ESTABLISHED BY AN ACT OF PARLIAMENT IN 2009

तमिलनाडु केन्द्रीय विश्वविद्यालय | CUTN | தமிழ்நாடு மத்தியப் பல்கலைக்கழகம்

CENTRAL UNIVERSITY OF TAMIL NADU

M.Sc HORTICULTURE (2023-24)

CURRICULUM BOOK

Department of Horticulture

School of Life Sciences

Central University of Tamil Nadu

July 2023

Effective from the Academic Year 2023-24 onwards

M.Sc Horticulture (2023-24)

CURRICULUM DEVELOPMENT COMMITTEE

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(संसदद्वारापारितअधिनियम 2009केअंतर्गतस्थापित)
CENTRAL UNIVERSITY OF TAMIL NADU
(Established by an Act of Parliament, 2009)
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School of Life Sciences

Department of Horticulture

M.Sc Syllabus

A. Vision

Vision Statement of the Department

Develop world class horticulture hub which can cater to the needs of all stakeholders for the ultimate well-being 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	Evolve into postgraduates with knowledge and understanding of concepts across diverse areas in Horticulture.
PSO2	Serve as skilled human resource tailored to formulate, analyse, and resolve complex problems in horticultural crops.
PSO3	Apply the knowledge and skills acquired to cater the needs of the industry, academia, research and the society for contributing to nation-building.
PSO4	Providing and promoting consultancy services in the fields of Horticultural research, training and dissemination of information and technology.
PSO5	Utilization of the opportunities present in the market for the upliftment of society.

D. PEO to Mission Statement Mapping

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

0-No correlation; 1-Very less correlation; 2-Moderate correlation; 3-High correlation

E. Graduate Attributes of M.Sc. (Horticulture) Program

1. Disciplinary Knowledge: Content and pedagogical knowledge synchronised with the curriculum frameworks and policies.
2. Communication Skills: Possess clarity in conveying the ideas.
3. Critical Thinking: Capacity to apply analytical thought in the teaching and learning process.
4. Problem Solving: Participate in the educational problem solving and applying the knowledge in the day-to-day professional endeavors.
5. Cooperation: Appreciate collaboration and cooperation among stakeholders of education.
6. ICT Skills: Selecting and integrating appropriate ICT skills for professional development.
7. Ethics: Doing what is right to society.
8. Self-Directed Learning: Developing autonomy and self-regulation in teaching learning and professional development.
9. Reasoning: Ability to interpret and draw the conclusion from qualitative/quantitative data with open-mindedness.
10. Creativity: Ability to produce new ideas**.**
11. Societal and Environmental Concern: Performing an act or solving a problem with respect to societal and environmental concern.
12. Lifelong Learning: Understands the need for learning and practices it throughout life.

F. Program Outcomes(PO)

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

PO1	Cater the needs of line departments and horticulture based industries through the acquired knowlege in horticulture.
PO2	Apply the gained knowledge and skills in academics, research and development and contribute significantly to societal benefits.
PO3	Can be part of multidisciplinary and interdisciplinary team in providing better solutions and innovative ideas towards sustainable development.
PO4	Develop into an enterpreneur by harnessing the acquired knowledge and skills of horticulture
PO5	Emerge as an ambassador of horticulture through the service rendered to the farming community.

G. PO to PEO Mapping

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

0-No correlation; 1-Very less correlation; 2-Moderate correlation; 3-High correlation

ABOUT

INAUGURAL YEAR

2019

PROGRAMMES OFFERED

MSc Horticulture (Fruit Science/Vegetable Science/Floriculture and Landscaping)

NOMENCLATURE AND COMMENCEMENT

These rules and regulations shall govern the post graduate studies in horticulture leading to the award of the following degrees.

1. Master of Science (Horticulture) in Fruit Science
2. Master of Science (Horticulture) in Vegetable Science
3. Master of Science (Horticulture) in Floriculture and Landscaping

All the three programs shall come into force with effect from the academic year 2023 – 2024.

DEFINITIONS

- An "Academic Year" shall consist of two semesters.
- "Subject" means a unit of instruction to be covered in a semester having specific number, title and credits.
- "Credit hour" means, one hour lecture plus two hours of library or homework or two hours of laboratory/field practical per week in a semester.
- "Grade Point of a subject" means the value obtained by dividing the percentage of marks earned in a subject by 10 and the Grade Point is expressed on a 10 point scale.
- "Credit Point" means the grade point multiplied by credit hours.
- "Grade Point Average" (GPA) means the quotient of the total credit points obtained by a student in various subjects at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 point scale and the GPA has to be corrected to two decimals.
- "Overall Grade Point Average" (OGPA) means the quotient of cumulative credit points obtained by a student in all the subjects taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

ELIGIBILITY FOR ADMISSION

Candidates for admission to the M.Sc.(Hort.) program should satisfy the following requirements.

Candidates should have completed any one of the following four year degree programs *viz.*, B.Sc. (Hons.) Agriculture/B.Sc.(Hons.)Horticulture/B.Sc.(Hort.)/B.Tech.(Hort.)/B.Sc(Ag.)/B.Tech.(Agri. Bio-tech.) from any recognized university.

Candidates who have undergone the program under conventional system should possess not less than a second class Bachelor's degree. For those under 10 point system a minimum OGPA of 6.00 out of 10.00 in the subject concerned is required. However, this will not apply to SC/ST candidates for whom a pass in the degree concerned is sufficient.

A common entrance test will be held for all the MSc (Horticulture) degree programs. Candidates shall be based on the rankings in the said entrance examinations.

DURATION

The duration for the M.Sc. (Horticulture) program will be of two years with four semesters. A student registered for M.Sc. (Horticulture) program should complete the course within four years from the date of his/her admission.

Credit Grade Point Requirements

A student enrolled for the Master's degree program to earn eligibility for the degree is required to complete 92 credits as detailed below:

S. No.	Course Components / Name of the Course	Credits
1	Core Courses (CC)	40
2	Core Courses Practical (CCP)	-
3	Discipline Specific Elective (DSE)	12
4	Project / Dissertation/Research	31
	Subtotal (1 to 4)	**83**
5	Open Elective (OE)	3
6	Soft-Skill (SS)	2
7	Internship / Field Visit / Training - Department Specific	4
	Total	**92**
8	Value Added Course	2

Discipline Specific Elective/Minor course (DSE/Mi): Courses are to be chosen by the students from the related discipline.

Minimum Grade Point Requirements

A post graduate student should maintain a minimum Grade Point of 6.50 out of 10 to secure a pass in a subject. In the subjects in whom a student fails, he/she has to reappear for the examination to get a pass in that subject.

Attendance Requirements

One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of 70% attendance in each subject separately for theory and practical's, shall not be permitted to appear for the final examination in that subject and will be required to repeat the subject when offered.

In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, School of life sciences on payment of condonation fee prescribed by the University.

ADVISORY COMMITTEE

Each post-graduate student shall have an Advisory Committee to guide him/her in carrying out the research program. The Advisory Committee shall comprise a Major Adviser (Chairman) and two members. Of the two members, either both will be from the same Department or at least one member can be from the related field from the other Departments. The Advisory Committee shall be constituted within two months from the date of commencement of the first semester.

PROGRAM OF STUDY

The student's plan for the post-graduate work, drawn up by the Advisory Committee, shall be finalized before the end of the first semester.

Program of research work: The outline of research work of the student, in the prescribed manner and as approved by the Advisory Committee, shall be forwarded by the Chairman to the Head of the Department concerned by the end of the first semester.

EVALUATION OF STUDENT PERFORMANCE

Type of course	**Internal marks**	**External marks**	**Total**
Courses with theory only	40	60	100
Courses with theory and practical	40	60	100
Courses with practical only	-	100	100

Theory Examinations Assessment (as with CUTN regulations)

The pattern of practicals part should be uniform across the departments

Grading

- The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the subject. Students who secure marks below 65 per cent in a subject will be treated as re-appearance (RA).
- Each subject shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a subject is divided by ten. The grade point is expressed on a10 point scale up to two decimals.
- The reappearance examinations for the candidates who fail in a subject or subjects will be held in the subsequent semester.
- Students who did not fulfill the required minimum attendance of 70% will be awarded 'E' grade and has to repeat the subject.

Non-Credit Compulsory Subjects

For non–credit compulsory subjects the evaluation processes will be as that of the regular subjects, however, the marks obtained will not be taken into account to calculate the CGPA.

Credit Seminar

Seminar is compulsory for all the students and each student should present a seminar of 0+1 credit in the third semester.

The seminar topic should be only from the major field and should not be related to the area of thesis research. The seminar topics are to be assigned to the students by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.

Under the guidance and supervision of the Chairman of the Advisory Committee, the student will prepare the seminar paper after reviewing all the available literature and present the seminar 2 weeks after completion of Mid-Semester Examination in the presence of the Head of the Department, Advisory Committee, staff members and PG students.

The Chairman will monitor the progress of the preparation of the seminar paper and correct the manuscript containing not less than 25 typed/printed pages with a minimum number of 50 references covering the recent 10 years. The student will submit 2 copies of the corrected manuscript to the Head of the Department concerned through the Chairman before presentation.

The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.

The performance of the student has to be evaluated for 100 marks and Grade Point will

be awarded by the Head of the Department concerned along with Advisory Committee.

The Grade Point may be given based on the following norms:

Coverage of Literature	40
Presentation	30
Use of Audio–Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
Total	**100**

Term Paper/Special Assignment

This has to be assigned to the student by the teacher in subject with theory and practical. Term papers should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Term papers / special assignments will be evaluated during practical examination.

Comprehensive Qualifying Examination

Only those students who successfully completed the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of written and oral examination.

Minimum Requirement for Qualifying Examination

The students who have passed major courses will be permitted to appear for the qualifying examination. The qualifying examination will be conducted before the end of the IV semester.

Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the HOD at the end of III semester to the Controller of Examinations, who will nominate as per need from the panel of the examiner.

Written Examination

The written examination consists of one paper covering major subjects only. The Controller of Examination will conduct the examination by getting the question paper from external. The Evaluation of answer papers and viva-voce examination will be done internally.

The question paper for the written examination will be of 3 hours duration and each question (Essay type) need not be restricted to any particular topic in a course but it should be comprehensive. The written examination will be conducted at the same time in all discipline. Qualifying marks for passing the written examination will be 60.

Comprehensive Qualifying Viva-Voce Examination

The advisory committee shall conduct the qualifying viva-voce examination.

The Head of Departments will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be graded as **Satisfactory/Unsatisfactory**.

Failure/Absence in Qualifying Examination

When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Head of the Department. A student, who apply for re-examination should attend written examination and viva-voce. Re-examination shall not take place earlier than three months after the first examination and it will be conducted by the advisory committee as previously indicated. If a student fails in the re-examination, further re-examination will be considered on the recommendation of the Advisory Committee, HOD and Dean. If the students fail in the qualifying examination, the research credits registered in the III semester should not be evaluated unless he / she successfully completes the qualifying examination.

Absence of Advisory Committee Member during Qualifying/Final Viva Voce Examination

Conducting qualifying and final viva voce examination in the absence of advisory committee members is not
allowed.

Under extra-ordinary circumstances if the qualifying/final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the advisory committee in consultation with the concerned member and Head of the Department will co-opt another member.

The co-opted member should be from the same department of the member who is not attending the examinations.

In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co- chairman with prior permission of Dean.

Research Work

The topic of thesis research to be carried out by the student will be assigned by the Chairman of the Advisory Committee in consultation with the Head/ Chairman of the Department concerned. After assigning the topic, each student may be instructed to submit a detailed program of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the program may be given to the student for carrying out the work during the semester in the prescribed proforma. The evaluation of research work done by the student should be based on the approved program.

Evaluation of Dissertation Work

Attendance register must be maintained in the department by HOD /chairman for all the students to monitor whether the student has 70% of attendance in research.

The student has to submit his/her research observation note book to the major Adviser. The major Adviser will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research

progress.

After completion of 70% attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and monitoring register and award **SATISFACTORY OR UNSATISFACTORY** depending upon quantity and quality of work done by the student during the semester.

The procedure of evaluating research credits under different situations are explained hereunder.

Situation-I
The students have completed the research credits as per the approved program and awarded **'SATISFACTORY'** by the advisory committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded **'UNSATISFACTORY'** he/she has to register afresh the same block of the research credits in the subsequent semester.

Situation-II
The student who does not satisfy the required **70 per cent** attendance shall be awarded grade 'E'.

Situation-III
The student who could not complete the research work as per the approved programme of work for reasons beyond his/her control such as

- Failure of crop
- Non-Incidence of pests or diseases or lack of such experimental conditions
- Non-availability of treatment materials like planting materials chemicals etc.
- Any other impeding/ unfavourable situation for satisfying the advisory committee
- Under the situations (II&III) grade 'E' should be awarded. The student has to re-register the same block of research credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) research credits.
- In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or want for favourable conditions.

Situation-IV

The student who fails to complete the research work after repeating the registration for the second time will be awarded ' **Unsatisfactory'** and in the mark sheet the 'second time' should be mentioned.

- For the registration of research credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University.
- Re-registration of further research credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.

Situation-V

- If a student could not complete qualifying examination till the end of the final semester/grace period, 'E' grade should be awarded for the final block of the research credits registered in the final semester. He/She has to re-register the same block of research credits in the next semester and attend the qualifying examination when conducted by the Controller of Examinations.

Submission of Dissertation

The thesis for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent research. The thesis shall be on topic falling within the field of the major subject and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the thesis.

The research credits registered in the last semester of post graduate programs should be evaluated only at the time of the submission of thesis, by the advisory committee. Students can submit the thesis at the end of the final semester. If a post graduate student has completed the thesis before the closure of the final semester, the chairman can convene the advisory committee meeting and take decision on the submission of thesis provided the student satisfies 80% attendance requirement. Two copies of the thesis should be submitted in paper pack for evaluation to the HOD.

Grace Period

Students can avail a grace period up to a month for submission of thesis/project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month grace period, the student has to re-register the credits in the forthcoming semester. The student who re-register the credits after availing the grace period will not be permitted to avail grace period.

Based on the recommendation of advisory committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while submission.

Submission of Dissertation after Re-registration

The minimum of 70% attendance requirement for submitting the thesis after, re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting degree.

Submission of Dissertation

The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside CUTN and shall be appointed by the University as per the recommendation of the Head of the Department.

The external examiner will send the evaluation report in duplicate one marked to the Controller of Examination and another to the Head of the Department along with the corrected copy of the thesis. If the report is favorable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee. The chairman of the advisory committee shall send the recommendations of the examining committee to the Controller of Examinations through Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.

In case of rejection of the thesis by the external examiner, the Controller of Examinations may on the recommendation of the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner chosen by the University. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.

If the revision of the thesis is recommended for repeating experiments, field trial etc., resubmission must be done by the candidate concerned after a minimum of six months. The revised version should be sent to the examiner who recommended revision.

After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder has to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in C.D. form.

Revision of Dissertation

If an examiner recommends for revision of thesis the following norms will be adopted.

For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the controller of examination**.**

At the time of submission, the advisory committee should give certificate for carrying out the corrections/recommendations. The resubmitted copies of thesis should be got corrected carrying out the necessary corrections indicated by the external examiner and necessary certificates obtained from the chairman and HOD before the conduct of the final viva-voce.

A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

Failure to Appear for Final Viva Voce/Non-Submission of Dissertation after Viva Voce

If a candidate fails to appear before the examining committee for final viva-voce, on the

date fixed by the HOD
the following are the time frame and penalty.
The re-viva-voce must be completed within two years. An amount of fine prescribed by the University must be charged to the candidate.

After successful completion of thesis final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration.

Result Notification
After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations**.**

The transcript will be prepared by controller of examinations. The various subjects taken by a student along with the credits and the grade obtained shall be shown on his transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

Award of Medals
Medal should be awarded only if the student secures at least 8.0 OGPA, clears all courses in first attempt and in the program having a batch of at least three students.

