality Cut Flowers. Timber Press. 2nd Edition, pp. 636. 2. Bhattacharjee SK. 2006. Vistas in Floriculture. Pointer Publ., Jaipur, India. 3. Bhattacharjee SK and De LC. 2003. Advanced Commercial Floriculture Vol.1. Aavishkar Publ. & Distributors, Jaipur India. 4. Bose TK, Yadav LP, Pal P, Parthasarathy VA and Das P. 2003. Commercial Flowers. Vol. I & II. Naya Udyog, Kolkata, India.

	5. Misra RL and Misra S. 2017. Commercial Ornamental Crops: Traditional and Loose Flowers. Kruger Brentt Publisher UK Ltd. 6. Mukherjee D. 2008. Speciality Cut Flowers-Production Technologies. Naya Udyog Kolkata, India. pp. 614. 7. Salunkhe K, Bhatt NR and Desai BB. 2004. Post harvest Biotechnology of Flowers and Ornamental Plants. Naya Prokash, Kolkata, India.
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b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
FLS611	Research Methodology	3	-	0	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire knowledge of the literature and a ample understanding of methodologies that are directly or indirectly relevant to their own research	Remember
CO2	Create, develop and exchange research knowledge in collaborative manner for the benefit society	Understand
CO3	Ascertain, deduce and link with new idea so as to make a quality publication that is acceptable by a peer review	Apply
CO4	Manage complex ethical concerns and make a vivid verdicts	Analyze

b. Syllabus

Units	Content
LI	Introduction to Research Methodology: Meaning and importance of Research - Types of Research - Selection and formulation of Research Problem; Research Design - Need - Features - Inductive, Deductive and Development of models; Developing a Research Plan - Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs; Hypothesis - Different Types - Significance - Development of Working Hypothesis, Null hypothesis; Research Methods: Scientific method vs. Arbitrary Method; Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive - Inductive logical process - Different types of inductive logical methods; Critical Literature Review: Primary and Secondary Sources, Web sources
LII	Statistics and Computer applications: Introduction to Statistics – Probability Theories - Conditional Probability, Poisson distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi Square Test, Association of Attributes t Test - ANOVA, Standard deviation Coefficient of variations. Correlation and Regression Analysis, Use of excel sheet for research analysis, Data Analysis using statistical packages, SPSS. Data Collection and Analysis: Sources of Data - Primary, Secondary and Tertiary; Types of Data - Categorical, nominal & Ordinal; Methods of Collecting Data - Observation, field investigations; Direct studies - Reports, Records or Experimental observations; Sampling methods - Data Processing and Analysis strategies - Graphical representation - Descriptive Analysis - Inferential Analysis - Correlation analysis - Least square method - Hypothesis - testing - Generalization and Interpretation – Modeling
LIII	Scientific Writing: Structure and components of Scientific Reports; Types of Report - Technical Reports and Thesis - Significance - Different steps in the preparation - Layout, structure and Language of typical reports - Illustrations and tables - Bibliography, Referencing and foot notes –Importance of Effective Communication; Preparing Research papers for journals, Seminars and Conferences - Design of paper using TEMPLATE; Preparation of Project Proposal - Title, Abstract, Introduction - Rationale, Objectives, Methodology - Time frame

	and work plan - Budget and Justification - References; Documentation and scientific writing Results and Conclusions, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography; Importance of Impact factor of a journal and citation Index
	Reference: Kothari, C. R. (2018), Research Methodology-methods and techniques, New Age International. Sahu, P. K. and Das, A. K. (2009). Agriculture and applied statistics, Vol-I, II. Kalyani Publishers, New Delhi. Gomez and Gomez. Statistical Procedures for Agricultural research, 1984. John Wiley & Sons, Inc. Newyork Peter Birmingham and David Wilkinson. Using Research Instruments. 2016. California state university Press. Patton, M. Q. Qualitative research & evaluation methods: Integrating theory and practice (4th ed.). 2015. Thousand Oaks, CA: SAGE Publications. Palys, T., & Atchison, C. Research decisions: Quantitative, qualitative, and mixed methods approaches (5th ed.). 2014. Toronto, Canada: Nelson Education. Michael P Marder, Research Methods for science, 2012. Cambridge university Press.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	3
CO4	2	3	3	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	25	25	25	25	100