M.Sc. Horticulture (Fruit Science) Programme Course Structure (92 Credits)

Sem	Compulsory Course (*) (Credits)	Major Course (MC)	Supporting course (S)	Dept. Specific Elective (DSE	Research ®	Seminar (S)	Open Elective (OE)	Soft Skill (SS)	Non-credit (NC)	Intern-ship (IC)	Value added course (VAC)	Credit
I	HOR2013 (2+1) HOR2014 (2 +1)	HOR2011 (2+1) HOR2012 (2+1)	HOR2015 (2+1) HOR2016 (2+1) HOR2017 (2+1)	Nil	HOR2018 (0+2)	Nil	Nil	Nil	Nil	Nil	Nil	**23**
II	Nil	HOR2021 (2+1) HOR2022 (2+1)	Nil	HOREC01 (2+1)/ HOREC02 (2+1) HOREC03 (2+1)/ HOREC04 (2+1)	HOR2023 (0+4) HOR2024 (3+0)	HOR2025 (0+1)	HOROE 01 (3+0)	Nil	Nil	Nil	HORVA01 (2+0)/ HORVA02 (2+0)	**23**
III	HOR2034 (2+0)	HOR2031 (2+1) HOR2032 (2+1) HFS613 (4+0)	Nil	HOREC05 (2+1)/ HOREC06 (2+1) HOREC07 (2+1)/ HOREC08 (2+1)	HOR2035 (4+2)	Nil	Nil	HORSE0 1 (2+0)/ HORSE0 2 (2+0)	Nil	Nil	Nil	**26**
IV	Nil	Nil	Nil	Nil	HOR2041 (0+16)	Nil	Nil	Nil	HOR2042	HOR2043 (0+4)	Nil	**18**
Total	**8**	**22**	**9**	**12**	**31**	**1**	**3**	**2**	**0**	**4**	**2**	**92**

Available credit :MSc - 92

M.Sc. Horticulture (Vegetable Science) Programme Course Structure (92 Credits)

Sem	Compulsory Course (*) (Credits)	Major Course (MC)	Supporting course (S)	Dept. Specific Elective (DSE	Research ®	Seminar (S)	Open Elective (OE)	Soft Skill (SS)	Non-credit (NC)	Intern-ship (IC)	Value added course (VAC)	Credit
I	HOR2013 (2+1) HOR2014 (2 +1)	HOR2011 (2+1) HOR2012 (2+1)	HOR2015 (2+1) HOR2016 (2+1) HOR2017 (2+1)	Nil	HOR2018 (0+2)	Nil	Nil	Nil	Nil	Nil	Nil	**23**
II	Nil	HOR2026 (2+1) HOR2027 (2+1)	Nil	HOREC09 (2+1)/ HOREC10 (2+1)	HOR2023 (0+4) HOR2024 (3+0)	HOR2025 (0+1)	HOROE 01 (3+0)	Nil	Nil	Nil	HORVA01 (2+0)/ HORVA02 (2+0)	**23**
				HOREC11 (2+1)/ HOREC12 (2+1)								
III	HOR2034 (2+0)	HOR2035 (2+1) HOR2036 (2+1) HFVS613 (4+0)	Nil	HOREC13 (2+1)/ HOREC14 (2+1)	HOR2035 (4+2)	Nil	Nil	HORSE01 (2+0)/ HORSE02 (2+0)	Nil	Nil	Nil	**26**
				HOREC15 (2+1)/ HOREC16 (2+1)								
IV	Nil	Nil	Nil	Nil	HOR2041 (0+16)	Nil	Nil	Nil	HOR2042	HOR2043 (0+4)	Nil	**18**
Total	**8**	**22**	**9**	**12**	**31**	**1**	**3**	**2**	**0**	**4**	**2**	**92**

Available credit :MSc - 92

M.Sc. Horticulture (Floriculture and Landscaping) Programme Course Structure (92 Credits)

Sem	Compulsory Course (*) (Credits)	Major Course (MC)	Supporting course (S)	Dept. Specific Elective (DSE	Research ®	Seminar (S)	Open Elective (OE)	Soft Skill (SS)	Non-credit (NC)	Intern-ship (IC)	Value added course (VAC)	Credit
I	HOR2013 (2+1) HOR2014 (2 +1)	HOR2011 (2+1) HOR2012 (2+1)	HOR2015 (2+1) HOR2016 (2+1) HOR2017 (2+1)	Nil	HOR2018 (0+2)	Nil	Nil	Nil	Nil	Nil	Nil	**23**
II	Nil	HOR2028 (2+1) HOR2029 (2+1)	Nil	HOREC17 (2+1)/ HOREC18 (2+1) HOREC19 (2+1)/ HOREC20 (2+1)	HOR2023 (0+4) HOR2024 (3+0)	HOR2025 (0+1)	HOROE 01 (3+0)	Nil	Nil	Nil	HORVA01 (2+0)/ HORVA02 (2+0)	**23**
III	HOR2034 (2+0)	HOR2037 (2+1) HOR2038 (2+1) HFL613 (4+0)	Nil	HOREC21 (2+1)/ HOREC22 (2+1) HOREC23 (2+1)/ HOREC24 (2+1)	HOR2035 (4+2)	Nil	Nil	HORSE0 1 (2+0)/ HORSE0 2 (2+0)	Nil	Nil	Nil	**26**
IV	Nil	Nil	Nil	Nil	HOR2041 (0+16)	Nil	Nil	Nil	HOR2042	HOR2043 (0+4)	Nil	**18**
Total	**8**	**22**	**9**	**12**	**31**	**1**	**3**	**2**	**0**	**4**	**2**	**92**

Available credit :MSc - 92

तमिलनाडुकेन्द्रीयविश्वविद्यालय
(संसदद्वारापारितअधिनियम 2009केअंतर्गतस्थापित)
CENTRAL UNIVERSITY OF TAMIL NADU
(Established by an Act of Parliament, 2009)
नीलक्कुड़ीपरिसर/Neelakudi Campus, कंगलान्चेरी/Kangalancherry,
तिरुवारूर/Thiruvarur- 610 005, Tamilnadu
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School of Life Sciences

Department of Horticulture

Regulation – 2023

Choice Based Credit System Curriculum and Syllabi
Two-year M.Sc. Horticulture Programme
Course Structure (92 Credits)

List of Content

Types of Courses	Short Form
Compulsory course	CC
Major Course	MC
Supporting course	SC
*Research	R
Seminar	S
Department Specific Elective	DSE (Mi)
Soft Skill	SS
Non Credit Compulsory	NC
Internship Course	IC
Open Elective	OE
Value Added Course	VAC

*** compulsory course**

SEMESTER I

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2011**	Biodiversity And Conservation of Horticultural Crops	MC	3	0	0	3	3	3
2	**HOR2012**	Postharvest Physiology and Biochemistry of Perishables	MC	2	0	1	3	3	4
3	**HOR2013**	Production Technology of Spices and Aromatic Crops	CC	2	0	1	3	3	4
4	**HOR2014**	Production Technology of Plantation and Medicinal Crops	CC	2	0	1	3	3	4
5	**HOR2015**	Basic Statistical Methods in Agricultural Research	SC	2	0	1	3	3	4
6	**HOR2016**	Laboratory Techniques, Library Information, Technical Writing and Research methodology	SC	2	0	1	3	3	4
7	**HOR2017**	Intellectual Property Rights and its Management in Agriculture	SC	2	0	1	3	3	4
8	**HOR2018**	Research-I	R	0	0	2	2	2	4
			Total	**15**	**0**	**8**	**23**	**23**	**31**

Fruit Science

SEMESTER II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2021**	Tropical Fruit Production	MC	2	0	1	3	3	4
2	**HOR2022**	Breeding of Fruit Crops	MC	2	0	1	3	3	4
3	**HOREC01/ HOREC02**	Export Oriented Fruit Production / Minor Fruit Production	DSE (Mi)	2	0	1	3	3	4
4	**HOREC03/ HOREC04**	Nutrition of Fruit Crops/ Biotechnology of Fruit Crops	DSE (Mi)	2	0	1	3	3	4
5	**HOR2023**	Research -II	R	0	0	4	4	4	8
6	**HOR2024**	Research -III	R	3	0	0	3	3	3
7	**HOR2025**	Seminar	S	0	0	1	1	1	2
8	**HOROE01**	Horticulture for Sustainability	OE	3	0	0	3	3	3
			Total	11	0	12	23	23	32
9	**HORVA01/ HORVA02**	Biofertilizer Production and Application in Agriculture / Biocontrol Agents in Crops	VAC	2	0	0	2	2	30*

***VAC minimum 30 contact hours. Mandatory course, but not counted for CGPA. Only Satisfactory / Not satisfactory.**

SEMESTER III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2031**	Subtropical and Temperate Fruit Production	MC	2	0	1	3	3	4
2	**HOR2032**	Propagation and Nursery Management of Fruit Crops	MC	2	0	1	3	3	4
3	**HOR2033**	Omics for Horticultural Crops	MC	4	0	0	4	4	4
4	**HOR2034**	Information Technology, AI and Machine Learning in Agriculture	CC	2	0	0	2	2	2
5	**HOREC05/ HOREC06**	Organic Fruit Culture / Climate Change and Canopy Management in Fruit Crops	DSE (Mi)	2	0	1	3	3	4
6	**HOREC07/ HOREC08**	Growth and Development of Fruit Crops / Postharvest Technology of Fruit Crops	DSE (Mi)	2	0	1	3	3	4
7	**HOR2035**	Research -IV	R	4	0	2	6	6	8
8	**HORSE01/ HORSE02**	Mushroom Cultivation / Landscape Architecture	SS	2	0	0	2	2	2
			Total	**20**	**0**	**6**	**26**	**26**	**32**

SEMESTER IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2041**	Research (dissertation) -V	R	0	0	16	16	16	32
2	**HOR2042**	Comprehensive exam and qualifying viva-voce (non-credit compulsory)	NC	0	0	0	0	0	0
3	**HOR2043**	Internship /Training (Continuous from the end of 2nd Semester)	IC	0	0	4	-	4	160**
			Total	**0**	**0**	**20**	**20**	**20**	

**** IC: 1 credit=40h @ 8hr/day×5days per week. Four-week course, conducted during 1st year summer vacation and evaluated in 4th semester.**

VEGETABLE SCIENCE

SEMESTER II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2026**	Production Technology of Warm Season Vegetable Crops	MC	2	0	1	3	3	4
2	**HOR2027**	Principles of Vegetable Breeding	MC	2	0	1	3	3	4
3	**HOREC09/ HOREC10**	Seed Production of Vegetable Crops / Production Technology of Underutilized Vegetable Crops	DSE (Mi)	2	0	1	3	3	4
4	**HOREC11/ HOREC12**	Systematics of Vegetable Crops / Postharvest Management of Vegetable Crops	DSE (Mi)	2	0	1	3	3	4
5	**HOR2023**	Research -II	R	0	0	4	4	4	8
6	**HOR2024**	Research -III	R	3	0	0	3	3	3
7	**HOR2025**	Seminar	S	0	0	1	1	1	2
8	**HOROE01**	Horticulture for Sustainability	OE	3	0	0	3	3	3
			Total	11	0	12	23	23	32
9	**HORVA01/ HORVA02**	Biofertilizer Production and Application in Agriculture / Biocontrol Agents in Crops	VAC	2	0	0	2	2	30*

***VAC minimum 30 contact hours. Mandatory course, but not counted for CGPA. Only Satisfactory / Not Satisfactory.**

SEMESTER III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2035**	Production Technology of Cool Season Vegetable Crops	MC	2	0	1	3	3	4
2	**HOR2036**	Growth and Development of Vegetable Crops	MC	2	0	1	3	3	4
3	**HOR2033**	Omics for Horticultural Crops	MC	4	0	0	4	4	4
4	**HOR2034**	Information Technology, AI and Machine Learning in Agriculture	CC	2	0	0	2	2	2
5	**HOREC13/ HOREC14**	Organic Vegetable Production / Breeding of Cross-Pollinated Vegetable Crops	DSE (Mi)	2	0	1	3	3	4
6	**HOREC15/ HOREC16**	Protected Cultivation of Vegetable Crops / Breeding of Self-Pollinated Vegetable Crops	DSE (Mi)	2	0	1	3	3	4
7	**HOR2035**	Research -IV	R	4	0	2	6	6	8
8	**HORSE01/ HORSE02**	Mushroom Cultivation / Landscape Architecture	SS	2	0	0	2	2	2
			Total	**20**	**0**	**6**	**26**	**26**	**32**

SEMESTER IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2041**	Research (dissertation) -V	R	0	0	16	16	16	32
2	**HOR2042**	Comprehensive exam and qualifying viva-voce (non-credit compulsory)	NC	0	0	0	0	0	0
3	**HOR2043**	Internship /Training (Continuous from the end of 2nd Semester)	IC	0	0	4	-	4	160**
			Total	**0**	**0**	**20**	**20**	**20**	

**** IC: 1 credit=40h @ 8hr/day×5days per week. Four week course, conducted during 1st year summer vacation and evaluated in 4th semester.**

FLORICULTURE AND LANDSCAPING

SEMESTER II

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2028**	Commercial Production of Loose Flowers	MC	2	0	1	3	3	4
2	**HOR2029**	Breeding of Ornamental Plants	MC	2	0	1	3	3	4
3	**HOREC17/ HOREC18**	Systematics of Ornamental Plants / Seed Production in Flower Crops	DSE (Mi)	2	0	1	3	3	4
4	**HOREC19/ HOREC20**	Turf Grass Management / Value Addition in Floriculture	DSE (Mi)	2	0	1	3	3	4
5	**HOR2023**	Research -II	R	0	0	4	4	4	8
6	**HOR2024**	Research -III	R	3	0	0	3	3	3
7	**HOR2025**	Seminar	S	0	0	1	1	1	2
8	**HOROE01**	Horticulture for Sustainability	OE	3	0	0	3	3	3
			Total	11	0	12	23	23	32
9	**HORVA01/ HORVA02**	Biofertilizer Production and Application in Agriculture / Biocontrol Agents in Crops	VAC	2	0	0	2	2	30*

***VAC minimum 30 contact hours. Mandatory course, but not counted for CGPA. Only Satisfactory / Not satisfactory.**

SEMESTER III

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2037**	Commercial production of cut flowers	MC	2	0	1	3	3	4
2	**HOR2038**	Ornamental gardening and landscaping	MC	2	0	1	3	3	4
3	**HOR2033**	Omics for Horticultural Crops	MC	4	0	0	4	4	4
4	**HOR2034**	Information Technology, AI and Machine Learning in Agriculture	CC	2	0	0	2	2	2
5	**HOREC21/ HOREC22**	Nursery management in ornamental plants / CAD for landscaping	DSE (Mi)	2	0	1	3	3	4
6	**HOREC23/ HOREC24**	Protected cultivation of flower crops / Indoor plants and Interiorscaping	DSE (Mi)	2	0	1	3	3	4
7	**HOR2035**	Research -IV	R	4	0	2	6	6	8
8	**HORSE01/ HORSE02**	Mushroom Cultivation / Landscape Architecture	SS	2	0	0	2	2	2
			Total	**20**	**0**	**6**	**26**	**26**	**32**

SEMESTER IV

S.No.	Code	Course Title	Category	Periods / Week			Total Contact Periods	Credits	Hours
				L	T	P			
1	**HOR2041**	Research (dissertation) -V	R	0	0	16	16	16	32
2	**HOR2042**	Comprehensive exam and qualifying viva-voce (non-credit compulsory)	NC	0	0	0	0	0	0
3	**HOR2043**	Internship /Training (Continuous from the end of 2nd Semester)	IC	0	0	4	-	4	**160****
			Total	**0**	**0**	**20**	**20**	**20**	

**** IC: 1 credit=40h @ 8hr/day×5days per week. Four-week course, conducted during 1st year summer vacation and evaluated in 4th semester.**

SEMESTER – I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2011	Biodiversity and Conservation of Horticultural Crops	3	-	-	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Elucidate importance & significance of global biodiversity & its preservation	Understand
CO2	Illustrate various techniques of germplasm conservation & documentation	Apply
CO3	Inspect the biodiversity concepts	Analyze
CO4	Assess an ecological understanding using digital tool	Skill

b. Syllabus

Units	**Content**
LI	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, vegetable, plantation and spice crop domestication; current status of germplasm availability/ database of fruit, vegetable, plantation and spice crops in India.
LII	Collection, Maintenance and Characterization: Exploration and collection of germplasm; sampling frequencies; size and forms of fruit and nut germplasm collections; active and base collections.
LIII	Germplasm conservation- in situ and ex situ strategies, on farm conservation; problem of recalcitrancy- cold storage of scions, tissue culture, cryopreservation, pollen and seed storage.
LIV	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.
LV	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, vegetable, plantation and spice varieties in India.

Tasks and Assignments:

- ✓ Documentation
- ✓ Assignments (Reading/ Writing),
- ✓ Exposure visits,
- ✓ Student presentations,
- ✓ Group Work,
- ✓ Practice record.

References:

1. Dhillon BS, Tyagi RK, Lal A and Saxena S. 2004. Plant Genetic Resource Management. Horticultural Crops.Narosa Publishing House, New Delhi.
2. Engles JM, Ramanath RV, Brown AHD and Jackson MT. 2002. Managing Plant Genetic Resources, CABI, Wallingford, UK.

3. Frankel OH and Hawkes JG. 1975. Crop Genetic Resources for Today and Tomorrow. Cambridge University Press, USA. Hancock J. 2012.
4. Plant Evolution and the Origin of Crops Species. CAB International. Jackson M, Ford-Lloyd B and Parry M. 2014.
5. Plant Genetic Resources and Climate Change. CABI, Wallingford, UK. Moore JN and Ballington Jr, JR. 1991.
6. Genetic Resources of Temperate Fruit and Nut Crops. ISHS, Belgium. Peter KV. 2008.
7. Biodiversity of Horticultural Crops. Vol. II. Daya Publ. House, Delhi. Peter KV. 2011. Biodiversity in Horticultural Crops.Vol.III. Daya Publ. House, Delhi.
8. Rana JC and Verma VD. 2011. Genetic Resources of Temperate Minor Fruits (Indigenous and Exotic). NBPGR, New Delhi. Rajasekharan PE, Rao V and Ramanatha V. 2019.
9. Conservation and Utilization of Horticultural Genetic Resources. Springer. Sthapit B, et al. 2016.
10. Tropical Fruit Tree Diversity (Good Practices for in situ and ex situ conservation). Bioversity International.
11. Routledge, Taylor and Francis Group. Virchow D. 2012. Conservation of Genetic Resources, Springer Verlag, Berlin.

c. Mapping of Program Outcomes with Course Outcomes

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

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**
HOR2012	Postharvest Physiology and Biochemistry of Perishables	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Understand about different factors affecting shelf life	Understand
CO2	Processes of respiration and ripening	Understand
CO3	Biosynthesis of ethylene and its action on ripening	Analyse
CO4	Develop the skill involved in the estimation of physical, physiological and biochemical changes associated.	Skill

b. Syllabus

Units	**Content**
LI	Introduction, biochemical structure and composition of fruits, vegetables and ornamentals. Biochemical changes during development and ripening. Structural Deterioration of the Produce-cell wall degradation, change in membrane lipid.:
LII	Biosynthesis of ethylene and its regulation. Ethylene action and ripening processes, its perception-action and regulation. Ethylene production and action inhibitors, their mode of action.
LIII	Determining maturity and maturity indices. Ripening processes: events of ripening and factors affecting them. Physiology of preharvest and postharvest; factors affecting shelf-life and quality of fruits, vegetables and ornamentals.
LIV	Respiration: respiratory climacteric, its significance. Transpiration and water stress during postharvest. Postharvest oxidative stress: active oxygen species, AOS generation, physiological effects on horticultural commodity, control of oxidative injury.
PV	Determination of physical parameters like specific gravity, fruit firmness, physiological loss in weight, chemical constituents like sugar, starch, pigments, Vitamin C, acidity during maturation and ripening in fruits/ vegetables; Estimation of ethylene evolved from ripening fruits; Delay/ Hastening of ripening by ethylene treatments; Determination of firmness, TSS, moisture, Titratable acid, sugar, protein, starch, fats, chlorophyll, carotene, anthocyanin, phenols and tannins; Measurement of respiration and ethylene evaluation.
Task and Assignment: ✓ Assignments (Reading/ Writing), ✓ Exposure visits, ✓ Student presentations, ✓ Group Work, ✓ Practice record.	

Reference:

1. Chadha KL and Pal RK. 2015. Managing postharvest quality and losses in horticultural crops. Vol-1, 2 & 3: General Issues, Astral International (P) Ltd., New Delhi
2. Hodges DM. 2003. Postharvest Oxidative Stress in Horticultural Crops, 1st Edition, ISBN 9781560229636
3. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest Biology and Technology of Fruits, Vegetables and Flowers, Wiley-Blackwell, ISBN: 9780813804088.
4. Sunil Pareek (Ed.) 2016. Postharvest Ripening Physiology of Crops,CRC Press, ISBN 9781498703802.
5. Thompson AK. 1995. Post harvest Technology of fruits and vegetables. Blackwell Sciences
6. Verma LR and Joshi VK. 2000. Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
7. Wills RBH and Golding J. 2017. Advances in Postharvest Fruit and Vegetable Technology, CRC Press, ISBN 9781138894051.
8. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
9. Websites

   Food and Agriculture Organization http://www.fao.org/home/en/ Respiration in plants http://ncert.nic.in/ncerts/l/kebo114.pdf

   Ethylene biosynthesis and its response http://www.biologydiscussion.com/plants/hormonesplants/ethylene-biosynthesis-and-its-responses-plant-hormones/25986

c. Mapping of Program Outcomes with Course Outcomes

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

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**
HOR2013	Production Technology of Spices and Aromatic 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	Gain knowledge on the production-related aspects of spices and aromatic crops.	Understand
CO2	Gain knowledge on the crop specific propagation and nursery aspects of spices and aromatic crops.	Understand
CO3	Analyse the morphological, chemical, physiological constituents of the spices and aromatic crops.	Analyse
CO4	Hands on experience on the production, value addition and marketing of spices and aromatic crops.	Skill

b. Syllabus

Units	**Content**
LI	Role of Spice and Aromatic crops: Introduction, importance of spice and aromatic crops, pharmaceutical significance, historical accent, present status – national and international, future prospects, role of Spices board and other development agencies.
LII	Classification of spice and aromatic crops: Major spices, minor spices, seed spices, tree spices, herbal spices. Varietal wealth: Botany and taxonomy, species, cultivars, commercial varieties/ hybrids in spice crops. Propagation and nursery management: Seed, vegetative and micropropagation methods, nursery techniques and nursery management practices.
LIII	Agro techniques: Climatic and soil requirements, site selection, layout, sowing/ planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, plant protection, precision farming, physiological disorders, protected cultivation.
LIV	Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons, mechanized harvesting. Postharvest management: Postharvest management including primary processing, grading, packaging and storage, GMP in major spice and aromatic crops. Aromatic plant-based industry: Essential oils, extraction. Indian perfumery industry, export.
	Spice Crops: Black pepper, small and large Cardamom, Ginger, Garlic, Coriander, Fenugreek, Cumin, Ajwain, Saffron, Vanilla, Nutmeg, Clove, Cinnamon, **Aromatic crops:** Palmarosa, lemongrass, citronella, patchouli, sweet flag, geranium, lavender, Ocimum sp.,
PV	Identification of seeds and plants, Botanical description of plant, Varietal features; Planting material production; Field layout and method of planting; Cultural practices; Harvest maturity, harvesting; Drying, storage, packaging; Primary processing; GAP in spice crops; Exposure visits to spice farms, research institutes.

Tasks and Assignments:

- ✓ Lecture
- ✓ Assignment (Reading/ Writing)
- ✓ Demonstration
- ✓ Presentation
- ✓ Exposure visits

Reference:

1. Agarwal S, Sastry EVD & Sharma RK. 2001. Seed Spices: Production, Quality, Export. Pointer Publ.
2. Arya PS. 2003. Spice Crops of India. Kalyani.
3. Bhattacharjee SK. 2000. Hand Book of Aromatic Plants. Pointer Publ.
4. Kumar N, A, Khader P, Rangaswami&Irulappan I. 2000. Introduction to Spices, Plantation
5. Crops, Medicinal and Aromatic Plants. Oxford & IBH.
6. Nybe EV, Miniraj N & Peter KV. 2007. Spices. New India Publ. Agency.
7. Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. Organic Spices. New India Publ. Agency.
8. Peter KV. 2001. Hand Book of Herbs and Spices. Vols. I-III. Woodhead Publ. Co. UK and CRC USA
9. Kumar N. 2018. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford &Ibh
10. Deepa Devi N.2017. A Text Book of Medicinal and Aromatic Crops. Aavishkar Publishers. ISBN- 13 : 978-8179105481
11. Farooqi Sreeramu. 2004. Cultivation of Medicinal & Aromatic Crops. Universities Press. ISBN-13 : 978-8173715044

c. Mapping of Program Outcomes with Course Outcomes

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

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**
HOR2014	Production Technology of Plantation and Medicinal 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	Students will understand practical knowledge on specialized production techniques of plantation and medicinal crops.	Understand
CO2	Gain knowledge on the crop specific propagation and nursery aspects in plantation and medicinal crops.	Skill
CO3	The students will be empowered in solving field problems.	Apply
CO4	They will become an successful entrepreneur with strong scientific and technical skills	Create

b. Syllabus

Units	**Content**
LI	Role of plantation and medicinal crops: Role of plantation and medicinal crops in national economy, area-production statistics at national and international level, classification, clean development mechanism and carbon sequestration potential of plantation and medicinal crops. Export potential: Export potential, problems and prospects and IPR issues in plantation and medicinal crops. Promotional programmes: Role of commodity boards and directorates in the development programmes of plantation and medicinal crops.
LII	Varietal wealth: Botany, taxonomy, species, cultivars and improved varieties in plantation and medicinal crops. Propagation and nursery management: Plant multiplication including in-vitro multiplication, nursery techniques and nursery management in plantation and medicinal crops.
LIII	Agro techniques: Systems of cultivation, cropping systems, multitier cropping, climate and soil requirements, systems of planting, high density planting, nutritional requirements, water requirements, fertigation, moisture conservation, role of growth regulators, macro and micro nutrients, nutrient deficiency symptoms, physiological disorders, shade regulation, weed management, training and pruning, crop regulation, plant protection, management of drought, precision farming.
LIV	Maturity indices and harvest: Maturity indices, harvesting methods, harvesting seasons and mechanized harvesting in plantation and medicinal crops. Post harvest management: Post harvest handling including primary processing, grading, packaging, storage and benefit cost analysis of plantation and medicinal crops.
	Plantation crops: Coffee and Tea, Cashew, Cocoa, Rubber, Palmyrah, Oil Palm, Coconut, Arecanut and Betel Vine. **Medicinal crops**: Senna, Catharanthus, Medicinal solanum, Ashwagandha, Aloevera, Glort lily, Medicinal Coleus, Isabgol and poppy;

PV	Description of botanical and varietal features; Selection of mother palms and seedlings; Nursery techniques; Soil and water conservation measures; Nutrient deficiency symptoms; Manuring practices; Pruning and training methods; Maturity standards; Harvesting and Processing; Project preparation for establishing plantations; GAP in plantation crops; Exposure visits to commercial plantations, research institutes.

Tasks and Assignments:

- ✓ Lecture
- ✓ Assignment (Reading/ Writing)
- ✓ Demonstration
- ✓ Presentation
- ✓ Exposure visits

Reference:

1. Chopra VL & Peter KV. 2005. Handbook of Industrial Crops. Panima.
2. Harler CR. 1963. The Culture and Marketing of Tea. Oxford Univ. Press.
3. Kurian A & Peter KV. 2007. Commercial Crops Technology. New India Publ. Agency.
4. Peter KV. 2002. Plantation Crops. National Book Trust.
5. Pradeep Kumar T, Suma B, Jyothibhaskar&Satheesan KN. 2008. Management of Horticultural Crops. Part I, II. New India Publ. Agency.
6. Rai PS &Vidyachandram B. 1981. Review of Work Done on Cashew. UAS, Research Series No.6, Bangalore.
7. Kumar N. 2018. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants.Oxford&Ibh
8. Deepa Devi N.2017. A Text Book of Medicinal and Aromatic Crops. Aavishkar Publishers. ISBN-13 : 978-8179105481
9. Farooqi Sreeramu. 2004. Cultivation of Medicinal & Aromatic Crops. Universities Press. ISBN- 13 : 978-8173715044

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3
CO2	3	3	3	3	2
CO3	2	1	2	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**
HOR2015	Basic Statistical Methods in Agricultural Research	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	To make students familiarize in acquiring data through observation and arranging the data through observation and arranging the data in presentable way	Understand
CO2	To make students aware of basic statistical tools available for simple analysis	Understand
CO3	To familiarize the students with different types of experimental designs available	Apply
CO4	To train them in the analysis and the interpretation and each experimental analysis	Analyze

b. Syllabus

Units	**Content**
LI	Classification, tabulation and graphical representation of data. Levels of measurement. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Probability distributions: Binomial, Poisson, Normal distributions and their applications. Concept of sampling distribution: t, χ2 and F distributions.
LII	Tests of significance based on normal, t, χ2 and F distributions. Non-parametric tests. Correlation and regression: Correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, simple and multiple linear regression model. Estimation of parameters.
LIII	Coefficient of determination. Introduction to multivariate analytical tools: Principal component analysis and cluster analysis. Planning of an experiment and basic principles of design of experiments. Analysis of variance. Completely randomized design (CRD), Randomized complete block design (RCBD), Latin square design (LSD).
LIV	Randomization procedure, analysis and interpretation of results. Concept of factorial experiments split plot and strip plot design. Planning of sample surveys. Sampling vs complete enumeration, Simple random sampling, Stratified sampling.
PV	Descriptive statistics Exercises on probability distributions. Correlation and regression analysis. Large sample tests, testing of hypothesis based on χ2, t and F. Exercises on non-parametric tests. Principal component analysis and cluster analysis. Analysis of data obtained from CRD, RBD, LSD. Analysis of data of factorial experiments. Selection of a random sample, estimation using simple random sampling. Exercises on stratified sampling.
	Task & Assignment: ✓ Power point presentations ✓ assignments, ✓ quiz ✓ Group tasks, ✓ student's presentations

References:

1. Aggarwal BL. 1996. Basic Statistics. Wiley Eastern Limited, New Age International Ltd.
2. Bansal ML, Singh S, Singh TP and Kumar R. 2004. Statistical Methods for Research Workers.Kalyani Publishers.
3. Chandel SRS. 2014. A Handbook of Agricultural Statistics. Achal Prakashan.
4. Goon AM, Gupta MK and Dasgupta B. 1968. Fundamentals of Statistics, vol I, II. The World Press, Calcutta.
5. Snedecor GW and Cochran WG. 1980. Statistical Methods. East West Press
6. Campbell, R.A. 1974. Statistics for Biologists. Cambridge University Press.
7. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. John Wiley.
8. Gupta, S.C. and Kapoor, V.K. 2007. Fundamentals of Mathematical Statistics. Sultan Chand and Sons.
9. Panse, V.G. and Sukhatme, P.V. 1967. Statistical Methods for Agricultural Workers. ICAR Publication.
10. Steel, R.G.D. and Torrie, J.H. 1960. Principles and Procedures of Statistics. McGraw Hill. 44
11. Katyal, Vijay. 2017. Statistical Designs and Analysis for Agricultural Field Experiments, NIPA, New Delhi
12. Gomez, K. A. and Gomez, A. A. 2015. Statistical Procedure for Agricultural Research. John Wiley & Sons, Indian Edition

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	2
CO2	3	3	3	3	2
CO3	3	3	3	2	2
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER – I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2016	Laboratory Techniques, Library Information, Technical Writing and Research methodology	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	To make the students acquaint with scientific writing and to make them confident in writing the research and review article	Understand
CO2	To make students acquire technical skills in handling the Instruments, Modern lab instruments	Skill
CO3	To make him aware of Laboratory rules and regulations	Remember
CO4	To familiarize the students when the libraries system of function and make him aware of different resources including e-resources available for the retrieval and utilization	Remember

b. Syllabus

Units	**Content**
LI	Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agrochemical doses in field and pot applications.
LII	Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.).
LIII	Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods
LIV	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.
PV	Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-

	ovens, incubators, water bath, oil bath. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability.