SEMESTER – I					
Course Code	Course Name	L	T	P	Credits
FLS691	Seminar 1	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – I to VI					
Course Code	Course Name	L	T	P	Credits
FLS699	Research	0	-	75	75

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Design a research plan with proper review of literature	Analyse
CO2	Present a recent advance with critical analysis	Skill
CO3	Conduct the research experiment with critical research appetite	Skill
CO4	Equip with knowledge of conducting research with a high problem solving research appetite.	Analysis
CO5	Interpret the data obtained for the research experiment through statistical tools	Remember
CO6	Equip with knowledge of conducting research with a high problem solving research appetite.	Remember

b. Syllabus

Units	Content
PI	Review collection, documentation, and developing a research plan.
PII	Structuring a scientific report, synopsis preparation, and presentation.
PIII	Selection of crop,
PIV	Preparation of field,
PV	Plotting and experimental design,
PVI	Procurement of chemicals and materials, Preparation of reagents, conduct of lab experiment.
PVII	Recording the results for the parameters and treatments decided
PVIII	Study of relevant research papers
PIX	Writing of 'Introduction' component of dissertation
PX	Writing of 'Review of Literature' part of dissertation
PXI	Development of 'Material' component of experiment
PXII	Development of 'Method' component of experiment
PXIII	Study of relevant research papers
PXIV	Evaluation of appropriateness of experiment-specific statistical analysis
PXV	Analysing the data through appropriate statistical tools
PXVI	Writing results and discussion with critical research interpretation from review of literature, compiling the Introduction, review of literature, Materials and methods, results and discussion with proper summery and conclusion in the form of thesis, Presenting the final research hypothesis to the research advisory committee and audience.

c. Evaluation Scheme: By Research Advisory committee once in 6 months and final thesis evaluation by external examiner followed by viva-voce

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FLS604	Biotechnological Approaches in Floricultural Crops	2	0	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Advancements in biotechnology of flower crops.	Analyze
CO2	Importance of biotechnology in floriculture	Understand
CO3	Equip the students with the advances in application of biotechnology in flower crops	Skill
CO4	Recent advances in tissue culture, genetic engineering and molecular biology of flower crops	Remember

b. Syllabus

Units	Content
LI	Scope of biotechnology: Present status of biotechnology, tools techniques and role in floriculture industry, physical factors and chemical factors influencing the growth and development of plant cell, tissue and organs, cyto-differentiation, organogenesis, somatic embryogenesis in important flower crops; Cell, tissue and organ culture; Micropropagation: In-vitro lines for biotic and abiotic stress – Meristem culture for disease elimination, production of haploids through anther and pollen culture – embryo and ovule culture, micrografting, wide hybridization and embryo rescue techniques, construction of somatic hybrids and cybrids, regeneration and characterization of hybrids and cybrids, in-vitro pollination and fertilization, hardening media, techniques and establishment of tissue culture plants in the primary and secondary nursery in important flower crops; Somaclonal variation and in-vitro conservation: Somaclonal variation and its applications – variability induction through in-vitro mutation, development of cell suspension cultures, types and techniques, Synthetic Seed technology, in-vitro production of secondary metabolites, role of bioreactors in production of secondary metabolites, quantification and quality analysis of secondary metabolites using HPLC/ MS/ GCMS/ in-vitro conservation and cryo-preservation techniques in important
LII	Genetic engineering and molecular biology; Genetic engineering: Gene cloning, genetic engineering: vectors and methods of transformation – electroporation, particle bombardment, Functional gene analysis techniques like PTGS including VIGS in ornamental plants, Agrobacterium mediated, transgenic plants in flower crops, Biosafety of transgenics isolation of DNA, RNA, quantification, Polymerase Chain Reaction for amplification; AGE and PAGE techniques; identification of molecular markers in important flower crops; Molecular approaches: Molecular markers as a tool for analysis of genetic relatedness and selection in ornamental crops. Molecular control of flower development, light sensing with respect to plant development, flower pigmentation, fragrance, senescence, ethylene synthesis pathway in important flower crops. Molecular biology- Gene isolation, characterization, manipulation and transfer in important flower crops. Construction of c- DNA library, DNA fingerprinting technique in economic flower crop varieties, RNAi, Genome editing basics, molecular approaches to control ethylene response, Fragrance, Plant Architecture, desirable