Tasks and Assignments:

- ✓ Assignments,
- ✓ Quiz
- ✓ Group tasks,
- ✓ Student's presentations

Reference:

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH &Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
3. Sadasivam and Manickam. 2013. Handbook of Biochemical Methods, Biotech Books

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	8	12	40
External	15	15	12	18	60
Total	**25**	**25**	**20**	**30**	**100**

SEMESTER – I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2017	Intellectual Property Rights and its Management in Agriculture	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Gain knowledge on the principles and tools of IPR	Understand
CO2	Gain knowledge on the protection subject matters related to IPR	Understand
CO3	Will be able to do documentation of different IPR tools	Apply

b. Syllabus

Units	**Content**
LI	Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs.
LII	Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers‘ rights and biodiversity protection.
LIII	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; Indian Legislations for the protection of various types of Intellectual Properties; National Biodiversity protection initiatives, Convention on Biological Diversity.
LIV	International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.
PV	Filling of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers‘ rights and biodiversity protection.

Tasks and Assignments:

- ✓ Assignments,
- ✓ Quiz
- ✓ Group tasks,
- ✓ Student’s presentations

Reference:

1. Erbisch FH &Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC& Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

5. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights inAnimal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
7. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

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

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOROE01	Horticulture for Sustainability (OE)	3	-	0	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Gain knowledge on the Scope and importance of horticulture	Understand
CO2	Gain knowledge on the production techniques of different horticultural crops	Apply
CO 3	Adaption of sustainable practices for the crop development and Societal welfare	Apply

b. Syllabus

Units	**Content**
LI	Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit vegetable and flower zones of India and of different states, value-added products.
LII	Nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Principles objectives, types and methods of pruning and training of fruit crops.
LIII	Production and management practices for fruit (Mango, Banana, Pomegranate, Ber, Guava), vegetable (Brinjal, Tomato, Bhendi, Potato, Chilli) and floriculture (Rose, Carnation, Jasmine, Tuberose, Marigold) crops.
LIV	Types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits,
LV	Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frames working, Type of fruits- morphology. Principles of organic farming, market chain management.
Tasks and Assignments: ✓ Assignments, ✓ Quiz ✓ Group tasks	

- ✓ Student's presentations

Reference:

1. Davies, F. T., Geneve, R. L., Hartmann, H. T., Wilson, S. B., Kester, D. 2018. Hart mann & Kester's Plant Propagation: Principles and Practices. United Kingdom: Pearson
2. Kumar, N. 2010. Introduction to Horticulture. Oxford-IBH, New Delhi
3. Nambisan, K.M.P. 1992. Design elements of landscape gardening. Oxford & IBH Publishing Company, New Delhi

. · **c. Mapping of Program Outcomes with Course Outcomes**

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

d. Evaluation Scheme

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

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HORVA01	Biofertilizer Production and Application in Agriculture (VAC)	2	0	0	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	To make students familiarized with use of microbes in agriculture	Understand
CO2	Learning the different methods of culturing of microbes	Understand
CO3	Production of biofertilizers for commercial usage.	Apply

b. Syllabus

Units	**Content**
LI	Biofertilizers – Introduction, types, importance of biofertilizers in agriculture – History of biofertilizers production, Classification of biofertilizers microorganisms used in biofertilizers production, A study of growth characteristics of various microbes used in biofertilizers production.
LII	Nitrogen cycle in Nature. Rhizobium - characters and classification – Rhizobium - legume symbiosis - Process of nodule formation - Factors affecting nodulation and nitrogen fixation, Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component, Biochemistry of nitrogen fixation, Cross inoculation groups amongst Rhizobium, Methods used for the studying selection of efficient strain of Rhizobium, Characteristics and classification of Azospirillum, Azotobacter, Gluconacetobacter.- Actinorhizal plants (Frankia) and Algal biofertilizers – Blue-green algae – Azolla.
LIII	Phosphorus cycle in Nature. Problems of phosphorus uptake - fixation of phosphorus – the microbial transformation of phosphorus- Phosphate solubilizing microorganisms characteristics, classification, role, and mechanisms - Pseudomonas and Bacillus, K, Zn, and silicate solubilizing microorganisms – factors affecting phosphate solubilization– AM fungi – characteristics and types of mycorrhizae – Plant Growth Promoting Rhizobacteria (PGPR)
LIV	Different formulations of biofertilizers – Types and characters - carrier – beads – pellets and liquid formulation – preservatives and additives-shelf life of different formulations- Quality standard for biofertilizers - BIS, methods of application of biofertilizers, the role of microorganisms in the decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers, Strategies of Mass multiplication and packing. Registration of biofertilizers. problem and constraints in production, Marketing, and monitoring field performance. Economics of microbial inoculants
LV	Equipment, machinery, and tools used for biofertilizer production. Preparation of media used for isolation and culturing of biofertilizers: Jensen's agar, NFb medium, Yeast extract mannitol agar, BGA-medium, Pikovaskaya's medium; Isolation of Rhizobium from root nodules, Isolation Azotobacter from rhizosphere of cereal crops, Beijernickia, Acetobacter from the soil, Azospirillium from roots of graminaceous plants, BGA from the soil, Mycorrhizae from the roots, PSM and sulfur-oxidizing microorganisms and their isolation in pure culture form. Estimating the efficiency of Rhizobium through pot culture experiments and through nodulation tests in test tubes and Leonard jar. Production of commercial biofertilizers viz. Rhizobium, Azotobacter, Azospirillum and Acetobacter: selection of efficient strains, carriers and their sterilization, mother culture preparation, mass multiplication using shake culture method, mixing of culture and carriers and preparation of packets. Production of carrier-based and grain-based phosphate solubilizing biofertilizers.

Task & Assignment:

- ✓ Visit to commercial biofertilizer production units and retail shops
- ✓ Powerpoint presentations to strengthen the subject knowledge among students

References:

1. S. Gianinazzi, Hannes Schüepp, J.M. Barea, K. Haselwandter.2012. Mycorrhizal Technology in Agriculture: From Genes to Bioproducts. Birkhäuser publisher
2. M.J. Dilworth,and A.R. Glenn. 1991. Biology and Biochemistry of Nitrogen fixation. Elsevier, Amsterdam
3. Umesh Chandra Mishra.2015. Facts for Liquid Biofertilizer. Partridge Publishing, Singapore. S.G.Borkar.2015. Microbes as Biofertilizers and their Production Technology .Wood head publisher. New Delhi.
4. P.Hyma. 2017. Biofertilizers: Commercial production Technology and quality control. Random publishers. New Delhi.
5. F.J. Bergersen and J.R. Postgate. 1987. A century of Nitrogen Fixation Research Present status and Future prospects. The Royal Soc., London.
6. Bhattacharyya..,P and Tandon HLS.2002.Dictionary of Biofertilizers and Organic Fertilizers. Fertilizer Development and Consultation Organization, New Delhi. 1 – 165.
7. Subba Rao, N.S. 1993. Biofertilizers in Agriculture and Forestry. Oxford and IBH. Publ. Co., New Delhi.
8. P. Somasegaran and H.J. Hoben. 1994.Hand book for Rhizobia; Methods in legume Rhizobium Technology, Springer-Verlag, New York.
9. Motsore, M. R., P. Bhattacharayya and Beena Srivastava, 2001. Biofertilizer Technology,Marketing and usage – A source Book – cum – glossary – FDCO, New Delhi, P. 584.

E reference

1. https://www.ncbi.nlm.nih.gov/pmc
2. https://www.researchgate.net
3. https://www.sciencedirect.com/science/

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	Total
Internal	10	15	15	40
External	20	20	20	60
Total	**30**	**35**	**35**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HORVA02	Bio-control Agents in Crops (VAC)	2	0	0	2

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

	Course Outcome	Level
CO1	To make students familiarized with importance of biocontrol agents	Understand
CO2	To understand the mechanisms of biocontrol culturing of microbes	Understand
CO3	Production of biocontrol agents for commercial usage.	Apply

b. Syllabus

Units	Content
LI	Biological control/Bio-control agents – Introduction, definitions, importance, History, principles, and scope of biological control in plant protection; important groups of parasitoids, predators, and pathogens; principles of classical biological control- importation, augmentation and conservation, Merits and demerits of biological control.
LII	Biology, adaptation, host-seeking behavior of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa, etc., and their mode of action. Biological control of weeds using insects. Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms, and its relevance in biological control.
LIII	Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application, and evaluation. Factors governing biological control, the role of the physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of insect pests and pathogens, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. Compatibility of different bioagents.
LIV	Importation of natural enemies-Quarantine regulations, biotechnology in biological control. Insect Growth Regulators and Botanicals in pest management. Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM, and organic farming systems, and biocontrol agents available in the market. Quality control system of biocontrol agents.
LV	Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal, and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Isolation, characterization, and maintenance of antagonists, methods of study of antagonism and antibiosis, and application of antagonists against the pathogen in vivo conditions. Study of cfu/g of formulated products.
Task & Assignment: ✓ Visit to commercial biocontrol production units ✓ Power point presentations to strengthen the subject knowledge among students ✓ Assignment submission ✓ Record and maintenance	

References:

1. Cook RJ & Baker KF. 1983. Nature and Practice of Biological Control of Plant Pathogens. APS, St. Paul, Mennisota.
2. Fokkemma MJ. 1986. Microbiology of the Phyllosphere. Cambridge Univ. Press, Cambridge.
3. Gnanamanickam SS (Eds). 2002. Biological Control of Crop Diseases. CRC Press, Florida.
4. Heikki MT & Hokkanen James M (Eds.). 1996. Biological Control - Benefits and Risks. Cambridge Univ. Press, Cambridge.
5. Mukerji KG, Tewari JP, Arora DK & Saxena G. 1992. Recent Developments in Biocontrol of Plant Diseases. Aditya Books, New Delhi
6. Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.
7. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
8. Dhaliwal GS & Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
9. Gerson H & Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman & Hall, New York.
10. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
11. Ignacimuthu SS & Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi.
12. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	Total
Internal	10	15	15	40
External	20	20	20	60
Total	**30**	**35**	**35**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2033	Omics for Horticultural Crops (4+0)	4	-	-	4

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Gain knowledge on the principles and tools of Genomics, Phenomics, Ionomics, metabolomics and proteomics	Understand
CO2	Gain knowledge on application part of Genomics, Phenomics, Ionomics, metabolomics and proteomics	Understand
CO3	Understanding and implementation of various tools used in the genomics and proteomics for the crop development	Apply

b. Syllabus

Units	**Content**
LI	*Introduction to omics* **- I**ntroduction to phenomics, genomics, transcriptomics, ionomics, proteomics, metabolomics, metagenomics, and bioinformatics- importance and potential applications in crop science.
LII	***Phenomics and genomics* -**'Phene and traits', phenotypic expression - morphological markers, co-segregation and correlation studies- specific traits associated with yield potential, stress adaptation (both biotic and abiotic stresses). Need for high throughput precision phenotyping approaches for basic studies and to generate genetic and genomic resources- an overview. Types of phenomic platforms. Phenomics facility and its utility in horticulture, Concept of Phenome Wide Association Studies (PWAS). Different methods of genome sequencing, principles of various sequencing chemistries, physical and genetic maps, Comparative and evolutionary genomics, functional genomics, nutrigenomics, Organelle genomics, applications in phylogenetics, gene identification, gene annotation, pairwise and multiple alignments, quantitative PCR, SAGE, MPSS, microarray, case studies of completed genomes, preliminary genome data analysis and application in horticulture.
LIII	***Transcriptomics and Proteomics* -** Transcriptome- profiling, Genome-wide and gene-specific transcriptomics approaches, differential expression analysis- Identification of differentially expressed genes through transcriptome, DNA chips and their use in transcriptome analysis, transcriptome profiling using microarrays and deep sequencing. Protein as component of functional omics, comparative proteomics and structural proteomics, Proteomics: Gel based and gel free, Basics of software used in proteomics, proteome analysis using mass spectrometry, crystallography and NMR, analysis of proteome data, study of protein- protein interactions. Proteomics Induced systemic resistance against pathogens and tolerance against abiotic stress in horticultural crops

LIV	***Ionomics and metabolomics*** **-** Essential, beneficial, dietary, toxic and other trace elements influencing crops growth, development and consumer preference. Elemental profiling and its applications in germplasm conservation, crop production, protection, improvement and crop utilization. Ionome finger printing and its application. Ionomics and climate change. High throughput precision ionome profiling methods and their advantage, complementation with other omics technologies. Primary and secondary metabolites. Elucidation of metabolic pathways, Sample preparation for metabolomics. Profiling of secondary metabolites and application in horticulture. Metabolite profiling methods and techniques involved in metabolite identification- LCMS, NMR, FTIR, MS. Metabolomics in biotic and biotic stress in crop plants. Metabolic pathway engineering and its application.
LV	***Metagenomics and Bioinformatics*** **-** Metagenomics, epigenetics, meta transcriptomics –meaning, Metagenome Sequencing, Single Cell Analysis, Host-Pathogen Interaction; Shotgun metagenomics; High-throughput sequencing; Comparative metagenomics. Bioinformatics basics, scope and importance of bioinformatics; Biological databases-data bases for different omics, big data analysis tools- bioinformatics tools used in comapartive omics, annotations, correlation of data obtained from different omics , Bioinformatics Tools Facilitate the Genome-Wide Identification of Protein-Coding Genes, Sequence analysis, Sequence submission and retrieval system.

Tasks and Assignments:

- ✓ Assignments,
- ✓ Quiz
- ✓ Group tasks,
- ✓ Student's presentations

Reference:

1. Aizat, W.M., Goh, H-H. and Baharum, S.N. (Eds.) 2018. Omics Applications for Systems Biology. Springer International Publishing.
2. Arivaradarajan, P., Misra, G. (Eds.) 2018. Omics Approaches, Technologies and Applications. Springer Singapore
3. Attwood, T.K., and Parry-Smith, D. J. 2004. Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
4. Baxter, I. 2010. Ionomics: The functional genomics of elements. Briefings in Functional Genomics. 9, (2): 149-156
5. David Edwards (Ed.) 2007. Plant Bioinformatics: Methods and Protocols. Humana Press, New Jersey, USA.
6. Fan TWM, Lane AN and Higashi RM. (Eds.) 2012. The Handbook of Metabolomics. Humana Press, Totowa, N
7. Kumar J, Pratap A and Kumar S. 2015. Plant Phenomics: An Overview. 10.1007/978-81- 322-2226-2_1.
8. Lesk, A.M. 2012. Introduction to Genomics, 2nd Edition. Oxford University Press
9. Leung, H.E. 2012. Integrative Proteomics. InTech
10. Lieber D.C. 2002. Introduction to Proteomics - Tools for the New Biology. Humana Press.
11. Lobos GA, Camargo AV, del Pozo A, Araus JL, Ortiz R and Doonan JH. 2017. Plant Phenotyping and Phenomics for Plant Breeding. Frontiers in Plant Science, 8, 2181.

12. Pieruschka R and Poorter H. 2012. Phenotyping plants: genes, phenes and machines. Functional Plant Biology, 39(11), 813-820.
13. Salt, DE. 2004. Update on ionomics. Plant Physiology 136: 2451-2456
14. Wang Y, Sun, M (Eds.), 2018. Transcriptome Data Analysis: Methods and Protocols. ISBN 978-1-4939-7710-9; Springer

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

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

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2034	Information Technology, AI and Machine Learning in Agriculture	2	-	-	2

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Gain knowledge on the principles and tools of Information technology	Understand
CO2	Gain knowledge on application part of IA	Understand
CO3	Understanding the machine learning and its application.	Understand

b. Syllabus

Units	**Content**
LI	Introduction to Computers, Anatomy of computer, Operating Systems, definition and types, Applications of MS Office for document creation & Editing, Data presentation, interpretation and graph creation. Database, concepts and types, uses of DBMS in Agriculture, World Wide Web.
LII	Use of ICT in Agriculture, Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc.,
LIII	Introduction to Artificial Intelligence (AI); Scope of AI: Games, theorem proving, natural language processing, robotics, expert system. Knowledge: General concept of knowledge, Knowledge based system, Representation of knowledge, Knowledge organization and manipulation, Acquisition of knowledge.
LIV	Search and Control strategies: Blind search, Breadth- first search, Depth – First search, Hill climbing method, Best – First search, Branch and Bound search.
LV	Mechine Learning: Concept of learning, learning automation, genetic algorithms, learning by induction. Expert System: Introduction to expert system, Characteristics features of expert system, Applications, Importance of Expert system, Rule based system architecture.

Tasks and Assignments:

- ✓ Assignments,
- ✓ Quiz
- ✓ Group tasks,
- ✓ Student's presentations

Reference:

1. Akerkar R. 2005. Introduction to Artificial Intelligence. Prentice-Hall of India.
2. Giarratano J. and Riley G. 1998. Expert Systems - Principles and Programming. 3rd Ed. PWS Publ.
3. Gonzalez A. and Dankel D. 2004. The Engineering of Knowledge-Based Systems. Prentice Hall.
4. Hill E.F. 2003. Jess in Action. Manning Publ.
5. Jackson P. 1999. Introduction to Expert Systems. Addison Wesley.

6. Nilson N.J. 2014. Artificial Intelligence: A New Synthesis. Maurgan Kaufman.
7. Nilson N.J. 2001. Principles of Artificial Intelligence. Narosa.
8. Rich E. and Knight K. 2002. Artificial Intelligence. Tata McGraw Hill.
9. Russell S. and Norvig P. 2003. Artificial Intelligence: A Modern Approach. Prentice Hall.
10. Vanitha G. 2011. Agro-informatics
11. http://www.agrimoon.com
12. http://www.agriinfo.in
13. http://www.eagri.org
14. http://www.agriglance.com
15. http://agritech.tnau.ac.in

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

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

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HORSE01	Mushroom Cultivation (SS)	**2**	**-**	**0**	**2**

a. Course Outcome (CO)

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

	Course Outcome	Level
CO1	Understanding the significance and types of edible mushrooms	Understand
CO2	Learning the isolation and culture of spawn in labs	Understand
CO3	Cultivation, processing and preservation of different edible mushrooms	Apply

b. Syllabus

Units	Content
LI	Introduction to mushrooms, Mushrooms -Taxonomical rank -History and Scope of mushroom cultivation - Edible and Poisonous Mushrooms-Vegetative characters, nutritional value, Medicinal value, genetic improvement of common edible mushrooms, Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*).
LII	Principles of mushroom cultivation. Structure and construction of mushroom house. Sterilization and sanitation of substrates for culture media. Spawn production - culture media preparation- production of pure culture, isolation of mother spawn and multiplication of spawn. Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting.
LIII	Cultivation techniques, harvesting, packing and storage of oyster and paddy straw mushroom. Problems in cultivation of mushroom - diseases, pests and nematodes.
LIV	Weed moulds and their management strategies. Economics of cultivation, postharvest technologies involved in cultivation aspects.
LV	Processing and preservation of mushrooms freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Value added products of mushrooms, economics of spawn and mushroom production and mushroom recipes. Health benefits of mushrooms, Nutritional and medicinal values of mushrooms. Therapeutic aspects- antitumor effect.

Task & Assignment:

- ✓ Assignments,
- ✓ Quiz
- ✓ Group tasks,
- ✓ Student's presentations

References:

1. Board NIIR. Handbook on Mushroom Cultivation and Processing. Centre for Information Technology.
2. Harander Singh 1991. Mushrooms-The art of cultivation- Sterling Publishers.
3. Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers & Publishers, New Delhi.
4. M. H. Pinkerton. (2013). Commercial Mushroom Growing. British Library Cataloguing-inPublication data.

5. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
6. Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
7. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
8. O.P. Ahlawat, R.P. Tewari (2007).Cultivation technology of Paddy straw Mushroom. National Research Centre for Mushroom (ICAR), Chambaghat, Solan, India.
9. Pandey. B. P. (1996). A textbook of fungi. Chand and Company N Delhi.
10. Pathak, V. N. and Yadav, N. (2010). Mushroom Production and Processing Technology. Agrobios, Jodhpur, India.
11. R. Gogoi, Y. Rathaiah, T.R. Borah. (2006).Mushroom cultivation technology. Scientific Publishers, Jodhpur, India.
12. S. Kannaiyan & K. Ramasamy (1980). A hand book of edible mushroom. Today & Tomorrows printers & publishers, New Delhi.
13. Subrata Biswas, M. Datta, S. V. Ngachan. (2012) Mushrooms: A Manual for Cultivation. PHI Learning Pvt Ltd.
14. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., Mysore Road, Bangalore.
15. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation. Mittal Publications, Delhi.
16. Tripathi, D.P. (2005).Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt .Ltd, New Delhi.
17. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000)

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	Total
Internal	10	15	15	40
External	20	20	20	60
Total	**30**	**35**	**35**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HORSE02	Landscape Architecture (SS)	2	-	0	2

a. Course Outcome (CO)

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

Course Outcome		**Level**
CO1	Enables to imbibe the principles and significances of landscaping	Understand
CO2	Useful to implement the acquired knowledge of landscaping at different geographical sites	Apply
CO3	Suitability of selectiveness of hard and soft-scaping components along with site specific lay-outs	Analyze
CO4	Hones the ability to prepare the landscape lay-outs	Skill

b. Syllabus

Units	**Content**
LI	Introduction to plant systematic & plant processes, Basic plant structure/morphology/anatomy, Basic plant functions/growth & development/physiology Principles of taxonomy / classification, identification and naming Familiarity with local flora, Growth regulators, Phyto-geographical Regions of India, Ecological and Botanical considerations in landscape design
LII	Site planning process and its significance; establishing relationship between site characteristics and design requirements. Inventory, documentation and site planning checklist, hard landscapes, outdoor furnitures
LIII	Traditional and contemporary landscapes; eastern traditions and islamic landscapes, rennaissance and the evolution of new thoughts, the evolution of the modern landscape, the modern movement, contemporary concepts and concerns, indian context
LIV	Urban landscape design, introduction, urban spaces, open space system, elements in urban landscape, case studies

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Report on exposure visits at regional landscaped areas

Reference:

1. Garden Cullen, The concise Townscape, Architectural press, London.
2. Pieluigi Nicholin, Francesco Repishti, Dictionary of today's landscape designers, Skira Editores P.A, 2003.
3. Elizabeth Barlow Rogers, Landscape Design – A Cultural &Architectural History, Hary & Abram inc. publishers, 2001.
4. Strom Steven, Site engineering for landscape Architects, John wiley and sons Inc.,2004.
5. Raunkier.C., the Life forms of Plants and statistical plant geography, 1934.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – IV					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2043	Internship/ Training	0	-	4	4

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	**Enrich their knowledge, and acquire skills on latest state of art of technologies in different frontier areas of horticultural sciences**	Skill

b. Syllabus

Units	Content
P1	**The students will be undergoing internship/ training in various frontier areas of horticulture and enrich their knowledge, and acquire skills on latest state of art of technologies.** **i. Horticulture based processing industries** **ii. Green house horticulture crop production** **iii. Seed production of horticultural crops** **iv. Commercial nurseries** **v. Dry-flower production industry** **vi. Bio-control agent production units** **vii. Bio-fertilizer production units** **viii. Agro-based NGO tie-ups**

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3

d. Evaluation Scheme

	CO1	Total
Internal	50	50
External	50	50
Total	**100**	**100**

SEMESTER – I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2018	Research-I	0	-	2	2

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

b. Syllabus

Units	**Content**
PI	Review collection, documentation, and developing a research plan.
PII	Structuring a scientific report, synopsis preparation, and presentation.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	0	3	0	0	0
CO2	0	3	0	0	0

d. Evaluation Scheme

	CO1	**CO2**	**Total**
Internal	0	0	0
External	50	50	100
Total	**50**	**50**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2023	Research-II	0	-	4	4

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Conduct the research experiment with critical research appetite	Skill

b. Syllabus

Units	**Content**
PI	Selection of crop,
PII	Preparation of field,
PIII	Plotting and experimental design,
PIV	Procurement of chemicals and materials, Preparation of reagents, conduct of lab experiment.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	0	3	0	0	0

d. Evaluation Scheme

	CO1	**Total**
Internal	0	0
External	100	100
Total	**100**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2024	Research-III	3	-	0	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Equip with knowledge of conducting research with a high problem solving research appetite.	Analysis

b. Syllabus

Units	**Content**
LI	Recording the results for the parameters and treatments decided
LII	Study of relevant research papers
LIII	Writing of 'Introduction' component of dissertation

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	0	3	0	0	0

d. Evaluation Scheme

	CO1	**Total**
Internal	40	40
External	60	60
Total	**100**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2035	Research-IV	4	-	2	6

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Interpret the data obtained for the research experiment through statistical tools	Remember

b. Syllabus

Units	**Content**
LI	Writing of 'Review of Literature' part of dissertation
LII	Development of 'Material' component of experiment
LIII	Development of 'Method' component of experiment
LIV	Study of relevant research papers
PI	Evaluation of appropriateness of experiment-specific statistical analysis
PII	Analysing the data through appropriate statistical tools

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	0	0

d. Evaluation Scheme

	CO1	**Total**
Internal	40	40
External	60	60
Total	**100**	**100**

SEMESTER – IV					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2041	Research V (Dissertation)	0	-	16	16

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Equip with knowledge of conducting research with a high problem solving research appetite.	Remember

b. Syllabus

Units	**Content**
PI	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. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	0	0

d. Evaluation Scheme

	CO1	**Total**
Internal	0	0
External	100	100
Total	**100**	**100**

SEMESTER – IV					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2042	Comprehensive Exam and 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

c. 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)

d. Evaluation Scheme

	CO1	**Total**
Internal	0	0
External	100	100
Total	**100**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2025	Seminar	0	-	1	1

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Gain depth knowledge on a specialized area of horticulture science	Analyze

b. Syllabus

Units	**Content**
PI	**Collection of literature, understanding the concepts and organizing the presentation and final presentation of seminar on a specialized topic in horticulture science**

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**2**	**2**	**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)

d. Evaluation Scheme

	CO1	**Total**
Internal	0	0
External	100	100
Total	**100**	**100**

Fruit Science

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2021	Tropical 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	Upgain knowledge on various production technologies of tropical fruits on sustainable basis	Upgain
CO2	Understand on various cultural operations in growing fruit crops	Understand
CO3	Analyse the importance of various agro techniques in propagation, planting and orchard floor management	Analyse
CO4	Apply several crop regulatory practices over the induction of flowering, fruit-set and harvesting	Apply

b. Syllabus

Units	**Content**
LI	Introduction: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements of Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.
LII	Agro-techniques: Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production of Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.
LIII	Crop management: Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders – causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting of Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.
LIV	Post harvest and biotic stress management: grading, packing, storage and ripening techniques; insect and disease management of Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.
PV	Distinguished features of tropical fruit species, cultivars and rootstocks; Demonstration of planting systems, training and pruning; Hands on practices on pollination and crop regulation; Leaf sampling and nutrient analysis; Physiological disorders – malady diagnosis; Physico-chemical analysis of fruit quality attributes; Field/ Exposure visits to tropical orchards; Project preparation for establishing commercial orchards
Task & Assignment: ✓ Class room Lectures ✓ Laboratory ✓ Field Practicals ✓ Student Seminars ✓ Presentations ✓ Field Tours	

- ✓ Demonstrations
- ✓ Assignments

References:

13. Bartholomew DP, Paull RE and Rohrbach KG. 2002. The Pineapple: Botany, Production, and Uses. CAB International.
14. Bose TK, Mitra SK and Sanyal D. 2002. Fruits of India – Tropical and Sub-Tropical.3rd Edn. Naya Udyog, Kolkata.
15. Dhillon WS. 2013. Fruit Production in India. Narendra Publ. House, New Delhi.
16. Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principlesand Practices. IBDC Publishers, New Delhi.
17. Litz RE. 2009. The Mango: Botany, Production and Uses. CAB International.
18. Madhawa Rao VN. 2013. Banana. ICAR, New Delhi.
19. Midmore D. 2015. Principles of Tropical Horticulture. CAB International.
20. Mitra SK and Sanyal D. 2013. Guava, ICAR, New Delhi.
21. Morton JF. 2013. Fruits of Warm Climates. Echo Point Book Media, USA.
22. Nakasome HY and Paull RE. 1998. Tropical Fruits. CAB International.
23. Paull RE and Duarte O. 2011. Tropical Fruits (Vol. 1). CAB International.
24. Rani S, Sharma A and Wali VK. 2018. Guava (Psidium guajava L.). Astral, New Delhi.
25. Robinson JC and Saúco VG. 2010. Bananas and Plantains. CAB International.
26. Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
27. Schaffer B, Wolstenholme BN and Whiley AW. 2013. The Avocado: Botany, Production and Uses. CAB International.
28. Sharma KK and Singh NP. 2011. Soil and Orchard Management. Daya Publishing House, New Delhi.
29. Valavi SG, Peter KV and Thottappilly G. 2011. The Jackfruit. Stadium Press, USA.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	2	3	3	3	2
CO3	3	2	3	2	2
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2022	Breeding of Fruit 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	Acquaint comprehensive knowledge on status and peculiarities of fruit breeding	Acquaint
CO2	Understand the Importance, Taxonomy and Genetic Resources of fruit crops	Understand
CO3	Analyse Blossom Biology and Breeding Systems of various fruit crops	Analyse
CO4	Practice different conventional and non-conventional breeding approaches in several fruit crops	Practice

b. Syllabus

Units	Content
LI	Introduction: Importance, Taxonomy and Genetic Resources: Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources of Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts
LII	Reproductive Biology: Blossom Biology and Breeding Systems: Blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes of Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts
LIII	Breeding approaches: Conventional and Non-Conventional Breeding: Approaches for crop improvement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits in Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts
LIV	Resistance breeding and Biotechnological interventions: resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts in Mango, Banana, Pineapple, Citrus, Grapes, Litchi, Guava, Pomegranate, Papaya, Apple, Pear, Plum, Peach, Apricot, Cherries, Strawberry, Kiwifruit, Nuts
PV	Exercises on bearing habit, floral biology; Pollen viability and fertility studies; Hands on practices in hybridization; Raising and handling of hybrid progenies; Induction of mutations and polyploidy; Evaluation of biometrical traits and quality traits; Screening for resistance against abiotic stresses; Developing breeding programme for specific traits; Visit to research stations working on fruit breeding

Task & Assignment:

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations

- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments

References:

1. Abraham Z. 2017. Fruit Breeding. Agri-Horti Press, New Delhi.
2. Badenes ML and Byrne DH. 2012. Fruit Breeding. Springer Science, New York.
3. Dinesh MR. 2015. Fruit Breeding, New India Publishing Agency, New Delhi.
4. Ghosh SN, Verma MK and Thakur A. 2018. Temperate Fruit Crop Breeding-Domestication to Cultivar Development. NIPA, New Delhi.
5. Hancock JF. 2008. Temperate Fruit Crop Breeding: Germplasm to Genomics. Springer Science, New York.
6. Jain SN and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Tropical Species. Springer Science, New York.
7. Jain S and Priyadarshan PM. 2009. Breeding Plantation and Tree Crops: Temperate Species. Springer Science, New York.
8. Janick J and Moore JN. 1996. Fruit Breeding. Vols. I–III. John Wiley & Sons, USA.
9. Kumar N. 2014. Breeding of Horticultural Crops: Principles and Practices. NIPA, N. Delhi.
10. Moore JN and Janick J. 1983. Methods in Fruit Breeding. Purdue University Press, USA.
11. Ray PK. 2002. Breeding Tropical and Subtropical Fruits. Narosa Publ. House, New Delhi.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	2	2
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC01	Export Oriented 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	Learn national and international trade scenario of fruit crops	Learn
CO2	Understand the Statistics and World Trade of commercial fruit crops	Understand
CO3	Practice the policies, norms and standards in export scenario of fruits	Practice
CO4	Evaluate the impact of infrastructure and plant material in export chain of fruit crops	Evaluate

b. Syllabus

Units	**Content**
LI	Introduction: Statistics and World Trade: National and international fruit export and import scenario and trends; Statistics and India's position and potentiality in world trade; export promotion zones in India. Government Policies
LII	Policies, Norms and Standards: Scope, produce specifications, quality and safety standards for export of fruits, viz., mango, banana, grape, litchi, pomegranate, walnut, apple and other important fruits
LIII	Post harvest and processing standards: Processed and value-added products, post-harvest management for export including packaging and cool chain; HACCP, Codex alimentarius, ISO certification; WTO and its implications, sanitary and phyto-sanitary measures.
LIV	Infrastructure and Plant Material: Quality fruit production under protected environment; different types of structures – Automated greenhouses, glasshouse, shade net, poly tunnels – Design and development of low cost greenhouse structures. Seed and planting material; meeting export standards, implications of plant variety protection – patent regimes.
PV	Export promotion zones and export scenario of fresh fruits and their products; Practical exercises on quality standards of fruits for export purpose; Quality standards of planting material and seeds; Hi-tech nursery in fruits; Practicals on ISO specifications and HACCP for export of fruits; Sanitary and phyto-sanitary measures during export of horticultural produce; Post harvest management chain of horticultural produce for exports; Visit to export oriented units/ agencies like APEDA, NHB, etc.