	flower traits, colour, shape, improving postharvest life, improving resistance for environmental stress, approaches to improve flower development, pigment production, secondary metabolite production, post-harvest biotechnology of flowers, ornamental plants, achievements of bio-technology in flower crops.
PII	Micropropagation, Pollen- Ovule and Embryo culture- Synthetic seed production; In-vitro mutation induction, in-vitro rooting – hardening at primary and secondary nurseries; DNA isolation from economic flower crop varieties – Quantification and amplification, DNA and Protein profiling – molecular markers, PCR Handling; Vectors for cloning and particle bombardment; DNA fingerprinting of flower crop varieties; Project preparation for establishment of low, medium and high cost tissue culture laboratories.
	References: 1. Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology- Concepts, Methods and Applications. Oxford & IBH Publ. Company, USA. pp. 200. 2. Debnath M. 2011. Tools and Techniques of Biotechnology. Pointer Publ. 3. Glover MD. 1984. Gene Cloning: The Mechanics of DNA Manipulation. Chapman & Hall Publ. 4. Gorden H and Rubsell S. 1960. Hormones and Cell Culture. AB Book Publ. 5. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Horticultural Biotechnology. Vols. I & II, 1018 p. New India Publ. Agency, New Delhi, India. 6. Keshavachandran R and Peter KV. 2008. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan. 312 p.

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FLS608	Current trends in production technology of floricultural crops	2	0	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The boon of advanced techniques to propel the booming floriculture industry	Analyze
CO2	The application of the latest techniques in growing and managing floricultural crops	Understand
CO3	Well-versed with the application of frontier tools to cause benefit to the floriculture industry and to manage effectively a commercial floriculture	Skill
CO4	The value of cutting-edge strategies of flower crop production	Remember

b. Syllabus

Units	Content
LI	Production technology Scope and scenario: Commercial flower production; scope and importance; global Scenario in cut flower production and trade, varietal wealth and diversity; soil and environment; cut flower, loose flowers, dry flowers and essential oil trade, flower seed production. Special characteristics and requirements. essential oil industry, recent advances in extraction methods. Cultural operations: Propagation and multiplication, greenhouse management, soil/ media decontamination techniques, micro irrigation, nutrition and fertigation, slow-release fertilizers and biofertilizers, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering. Crop Regulation: Flower forcing and year-round flowering through physiological interventions, Chemical regulation, Environmental manipulation, important insect pests, diseases, nematodes and their management through IPM and IDM, quarantine measures for export and other export norms. Advances in production technology of crops: Advances in roses, chrysanthemum, tuberose, gladiolus, marigold, Crossandra. Jasmine, gerbera, carnation, orchids, anthuriums, lilum, lisianthes, limonium, gypsophylla, etc.
LII	Mechanization and Post harvest management Mechanization: automation, sensors, sowing and planting devices, harvesting, grading and packing, ICT and AI in floriculture. Post-harvest management: Harvest indices, Harvesting techniques; Post harvest handling for local, distant and export market, Cluster production, Contract farming, FPOs, Value chain management.
PII	- Greenhouse management; Soil decontamination techniques (2); - Microirrigation; Nutrition and fertigation (2); - Special practices- bending, netting, pinching, disbudding, defoliation and chemical pruning, etc. (2); - Photoperiodic and chemical induction of flowering (2); - Assessing harvest indices; Post-harvest handling (2);