Task & Assignment:

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments
- ✓ Training

References:

1. Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House, New Delhi.
2. Chetan GF. 2015. Export Prospects of Fruits and Vegetables from India: A study of Export market in EU. A project report. Anand Agricultural University, Anand, Gujarat.
3. Dattatreylul M. 1997. Export potential of Fruits, Vegetables and Flowers from India. NABARD, Mumbai.
4. Islam, C.N. 1990. Horticultural Export of Developing Countries: Past Preferences, Future Prospects and Policies. International Institute of Food Policy Research, USA.

e-Resources

5. http://apeda.gov.in
6. http://nhb.gov.in
7. http://indiastat.com

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	3
CO2	3	3	3	3	3
CO3	2	3	3	3	3
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC02	Minor 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	Upgain basic knowledge on underexploited minor fruit crops	Upgain
CO2	Understand the Occurrence, Adoption and General Account of minor fruit crops	Understand
CO3	Practice the propagation and cultural practices for minor fruits	Practice
CO4	Access the feasibility over the standards of post-harvest management systems for minor fruits	Access

b. Syllabus

Units	Content
LI	Introduction: Occurrence, Adoption and General Account: Importance – occurrence and distribution, climate adaptation in fragile ecosystem and wastelands by Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, woodapple, cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, seabuckthorn, hazel nut and other minor fruits of regional importance
LII	Agro-Techniques: Propagation and Cultural Practices: Traditional cultural practices and recent development in agro-techniques; propagation of Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, woodapple, cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, seabuckthorn, hazel nut and other minor fruits of regional importance
LIII	Flowering, fruiting and fruit quality: Botany-floral biology, growth patterns, mode of pollination, fruit set, ripening, fruit quality of Bael, chironji, fig, passion fruit, jamun, phalsa, karonda, woodapple, cactus pear, khejri, kair, pilu, lasoda, loquat, tamarind, dragon fruit, monkey jack, mahua, khirni, amra, kokum, cape gooseberry, kaphal, persimmon, pistachio, seabuckthorn, hazel nut and other minor fruits of regional importance
LIV	Value addition and Utilization: Post harvest management, marketing in terms of medicinal and antioxidant values; their uses for edible purpose and in processing industry of minor fruits
PV	Visits to institutes located in the hot and cold arid regions of the country; Identification of minor fruits plants/cultivars; Collection of leaves and preparation of herbarium; Allelopathic studies; Generating know-how on reproductive biology of minor fruits; Fruit quality attributes and biochemical analysis; Project formulation for establishing commercial orchards in fragile ecosystems
Task & Assignment: ✓ Class room Lectures ✓ Laboratory ✓ Field Practicals ✓ Student Seminars ✓ Presentations ✓ Field Tours	

- ✓ Demonstrations
- ✓ Assignments
- ✓ Training

References:

1. Ghosh SN, Singh A and Thakur A. 2017. Underutilized Fruit Crops: Importance and Cultivation. Jaya Publication House, New Delhi.
2. Krishna H and Sharma RR, 2017. Fruit Production: Minor Fruits. Daya Publishing House, New Delhi.
3. Mazumdar BC. 2014. Minor Fruit Crops of India: Tropical and Subtropical. Daya Publication House, New Delhi.
4. Nath V, Kumar D, Pandey V and Pandey D. 2008. Fruits for the Future. Satish Serial Publishing House, New Delhi.
5. Pareek OP, Sharma S, and Arora RK. 2007. Underutilised Edible Fruits and Nuts, IPGRI, Rome.
6. Peter KV. 2010. Underutilized and Underexploited Horticultural Crops. NIPA, New Delhi.
7. Rana JC and Verma VD. 2011. Genetic Resources of Temperate Minor Fruit (Indigenous and Exotic). NBPGR, New Delhi.
8. Saroj PL and Awasthi OP. 2005. Advances in Arid Horticulture, Vol. II: Production Technology of Arid and Semiarid Fruits. IBDC, Lucknow.
9. Saroj PL, Dhandar DG and Vashishta BB. 2004. Advances in Arid Horticulture, Vol.-1 Present Status. IBDC, Lucknow.
10. Singh et al. 2011. Jamun. ICAR, New Delhi.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	2	3	3	3
CO3	3	3	3	2	3
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC03	Nutrition of Fruit 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	Acquaint with principles and practices involved in nutrition of fruit crops	Acquaint
CO2	Understand the importance and various types of fruit nutrients and their uptake mechanisms	Understand
CO3	Diagnose soil and plant status of fruit crops with respect to various nutrients	Diagnose
CO4	Practice the integrated nutrient management concepts in fruit crops	Practice

b. Syllabus

Units	**Content**
LI	Introduction: General Concepts and Principles: Importance and history of nutrition in fruit crops, essential plant nutrients, factors affecting plant nutrition; nutrient uptake and their removal from soil
LII	Diagnostics, Estimation and Application: Nutrient requirements, root distribution in fruit crops, soil and foliar application of nutrients in major fruit crops, fertilizer use efficiency. Methods and techniques for evaluating the requirement of macro- and micro-elements, Diagnostic and interpretation techniques including DRIS
LIII	Nutrient management: Role of different macro and micro-nutrients, their deficiency and toxicity disorders, corrective measures to overcome deficiency and toxicity disorders
LIV	Integrated Nutrient Management (INM): Fertigation in fruit crops, biofertilizers and their use in INM systems
PV	Visual identification of nutrient deficiency symptoms in fruit crops; Identification and application of organic, inorganic and bio-fertilizers; Soil/ tissue collection and preparation for macro- and micro-nutrient analysis; Analysis of soil physical and chemical properties- pH, EC, Organic carbon; Determination of N,P,K and other macro- and micronutrients; Fertigation in glasshouse and field grown horticultural crops; Preparation of micro-nutrient solutions, their spray and soil applications

Task & Assignment:

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments
- ✓ Training

References:

1. Atkinson D, Jackson JE and Sharples RO. 1980. Mineral Nutrition of Fruit Trees. Butterworth – Heinemann.
2. Bould C, Hewitt EJ and Needham P. 1983. Diagnosis of Mineral Disorders in Plants Vol.1 Principles. Her Majesty's Stationery Office, London.
3. Cooke GW. 1972. Fertilizers for maximizing yield. Grenada Publishing Ltd, London.
4. Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley Eastern Ltd.
5. Kanwar JS. 1976. Soil Fertility-Theory and Practice. ICAR, New Delhi.
6. Marchner Horst. 1995. Mineral Nutrition of Higher Plants, 2nd Ed. Marschner, Academic Press Inc. San Diego, CA.
7. Mengel K and Kirkby EA. 1987. Principles of Plant Nutrition. 4th Ed. International Potash Institute, Worblaufen-Bern, Switzerland.
8. Prakash M. 2013. Nutritional Disorders in Fruit Crops: Diagnosis and Management. NIPA, New Delhi.
9. Tandon HLS. 1992. Management of Nutrient Interactions in Agriculture. Fertilizer Development and Consultation Organization, New Delhi.
10. Westerman RL. 1990. Soil Testing and Plant Analysis, 3rd Ed. Soil Science Society of America, Inc., Madison, WI.
11. Yawalkar KS, Agarwal JP and Bokde S. 1972. Manures and Fertilizers. 3rd Ed. Agri Horticultural Publishing House, Nagpur

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	2
CO2	3	3	3	3	3
CO3	3	3	2	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC04	Biotechnology of Fruit 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	Understand basic principles and methods of plant tissue culture and other biotechnological tools	Understand
CO2	Learn *In-vitro* Culture and Hardening techniques in several fruit crops	Learn
CO3	Explore various genetic manipulation techniques and technologies for fruit crops	Explore
CO4	Practice various biotechnological tools pertain to fruit crops	Practice

b. Syllabus

Units	**Content**
LI	Introduction: History and Basic Principles: Introduction and significance, history and basic principles, influence of explant material, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture
LII	Tissue culture: *In-vitro* Culture and Hardening: Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture. Use of bioreactors and *in-vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues. Hardening and *ex vitro* establishment of tissue cultured plants.
LIII	*In-vitro* Breeding and Transgenics: Somatic cell hybridisation, construction and identification of somatic hybrids and cybrids, wide hybridization, *in-vitro* pollination and fertilization, haploids, *in-vitro* mutation, artificial seeds, cryopreservation, *In-vitro* selection for biotic and abiotic stress.
LIV	Gene Technologies: principles and methods, transgenics in fruit crops, use of molecular markers and genomics. Gene silencing, gene tagging, gene editing, achievements of biotechnology in fruit crops
PV	An exposure to low cost, commercial and homestead tissue culture laboratories; Media preparation, Inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus; Sub-culturing techniques on anther, ovule, embryo culture, somaclonal variation; *In-vitro* mutant selection against abiotic stress; Protoplast culture and fusion technique; Development of protocols for mass multiplication; Project development for establishment of commercial tissue culture laboratory
Task & Assignment: ✓ Class room Lectures ✓ Laboratory ✓ Field Practicals ✓ Student Seminars ✓ Presentations ✓ Field Tours	

- ✓ Demonstrations
- ✓ Assignments
- ✓ Training

References:

1. Bajaj YPS. Eds., 1989. Biotechnology in Agriculture and Forestry. Vol. V, Fruits. Springer, USA.
2. Brown TA. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publishing, USA.
3. Chahal GS and Gosal SS. 2010. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa, New Delhi.
4. Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology – Concepts, Methods and Applications. Oxford & IBH, New Delhi.
5. Kale C. 2013. Genome Mapping and Molecular Breeding in Plant, Vol 4. Fruit and Nuts. Springers.
6. Keshavachandran R and Peter KV. 2008. Plant Biotechnology: Tissue Culture and Gene Transfer. Orient & Longman, Universal Press, US.
7. Keshavachandran R, Nazeem PA, Girija D, John PS and Peter KV. 2007. Recent Trends in Biotechnology of Horticultural Crops. Vols. I, II. NIPA, New Delhi.
8. Litz RE. 2005. Biotechnology of Fruit and Nut Crops. CABI, UK.
9. Miglani GS. 2016. Genetic Engineering – Principles, Procedures and Consequences. Narosa Publishing House, New Delhi.
10. Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK and Mohanadas S. 2001. Biotechnology of Horticultural Crops. Vols. I–III. Naya Prokash, Kolkata.
11. Peter KV. 2013. Biotechnology in Horticulture: Methods and Applications. NIPA, New Delhi.
12. Vasil TK, Vasi M, While DNR and Bery HR. 1979. Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture. Platinum Press, UK.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	3
CO3	3	2	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2031	Subtropical and Temperate 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	Understand cultural and management practices for growing subtropical and temperate fruits	Understand
CO2	Learn principles and practices of producing subtropical and temperate fruits	Learn
CO3	Narrate the propagation, planting and orchard floor management practices	Narrate
CO4	Explain flowering, fruit-set and harvesting mechanisms in subtropical and temperate fruits	Explain

b. Syllabus

Units	Content
LI	Introduction: Origin, distribution and importance, major species, rootstocks, commercial varieties of regional, national & international importance, eco-physiological requirements of Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.
LII	Propagation, Planting and Orchard Floor Management: Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production of Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.
LIII	Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting of Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.
LIV	Post harvest and crop protection: grading, packing, storage and ripening techniques; insect and disease management of Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.
PV	Distinguished features of fruit species, cultivars and rootstocks; Demonstration of planting systems, training and pruning; Hands on practices on pollination and crop regulation; Leaf sampling and nutrient analysis, Physiological disorders-malady diagnosis; Physico-chemical analysis of fruit quality attributes; Field/ Exposure visits to subtropical and temperate orchards; Project preparation for establishing commercial orchards
Task & Assignment: ✓ Class room Lectures	

- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations

References:

1. Chadha KL and Awasthi RP. 2005. The Apple. Malhotra Publishing House, New Delhi.
2. Chadha TR. 2011. A Text Book of Temperate Fruits. ICAR, New Delhi
3. Creasy G and Creasy L. 2018. Grapes. CAB International.
4. Dhillon WS. 2013. Fruit Production in India. Narendra Publishing House, New Delhi.
5. Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. Temperate and Subtropical Fruit Production. CAB International.
6. Ladanyia M. 2010. Citrus Fruit: Biology, Technology and Evaluation. Academic Press.
7. Layne DR and Bassi D. 2008. The Peach: Botany, Production and Uses. CABI.
8. Menzel CM and Waite GK. 2005. Litchi and Longan: Botany, Production and Uses. CAB International.
9. Rajput CBS, and Haribabu RS. 2006. Citriculture, Kalyani Publishers, New Delhi.
10. Sandhu S and Gill BS. 2013. Physiological Disorders of Fruit Crops. NIPA, New Delhi.
11. Sharma RM, Pandey SN and Pandey V. 2015. The Pear – Production, Post-harvest Management and Protection. IBDC Publisher, New Delhi.
12. Sharma RR and Krishna H. 2018. Textbook of Temperate Fruits. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
13. Singh S, Shivshankar VJ, Srivastava AK and Singh IP. 2004. Advances in Citriculture. NIPA, New Delhi.
14. Tromp J, Webster AS and Wertheim SJ. 2005. Fundamentals of Temperate Zone Tree Fruit Production. Backhuys Publishers, Lieden, The Netherlands.
15. Westwood MN. 2009. Temperate Zone Pomology: Physiology and Culture. Timber Press, USA.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2032	Propagation and Nursery Management of Fruit 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	Understand the knowledge on principles and practices of macro and micropropagation	Understand
CO2	Learn various management practices and regulation under nursery	Learn
CO3	Explore and handle various propagation structures and propagated materials in nursery	Explore
CO4	Practice certain conventional and asexual propagation techniques, micropropagation of commercial fruit crops	Practice

b. Syllabus

Units	**Content**
LI	Introduction: Understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing
LII	Conventional Asexual Propagation: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working
LIII	Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules
LIV	Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine
PV	Hands on practices on rooting of dormant and summer cuttings; Anatomical studies in rooting of cutting and graft union; Hands on practices on various methods of budding and grafting; Propagation by layering and stooling; Micropropagation-explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening; Visit to commercial tissue culture laboratories and accredited nurseries
Task & Assignment: ✓ Class room Lectures ✓ Laboratory ✓ Field Practicals ✓ Student Seminars ✓ Presentations	

- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments
- ✓ Training

References:

1. Bose TK, Mitra SK and Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkatta.
2. Davies FT, Geneve RL and Wilson SB. 2018. Hartmann and Kester's Plant Propagation, Principles and Practices. Pearson, USA/ PrenticeHall of India. New Delhi.
3. Gill SS, Bal JS and Sandhu AS. 2016. Raising Fruit Nursery. Kalyani Publishers, New Delhi.
4. Jain S and Ishil K. 2003. Micropropagation of Woody Trees and Fruits. Springer.
5. Jain S and Hoggmann H. 2007. Protocols for Micropropagation of Woody Trees and Fruits. Springer.
6. Joshi P. 2015. Nursery Management of Fruit Crops in India. NIPA, New Delhi.
7. Love et al. 2017. Tropical Fruit Tree Propagation Guide. UH-CTAHR F_N_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA.
8. Peter KV, eds. 2008. Basics of Horticulture. New India Publishing Agency, New Delhi.
9. Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. NIPA, New Delhi.
10. Sharma RR. 2014. Propagation of Horticultural Crops. Kalyani Publishers, New Delhi.
11. Sharma RR and Srivastav M. 2004. Propagation and Nursery Management. Intl. Book Publishing Co., Lucknow.
12. Singh SP. 1989. Mist Propagation. Metropolitan Book Co.
13. Singh RS. 2014. Propagation of Horticultural Plants: Arid and Semi-Arid Regions. NIPA, New Delhi.
14. Tyagi S. 2019. Hi-Tech Horticulture. Vol I: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	2	3	3	3
CO3	3	3	2	3	3
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC05	Organic Fruit Culture	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Understand on organic production of fruit crops	Understand
CO2	Familiarize with the concepts and practices of organic and other natural farming systems for fruit crops	Familiarize
CO3	Discover the principles, farming systems and practices for organic fruit production	Discover
CO4	Generate the procedures, policies and regulation for inspection and certification of organic fruit produce	Generate

b. Syllabus

Units	**Content**
LI	Introduction: Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis
LII	Farming System and Bio-inputs: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes
LIII	Intercropping and stress management in organic culture: Inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management. Organic seeds and planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops
LIV	Certification: Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody, certification trademark – The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production
PV	Design of organic orchards/ farms management; Conversion plan; Nutrient management and microbial assessment of composts and bio-enhancers; Preparation and application of composts, bio-enhancers and bio-pesticides; Organic nursery raising; Application of composts, bio-enhancers, bio-fertilisers and bio-pesticides, green manure, cover, mulching; Preparation and use of neem based products; Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases; Soil solarisation; Frame work for GAP; Documentation for certification
Task & Assignment:	

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments

References:

1. Claude A. 2004. The Organic Farming Sourcebook. Other India Press, Mapusa, Goa, India.
2. Dabholkar SA. 2001. Plenty for All. Mehta Publishing House, Pune, Maharashtra.
3. Das HC and Yadav AK. 2018. Advances in Organic Production of Fruit Crops. Westville Publishing House, New Delhi.
4. Deshpande MS. 2003. Organic Farming with respect to Cosmic Farming. Mrs. Pushpa Mohan Deshpandey, Kolhapur, Maharashtra.
5. Deshpande WR. 2009. Basics of Organic Farming. All India Biodynamic and Organic Farming Association, Indore. MP. Gaur AC,
6. Neblakantan S and Dargan KS. 1984 Organic Manures. ICAR, New Delhi.
7. Lampkin, N. and Ipswich, S. 1990. Organic Farming. Farming Press. London, UK.
8. Lind K, Lafer G, Schloffer K, Innershofer G and Meister H. 2003. Organic Fruit Growing. CAB International.
9. Palaniappan SP and Annadurai K. 2008. Organic Farming- Theory and Practice. Scientific Publishers, Jodhpur, Rajasthan, India.
10. Palekar S. 2004. The Technique of Spritual Farming. Chandra Smaritee, Sai Nagar, Amrawati, Maharashtra.
11. Proctor P. 2008. Biodynamic Farming and Gardening. Other India Press, Mapusa, Goa.
12. Ram RA and Pathak RK. 2017. Bioenhancers. Lap Lambert Academic Publishing, AP.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	3
CO2	3	3	3	3	3
CO3	2	3	3	3	3
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC06	Climate Change and Canopy 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 Outcome	**Level**
CO1	Understand the impact of climate change and its management in fruit production	Understand
CO2	Access the effects of nature and extent of altered behaviour or damage due to climate change and its mitigation	Access
CO3	Apply the scientific concepts of pruning and training in senile orchards	Apply
CO4	Analyse the impacts of canopy regulation with several means with production and quality of fruits	Analyse

b. Syllabus

Units	**Content**
LI	Introduction and Impact Assessment: Climate change; factors affecting climate change; Global warming, effect of climate change on spatio-temporal patterns of temperature and rainfall, concentrations of greenhouse gasses in atmosphere. pollution levels such as tropospheric ozone, change in climatic variability and extreme events. Sensors for recording climatic parameters, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, longer growing seasons and shifts in plant hardiness for fruit crops
LII	Mitigation and response: Climate mitigation measures through crop management- use of tolerant rootstocks and varieties, mulching – use of plastic- windbreak- spectral changes- protection from frost and heat waves. Climate management in greenhouse- heating – vents – CO2 injection – screens – artificial light. Impact of climate changes on invasive insect, disease, weed, fruit yield, quality and sustainability. Climate management for control of pests, diseases, quality, elongation of growth and other plant processes- closed production systems. Responses of fruit trees to climatic variability vis-a-vis tolerance and adaptation; role of fruit tree in carbon sequestration
LIII	Canopy management - importance and factors affecting canopy development; Canopy types and structures, canopy manipulation for optimum utilization of light and its interception; Spacing and utilization of land area – Canopy classification
LIV	Physical Manipulation and Growth Regulation: Canopy management through rootstock and scion. Canopy management through plant growth regulators, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality
PV	Study of different types of canopies; Training of plants for different canopy types; Canopy development through pruning; Understanding bearing behaviour and canopy management in different fruits; Use of plant growth regulators; Geometry of planting; Development of effective canopy with support system; Study on effect of different canopy types on production and quality of fruits
Task & Assignment: ✓ Class room Lectures	

- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations
- ✓ Assignments

References:

1. Dhillon WS and Aulakh PS. 2011. Impact of Climate Change in Fruit Production. Narendra Publishing House, New Delhi.
2. Peter KV. 2008. Basics in Horticulture. New India Publishing Agency, New Delhi.
3. Ramirez F and Kallarackal J. 2015. Responses of Fruit Trees to Global Climate Change. Spinger Verlag.
4. Rao GSLHV. 2008. Agricultural Meteorology. Prentice Hall, New Delhi.
5. Rao GSLHV, Rao GGSN, Rao VUM and Ramakrishnan YS. 2008. Climate Change and Agriculture over India. ICAR, New Delhi.
6. Schafeer B and Anderson P. 1994. Handbook of Environmental Physiology of Fruit Crops.Vol. 1 & 2. CRC Press. USA.
7. Bakshi JC, Uppal DK and Khajuria HN. 1988. The Pruning of Fruit Trees and Vines. Kalyani Publishers, New Delhi.
8. Chadha KL and Shikhamany SD. 1999. The Grape, Improvement, Production and Post Harvest Management. Malhotra Publishing House, Delhi.
9. Iyer CPA and Kurian RM. 2006. High Density Planting in Tropical Fruits: Principles and Practices. IBDC Publishers, New Delhi.
10. Pradeepkumar T. 2008. Management of Horticultural Crops. NIPA, New Delhi.
11. Singh G. 2010. Practical Manual on Canopy Management in Fruit Crops. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi.
12. Srivastava KK. 2012. Canopy Management in Fruits. ICAR, New Delhi

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	2	3	3	3	3
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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC07	Growth and Development of Fruit 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	Understand on of various growth and development processes in fruit crops	Understand
CO2	Remember the role of environment and growth substances	Remember
CO3	Apply the skills to realise optimum growth and development under stress conditions	Apply
CO4	Analyse the impact of physical and chemical manipulation of growth and development	Analyse

b. Syllabus

Units	Content
LI	Introduction: Growth and development - definition, parameters of growth and development, growth dynamics and morphogenesis
LII	Climatic Factors: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism; Assimilate partitioning, influence of water and mineral nutrition in growth and development
LIII	Hormones and Developmental Physiology: Concepts of plant hormone and bioregulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinosteroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development
LIV	Strategies for Overcoming Stress: Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development
PV	Understanding dormancy mechanisms in fruit crops and seed stratification; Techniques of growth analysis; Evaluation of photosynthetic efficiency under different environments; Exercises on hormone assays; Practical's on use of growth regulators; Understanding ripening phenomenon in fruits; Study on impact of physical manipulations on growth and development; Study on chemical manipulations on growth and development; Understanding stress impact on growth and development

Task & Assignment:

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations

- ✓ Assignments
- ✓ Training

References:

1. Bhatnagar P. 2017. Physiology of Growth and Development of Horticultural Crops. Agrobios (India).
2. Buchanan B, Gruiessam W and Jones R. 2002. Biochemistry and Molecular Biology of Plants. John Wiley & Sons, NY, USA.
3. Dhillon WS and Bhatt ZA. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.
4. Durner E. 2013. Principles of Horticultural Physiology. CAB International
5. Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley & Sons, NY, USA.
6. Faust M. 1989. Physiology of Temperate Zone Fruit Trees. John Willey & Sons, NY, USA.
7. Fosket DE. 1994. Plant Growth and Development: a Molecular Approach. Academic Press, USA.
8. Leopold AC and Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill, New Delhi.
9. Roberts J, Downs S and Parker P. 2002. Plant Growth Development. In: Salisbury FB and Ross CW. (Eds.) Plant Physiology. 4th Ed.Wadsworth Publications, USA.
10. Schafeer, B. and Anderson, P. 1994. Handbook of Environmental Physiology of Fruit Crops. Vol. 1 & 2. CRC Press. USA.
11. Seymour GB, Taylor JE and Tucker GA. 1993. Biochemistry of Fruit Ripening. Chapman & Hall, London

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	3	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC08	Postharvest Technology of Fruit 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	Understand on physiochemical changes associated with fruit crops after harvest and management of postharvest losses.	Understand
CO2	Remember the principles and methods of food preservation	Remember
CO3	Able to analyse the physiochemical changes after harvest and storage in fruits	Analyse
CO4	Able to develop skill in processing and development of processed fruit products	Skill

b. Syllabus

Units	**Content**
LI	Introduction: History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes; Climacteric and non-climacteric fruits: Regulation of ripening by use of chemicals and growth regulators; Control of sprouting, rooting and discoloration
LII	Maturity, Harvest and Post-harvest operations: Maturity indices, Harvesting and harvesting tools; special operation in harvest; prepackage Operation: Precooling, washing, sorting, grading of fruit crops for local and export markets; Postharvest handling of fruits; Equipments for washing, sizing, grading etc.
LIII	Pre and Postharvest treatments for extending storage life/ vase life: VHT, irradiation treatment, skin coating, degreening, etc. Pre-packaging, Packaging techniques for local market and export. Standards and specifications for fresh produce
LIV	Postharvest handling system and marketing: Importance; principles of transport, modes of transportation, types of vehicles and transit requirements for different horticultural produce. Marketing: Factors influencing marketing of perishable crops, marketing systems and organizations
PV	Study of maturity indices for harvest of fruit crops; Protective skin coating with wax emulsion and pre and Postharvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and fruity vegetables; Pre-packaging of perishables; Extension of vaselife by use of chemicals and growth regulators; Utility of growth retardants; Study of modern harvesting, sorting and grading equipment's; Study of effect of pre-cooling on shelf-life and quality of fresh fruits; Visit to packaging centres; Visit to local markets, cooperative organizations, super markets dealing with marketing of Perishables.

Task & Assignment:

- ✓ Class room Lectures
- ✓ Laboratory
- ✓ Field Practicals
- ✓ Student Seminars
- ✓ Presentations
- ✓ Field Tours
- ✓ Demonstrations

- ✓ Assignments
- ✓ Training

References:

1. Bhattacharjee SK and Dee LC. 2005. Postharvest technology of flowers and ornamental plants. Pointer publishers, Jaipur.
2. Chattopadhyay SK. 2007. Handling, transportation and storage of fruit and vegetables. GeneTech books, New Delhi.
3. FAO. 2007. Handing and Preservation of Fruits and Vegetables by Combined methods for Rural Areas-Technical Manual. FAO Agr.Ser.Bull., 149.
4. Kader AA. 1992. Postharvest technology of horticultural crops. 2nd ed university of California.
5. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest Biology and Technology of Fruits, Vegetables and Flowers, Wiley-Blackwell, ISBN: 9780813804088.
6. Pruthi JS. 2001 (Reprint). Major spices of India crop management and Postharvest technology. ICAR, NewDelhi
7. Stawley J Kays. 1998. Postharvest physiology of perishable plant products. CBS publishers.
8. Sudheer KP, Indira V. 2007. Postharvest Technology of Horticultural Crops, Peter K.V. (Ed.), New India Publishing Agency, ISBN 9788189422431.
9. Sunil Pareek (Ed.) 2016. Postharvest Ripening Physiology of Crops, CRC Press, ISBN 9781498703802.
10. Thompson AK. (Ed.) 2014. Fruit and Vegetables: Harvesting, Handling and Storage (Vol. 1 & 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.
11. Verma LR and Joshi VK. 2000. Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
12. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
13. Wills RBH and Golding J. 2017. Advances in Postharvest Fruit and Vegetable Technology, CRC Press, ISBN 9781138894051.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	3	3	3
CO3	3	3	2	3	3
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

Vegetable Science

SEMESTER II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2026	Production of Warm Season Vegetable 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**
CO 1	Understand the impact of Eco physiological aspects in production of warm season vegetables	Understand
CO 2	Apply the knowledge of skills oriented to production of major tropical vegetables	Apply
CO 3	Access various deficiencies, disorders and the solutions to overcome the constraints in crop production of warm season vegetables	Analyse
CO 4	Acquaint skill for the demonstration of various plant growth substances and herbicides, seed extraction techniques	Skill

b. Syllabus

Units	**Content**
LI	Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, pest and disease Management, post- harvest management, plant protection measures, economics of crop production of *Fruit vegetables*- Tomato, brinjal, hot pepper, sweet pepper and okra.
LII	Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, pest and disease Management, post- harvest management, plant protection measures, economics of crop production of *Beans*—French bean, Indian bean (Sem), cluster bean and cowpea.
LIII	Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, pest and disease Management, post- harvest management, plant protection measures, economics of crop production of *Cucurbits*—Cucumber, melons, gourds, pumpkin and squashes.
LIV	Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, pest and disease Management, post- harvest management, plant protection measures, economics of crop production of *Tuber crops*—Sweet potato, elephant foot yam, tapioca, taro and yam. *Leafy vegetables*—Amaranth and drumstick.
PV	Scientific raising of nursery and seed treatment, Sowing, transplanting, vegetable grafting, Description of commercial varieties and hybrids, Demonstration on methods of irrigation, fertilizers and micronutrients application, Mulching practices, weed management, Use of plant growth substances in warm season vegetable crops, Study of nutritional and physiological disorders, Studies on hydroponics, aeroponics and

	other soilless culture, Identification of important pest and diseases and their control, Preparation of cropping scheme for commercial farms, Visit to commercial farm, greenhouse/ polyhouses, Visit to vegetable market, Analysis of benefit to cost ratio

Tasks and Assignments

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Bose TK, Som MG and Kabir J. (Eds.). 1993. Vegetable crops. Naya prokash.
2. Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003. Vegetable Crops. Vols. I-III. NayaUdyog.
3. Bose TK, Som MG &Kabir J. (Eds.). 2002. Vegetable Crops. NayaProkash.
4. BrownHD& Hutchison CS. Vegetable Science. JB Lippincott Co.
5. ChadhaKL&KallooG.(Eds.).1993-94.Advances in Horticulture.Vols. A. V-X.Malhotra Publ. House.
6. Chadha KL. (Ed.). 2002.Hand Book of Horticulture. ICAR.
7. Chauhan DVS.(Ed.).1986.Vegetable Production in India. Ram Prasad & Sons.
8. DecoteauDR. 2000. Vegetable Crops. Prentice Hall.
9. Edmond JB, Musser AM &Andrews FS. 1964. Fundamentals of Horticulture. Blakiston Co
10. Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.Gopalakrishanan TR. 2007. Vegetable Crops.NewIndiaPubl.Agency.Hazra P &Som MG. (Eds.).1999.Technology for Vegetable Production and Improvement.NayaProkash.
11. Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
12. KallooG& Singh K (Ed.). 2000. Emerging Scenario in Vegetable Research and Development. Research Periodicals & Book Publ. House.
13. Nayer NM & More TA 1998. Cucurbits.Oxford& IBH Publ. Palaniswamy& Peter KV. 2007. Tuber Crops. New India Publ. Agency.Pandey AK &MudranalayV. (Eds.). Vegetable Production in India:Important Varieties and Development Techniques.
14. RanaMK. 2008. Olericulture in India. Kalyani.
15. RanaMK. 2008. Scientific Cultivation of Vegetables. Kalyani.
16. RubatzkyVE&Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall

c. Mapping of Program Outcomes with Course Outcomes

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

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**
HOR2027	Principles of Vegetable Breeding	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 students were exposed to basic concepts of genetics and plant breeding	Understand
CO2	The plant breeding methodologies and applications employed for self, cross and vegetative propagated crops were exposed.	Apply
CO3	Students were imparted with knowledge on genetic engineering and technologies like tissue-culture, GMO etc.,	Analyze
CO4	Students were deployed with different methods of plant breeding like pure line selection, mass selection, pedigree method and other hybrid crop varieties production for special crop improvement such as drought resistance, high yield, pest and disease resistance was given special emphasis.	Skill

b. Syllabus

Units	**Content**
LI	*Importance and history*- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.
LII	*Selection procedures*- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).
LIII	*Heterosis breeding*- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms. *Mutation and Polyploidy breeding*; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment
LIV	*Ideotype breeding*- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of *In-vitro* and molecular techniques in vegetable improvement.
PV	Floral biology and pollination behaviour of different vegetables. Techniques of selfing and crossing of different vegetables, viz., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.. Breeding system and handling of filial generations of different vegetables. Exposure to biotechnological lab practices. Visit to breeding farms.