	• Case studies (2); • Visit to commercial cut flower and essential oil units (4).
	References: • Bose TK, Maiti RG, Dhua RS and Das P. 1999. <i>Floriculture and Landscaping</i>. Naya Prokash, Kolkata, India. • Chadha KL and Choudhury B. 1992. <i>Ornamental Horticulture in India</i>. ICAR, New Delhi, India. • George S and Peter KV. 2008. <i>Plants in a Garden</i>. New India Publ. Agency, New Delhi, India. • Lauria A and Victor HR. 2001. <i>Floriculture-Fundamentals and Practices</i>. Agrobios Publ., Jodhpur, India. • Misra RL and Misra S. 2017. <i>Commercial Ornamental Crops: Traditional and Loose Flowers</i>. Kruger Brentt Publisher UK Ltd. • Randhawa GS and Mukhopadhyay A. 1986. <i>Floriculture in India</i>. Allied Publ. • Reddy S, Janakiram T, Balaji T, Kulkarni S and Misra RL. 2007. <i>Hi- Tech Floriculture</i>. Indian Society of Ornamental Horticulture, New Delhi India. • Singh AK. 2006. <i>Flower Crops: Cultivation and Management</i>. New India Publ. Agency, New Delhi, India. • Singh AK. 2014. <i>Breeding and Biotechnology of Flowers</i>, Vol.1: Commercial Flowers. New India Publ. Agency, New Delhi, India.

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	3	3	3	3
CO3	3	2	3	3
CO4	3	3	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FLS606	Vertical Gardening	1	0	2	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The importance of green walls/ living walls in view of the unprecedented increase in pollution	Analyze
CO2	The development in vertical gardening which is expanding across the country	Understand
CO3	Equip the students with the latest developments in vertical gardening	Skill
CO4	The advancements and advent of vertical green structures for development of green sustainable smart cities	Remember

b. Syllabus

Units	Content
LI	Importance, Scope: Present status of vertical gardening, benefits of vertical gardening, History of vertical gardens, role of indoor plants in mitigating pollution; Growth: Factors influencing the growth and development of the plants including light, humidity, temperature, nutrition, irrigation, growth regulation; Making of vertical gardens: Containers, media, frames, cost effective components, cables, wires, nets for the vertical formations, modular living walls; Green roofing; Green Facades: Influence of green facades in providing thermal comfort, atmospheric cleansing and related environmental benefits, Energy saving potential of green façades, Aesthetic appeal of green structures and other relevant studies on urban greening; Mitigation of pollution: Plants suitable, Dust mitigation, Radiation absorption, Pollution mitigation, Acoustic attributes of urban greening; Maintenance: Lifecycle, maintenance, Plants with low light, medium, high intensity requirement, cost effectiveness and overall sustainability of living walls.
PII	Identification of plants; Designing of vertical gardens for different locations; Maintenance of vertical gardens; Economics; Project preparation; Exposure visit.
PIII	Understanding of different vertical gardening system-based constructional structures (like living walls, modular trellis system, wire-rope met walls); practical experience in building construction and installation components related aspects required for vertical gardening; local adaptation-based knowledge on adoption of best practices for vertical gardening establishment
	References: 1. Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology- Concepts, Methods and Applications. Oxford & IBH Publ. Company, USA. pp. 200. 2. Debnath M. 2011. Tools and Techniques of Biotechnology. Pointer Publ. Glover MD. 1984. Gene Cloning: The Mechanics of DNA Manipulation. Chapman & Hall Publ. 3. Gorden H and Rubsell S. 1960. Hormones and Cell Culture. AB Book Publ. 4. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Horticultural Biotechnology. Vols. I & II, pp. 1018. New₁ India Publ. Agency, New Delhi, India.

	5. Keshavachandran R and Peter KV. 2008. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan. pp. 312.
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b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	2	3	3	2
CO3	3	2	3	3
CO4	3	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER –II					
Course Code	Course Name	L	T	P	Credits
FLS609	Recent developments in protected cultivation of floricultural crops	2	0	1	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	The importance(s) to augment the sustainability in protected cultivation of flowers	Analyze
CO2	The significance of protected cultivation in current era	Understand
CO3	Aims to equip students with skills to manage and optimize the growth of flowers in controlled environments	Skill
CO4	Cultivation of floricultural crops, contributing to a more sustainable and profitable future for the floriculture industry.	Remember

b. Syllabus

Units	Content
LI	Production technology Scope and Scenario: Prospects of protected floriculture in India, growing structures, basic considerations in establishment and operation of green houses, functioning and maintenance. Global trade, forward and backward linkages for import clusters, International and national auction houses. Microclimate management: Environmental control systems in greenhouse, regulation of light through LEDs containers, substrate culture, soil decontamination techniques, aeroponics, hydroponics and vertical farming. Cultural operations: Water and nutrient management, crop regulation, special horticultural practices under protected cultivation of rose, chrysanthemum, carnation, orchids, anthurium, gerbera, liliun, cut foliage and potted ornamental crops; plant architecture management in ornamental plants. Advances in flower crops: Advances in protected cultivation of important flowering (rose, chrysanthemum, carnation, gerbera, orchids, anthurium, liliun, and foliage plants (agloenema, monstera, dracaena, syngonium, pothos, diffenbachia, asparagus sps, ferns etc.)
LII	Precision floriculture and regulations Precision floriculture: Precision floriculture, principles and concepts, enabling technologies of precision floriculture, remote sensing, sensors, automation in greenhouses, solar greenhouses, retractable greenhouses. computers and robotics, decision support systems, apps, cold chain management, use of AI for production and trade. Regulations: PBR/ IPR issues; Forward and backward linkages, 100% EOU, packaging and export standards, Cool chain Management, non-tariff barriers, APEDA export marketing channels, regulations for auction houses, major markets etc.
PIII	Growing structures, basic considerations in establishment and operation ¹ of greenhouses;

	• Environmental control systems in greenhouse; • Containers, substrate culture, soil decontamination techniques ; • Crop regulation; • Special horticultural practices under protected cultivation; • Precision equipments, computers and robotics in precision farming; • Harvest indices, harvesting, post harvest handling, marketing; • Export and cold chain management.
	References: • Bhattacharjee SK. 2018. <i>Advances in Ornamental Horticulture</i>. Vols. I-VI. Pointer Publ.Reprint, 2065 p. • Bose TK, Maiti RG, Dhua RS and Das P. 1999. <i>Floriculture and Landscaping</i>. Naya Prokash, Kolkata, India. • Reddy S, Janakiram T, Balaji, Kulkarni S and Misra RL. 2007. <i>Hi-Tech Floriculture</i>. Indian Society of Ornamental Horticulture, New Delhi, India.

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	2	3
CO2	3	3	2	2
CO3	3	3	2	3
CO4	2	3	3	2

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	25	25	10	0	60
Total	35	35	20	10	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
CPERPE	Research and Publication Ethics	1	-	1	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquire the knowledge on Philosophy and ethics, Scientific conduct, Publication ethics.	Understand
CO2	Acquire the knowledge on Open access publishing, Publication misconduct, data base and plagiarism	Apply

b. Syllabus

Units	Content
LI	Philosophy and ethics: Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and relations. Scientific conduct: Ethics with respect to science and research, Intellectual honest and research integrity. Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Publication ethics: Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
PI	Open access publishing: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Publication misconduct: A. Group Discussions, Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad. B. Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools. Databases and research metrics: A. Databases, Indexing databases, Citation databases: Web of Science, Scopus, etc. B. Research Metrics, Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.
	Reference: 1. https://www.ugc.ac.in/pdfnews/9836633_Research-and-Publication-Ethics.pdf .

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	2	0
CO2	2	3	1	1	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	Total
Internal	20	20	40
External	30	30	60
Total	50	50	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
FLS692	Seminar 2	0	-	1	1

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Analyze the tactics in development of proficiency in presentation of scientific facts	Analyze
CO2	Understand the research values in overcome the constraints in various divisions of horticulture sector	Understand
CO3	Apply the skills in delivery of scientific knowledge in the common forum	Apply
CO4	Reminisce the scientific backgrounds in applied research	Remember

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	2
CO3	2	3	3	3	1
CO4	3	3	3	3	1

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	0	0	0	0	0
External	30	30	20	20	100
Total	30	30	20	20	100

SEMESTER – II					
Course Code	Course Name	L	T	P	Credits
FLS610	Comprehensive Exam, Qualifying Viva-voce (Non-Credit Compulsory)	-	-	-	-

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	Level
CO1	Acquiring overall knowledge on specialized courses undergone in the respective specializations of students.	Analyse

b. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3

(If the correlation between mission statement and program specific outcome is high 3 is assigned, for moderate 2, for low 1, and for 0 are assigned)

c. Evaluation Scheme

	CO1	Total	Result
Internal	0	0	Satisfactory/ non- satisfactory
External	100	100	
Total	100	100	