Tasks and Assignments:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

Reference:

1. Allard RW. 1960. *Principle of plant breeding*. John Willey and Sons, USA.
2. Kalloo G. 1988. *Vegetable breeding* (Vol. I, II, III). CRC Press, Fl, USA.
3. Kole CR. 2007. *Genome mapping and molecular breeding in plants-vegetables*. Springer, USA.
4. Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p.
5. 488.
6. Prohens J and Nuez F. 2007. *Handbook of plant breeding-vegetables* (Vol I and II). Springer,
7. USA.
8. Singh BD. 2007. *Plant breeding- principles and methods* (8th edn.). Kalyani Publishers, New Delhi.
9. Singh Ram J. 2007. *Genetic resources, chromosome engineering, and crop improvement-vegetable crops* (Vol. 3). CRC Press, Fl, USA.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	3	3	3
CO3	3	2	3	2	1
CO4	2	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	25	25	10	0	60
Total	**35**	**35**	**20**	**10**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC09	Seed Production of 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	Basic principles and seed legislative aspects in India will be learnt by the students.	Remember
CO2	The students can understand the seed production techniques followed in self-pollinated, cross pollinated and vegetatively propagated vegetable crops.	Understand
CO3	The students will be having practical exposure and develop skill on hybrid seed production in vegetable crops	Skill
CO4	The student will be turnout to be a successful seed producer and independently start seed production business.	Apply

b. Syllabus

Units	**Content**
LI	*Introduction, history, propagation and reproduction*—Introduction, definition of seed and its quality, seed morphology, development and maturation; Apomixis and fertilization; Modes of propagation and reproductive behaviour; Pollination mechanisms and sex forms in vegetables; History of vegetable seed production; Status and share of vegetable seeds in seed industry.
LII	*Agro-climate and methods of seed production*—Agro-climate and its influence on quality seed production; Deterioration of crop varieties, genetical and agronomic principles of vegetable seed production; Methods of seed production, hybrid seeds and techniques of large-scale hybrid seed production; Seed village concept.
LIII	*Seed multiplication and its quality maintenance*—Seed multiplication ratios and replacement rates in vegetables; Generation system of seed multiplication; Maintenance and production of nucleus, breeder, foundation, certified/ truthful label seeds; Seed quality and mechanisms of genetic purity testing. *Seed harvesting, extraction and its processing*—Maturity standards; Seed harvesting, curing and extraction; Seed processing, viz., cleaning, drying and treatment of seeds, seed health and quality enhancement, packaging and marketing; Principles of seed storage; Orthodox and recalcitrant seeds; Seed dormancy.
LIV	Improved agro-techniques and field and seed standards—Improved agro-techniques; Field and seed standards in important solanaceous, leguminous and cucurbitaceous vegetables, cole crops, leafy vegetables, bulbous and root crops and okra; clonal propagation and multiplication in vegetative propagated crops; Seed plot technique and true potato seed production in potato.
PV	Study of floral biology and pollination mechanisms in vegetables. Determination of modes of pollination. Field and seed standards. Use of pollination control mechanisms in hybrid seed production of important vegetables. Maturity standards and seed extraction methods. Seed sampling and testing. Visit to commercial seed production areas. Visit to seed processing plant. Visit to seed testing laboratories.
Tasks and Assignments: ✓ Student PowerPoint Presentation on selected topic	

- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ 5. Field experiments

Reference:

1. Agarwaal PK and Anuradha V. 2018. *Fundamentals of seed science and technology*. Brilliant publications, New Delhi.
2. Agrawal PK and Dadlani M. (Eds.). 1992. *Techniques in seed science and technology*. South asian Publ.
3. Agrawal RL. (Ed.). 1997. *Seed technology*. Oxford and IBH.
4. Basra AS. 2000. *Hybrid seed production in vegetables*. CRC press, Florida, USA.
5. Bench ALR and Sanchez RA. 2004. *Handbook of seed physiology*. Food products press, NY/ London.
6. Bendell PE. (Eds.). 1998. *Seed science and technology: Indian forestry species*. Allied Publ.
7. Chakraborty SK, Prakash S, Sharma SP and Dadlani M. 2002. *Testing of distinctiveness, uniformity and stability for plant variety protection*. IARI, New Delhi
8. Copland LO and McDonald MB. 2004. *Seed science and technology*, Kluwer Academic Press.
9. Fageria MS, Arya PS and Choudhary AK. 2000. *Vegetable crops: breeding and seed production*. Vol. I. Kalyani Publishers, New Delhi.
10. George RAT. 1999. *Vegetable seed production* (2nd Edition). CAB International.
11. Kalloo G, Jain SK, Vari AK and Srivastava U. 2006. *Seed: A global perspective*. Associated publishing company, New Delhi.
12. Hazra P and Som HG. 2015. *Seed production and hybrid technology of vegetable crops*. Kalyani publishers, Ludhiana.
13. Kumar JC and Dhaliwal MS. 1990. *Techniques of developing hybrids in vegetable crops*. Agro botanical publ.
14. More TA, Kale PB and Khule BW. 1996. *Vegetable seed production technology*. Maharashtra state seed corp.
15. Rajan S and Markose BL. 2007. *Propagation of horticultural crops*. New India publ. agency.
16. Singh NP, Singh DK, Singh YK and Kumar V. 2006. *Vegetable seed production technology*. International book distributing Co.
17. Singh SP. 2001*. Seed production of commercial vegetables*. Agrotech publ. academy.
18. Singhal NC. 2003. *Hybrid seed production*. Kalyani publishers, New Delhi

c. Mapping of Program Outcomes with Course Outcomes

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

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 II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC10	Production Technology of Underutilized Vegetable 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**
CO 1	Appreciate the scope and scenario of production of underutilized vegetable crops in India	Understand
CO 2	Acquire knowledge about the production technology of underutilized vegetable crops	Apply
CO 3	Adopting production of lesser utilised crops as entrepreneur	Analyze

b. Syllabus

Units	**Content**
LI	Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post-harvest management of: *Stem and bulb crops*—Asparagus, leek and chinese chive
LII	Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post-harvest management of: *Cole and salad crops*—Red cabbage, Chinese cabbage, kale, sweet corn and baby corn Yam—Elephant foot yam, yam, yam & *B*eans bean, lima bean and winged bean.
LIII	Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post-harvest management of: *Leafy vegetables*—Celery, parsley, Indian spinach (poi), spinach, chenopods, chekurmanis and indigenous vegetables of regional importance
LIV	Importance and scope, botany and taxonomy, climate and soil requirement, commercial varieties/ hybrids, improved cultural practices, physiological disorders, harvesting and yield, plant protection measures and post-harvest management of: Gourds and melons—Sweet gourd, spine gourd, teasle gourd, round gourd, and little/ Ivy gourd, snake gourd, pointed gourd, kachri, long melon, snap melon and gherkin
PV	Identification and botanical description of plants and varieties. Seed/ planting material. Production, lay out and method of planting. Important cultural operations. Identification of important pests and diseases and their control. Maturity standards and harvesting. Visit to local farms.

Tasks and Assignments:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ 5. Field experiments

References:

1. Bhat KL. 2001. Minor vegetables-untapped potential. Kalyani publishers, New Delhi.
2. Indira P and Peter KV. 1984. Unexploited tropical vegetables. Kerala agricultural university, Kerala.
3. Pandey AK. 2011. Aquatic vegetables. Agrotech publisher academy, New Delhi.
4. Peter KV. (Eds.). 2007-08. Underutilized and underexploited horticultural crops. Vol.1-4, New India publishing agency, Lucknow.
5. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
6. Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II and III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.

7. Rana MK. 2018. Vegetable crop science. CRC Press Taylor and Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742 ISBN: 978-1-1380-3521-8
8. Rubatzky VE and Yamaguchi M. 1997. World vegetables: vegetable crops. NBPGR, New Delhi.

c. Mapping of Program Outcomes with Course Outcomes

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

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**
HOREC11	Systematics of Vegetable 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**
CO 1	Acquire knowledge on identification, description, classification and maintenance of vegetable species and varieties	Understand
CO 2	Collecting locally available allied species of vegetable crops	Apply
CO 3	Preparing herbarium and specimens	Skill

b. Syllabus

Units	**Content**
LI	*Significance of systematic*—Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops
LII	*Origin and evolution*—Origin, history, evolution and distribution of vegetable crops *Cytology*—Cytological level of various vegetable crops with descriptive keys
LIII	*Botanical and morphological description*—Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetable
LIV	*Molecular markers*—Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops *Biodiversity*- Importance, collection of local species, identification and preservation modes
PV	Identification, description, classification and maintenance of vegetable species and varieties. Survey, collection of allied species and genera locally available. Preparation of keys to the species and varieties. Methods of preparation of herbarium and specimens

Tasks and Assignments:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Chopra GL. 1968. Angiosperms- systematics and life cycle. S. Nagin.
2. Dutta AC. 1986. A class book of botany. Oxford Univ. Press.
3. Pandey BP. 1999. Taxonomy of angiosperm. S. Chand and Co
4. Peter KV and Pradeep kumar T. 2008. Genetics and breeding of vegetables. (Revised), ICAR.
5. Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
6. 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.
7. 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.
8. Simmonds NW and Smartt J. 1995. Evolution of crop plants. Wiley-Blackwell.
9. Soule J. 1985. Glossary for Horticultural Crops. John Wiley and Sons.
10. Srivastava U, Mahajan RK, Gangopadyay KK, Singh M and Dhillon BS. 2001. Minimal descriptors of agri-horticultural crops. Part-II: Vegetable Crops. NBPGR, New Delhi.
11. Vasistha. 1998. Taxonomy of angiosperm. Kalyani Publishers, New Delhi.
12. Vincent ER and Yamaguchi M. 1997. World vegetables. 2nd Ed. Chapman and Hall

Mapping of Program Outcomes with Course Outcomes

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

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**
HOREC12	Postharvest Management of Vegetable 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**
CO 1	Regulation of postharvest losses by using chemicals and growth regulators	Understand
CO 2	Pre and postharvest treatments for extending shelf life of vegetable crops	Apply
CO 3	Packinghouse operations for extending the shelf life of vegetable crops	Analyze
CO 4	Successful storage of vegetable crops	Skill

b. Syllabus

Units	**Content**
LI	*Importance and scope*—Importance and scope of post-harvest management of vegetables *Maturity indices and biochemistry*—Maturity indices and standards for different vegetables; Methods of maturity determination; Biochemistry of maturity and ripening; Enzymatic and textural changes; Ethylene evolution and ethylene management; Respiration and transpiration along with their regulation methods
LII	*Harvesting and losses factors*—Harvesting tools and practices for specific market requirement; Postharvest physical and biochemical changes; Preharvest practices and other factors affecting postharvest losses
LIII	*Packing house operations*—Packing house operations; Commodity pre-treatments chemicals, wax coating, precooling and irradiation; Packaging of vegetables, prevention from infestation, management of postharvest diseases and principles of transportation
LIV	*Methods of storage*—Ventilated, refrigerated, modified atmosphere and controlled atmosphere storage, hypobaric storage and cold storage; Zero-energy cool chamber, storage disorders like chilling injury in vegetables
PV	Studies on stages and maturing indices. Ripening of commercially important vegetable crops. Studies of harvesting, pre-cooling, pre-treatments, physiological disorders- chilling injury. Improved packaging. Use of chemicals for ripening and enhancing shelf life of vegetables. Physiological loss in weight, estimation of transpiration, respiration rate and ethylene release. Storage of important vegetables. Cold chain management. Visit to commercial packinghouse, cold storage and control atmosphere storage.
Tasks and Assignments: ✓ Student PowerPoint Presentation on selected topic ✓ Assignment writing on selected topic ✓ Quiz and Group discussion ✓ Practical record submission and maintenance ✓ Field experiments		
References: 1. Chadha KL and Pareek OP. 1996. Advances in horticulture. Vol. IV. Malhotra Publ. House. 2. Chattopadhyay SK. 2007. Handling, transportation and storage of fruit and vegetables. GeneTech books, New Delhi. 3. Haid NF and Salunkhe SK. 1997. Postharvest physiology and handling of fruits and vegetables. Grenada Publ.		

4. Mitra SK. 1997. Postharvest physiology and storage of tropical and sub-tropical fruits. CABI.
5. Paliyath G, Murr DP, Handa AK and Lurie S. 2008. Postharvest biology and technology of Fruits, vegetables and flowers. Wiley-Blackwell, ISBN: 9780813804088.
6. Ranganna S. 1997. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill.
7. Stawley JK. 1998. Postharvest physiology of perishable plant products. CBS publishers.
8. Sudheer KP and Indira V. 2007. Postharvest technology of horticultural crops. New India Publ. Agency.
9. Thompson AK. (Ed.). 2014. Fruit and vegetables: harvesting, handling and storage (Vol. 1 and 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.
10. Verma LR and Joshi VK. 2000. Postharvest technology of fruits and vegetables: handling, processing, fermentation and waste management. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
11. Willis R, McGlassen WB, Graham D and Joyce D. 1998. Postharvest: An introduction to the physiology and handling of fruits, vegetables and ornamentals. CABI.
12. Wills RBH and Golding J. 2016. Postharvest: an introduction to the physiology and handling of fruit and vegetables, CABI Publishing, ISBN 9781786391483.
13. Wills RBH and Golding J. 2017. Advances in postharvest fruit and vegetable technology, CRC Press, ISBN 9781138894051.

Mapping of Program Outcomes with Course Outcomes

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

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 – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2035	Production Technology of Cool Season Vegetables	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Student had imparted knowledge on the principles of propagation and production techniques of sub-tropical and temperate vegetables.	Remember
CO2	Students analysed the of sign and symptoms for detection of pathogens and disease, integrated methods of disease management, use of biological and chemicals in disease management.	Understand
CO3	Hands on training on various propagation methods and important cultural practices for major cool season vegetables were provided.	Apply
CO4	Students gained knowledge on principles and utilization of integrated pest management of cool season vegetables	Analyse

b. Syllabus

Units	**Content**
LI	Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hrydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (Grading, packaging and marketing), pest and disease management and production economics of; *Bulb and tuber crops*—Onion, garlic and potato.
LII	Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hrydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (Grading, packaging and marketing), pest and disease management and production economics of *Cole crops*—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.
LIII	Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hrydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (Grading, packaging and marketing), pest and disease

	management and production economics of *Root crops*: carrot, radish, turnip, Beetroot,
LIV	Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hrydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (Grading, packaging and marketing), pest and disease management and production economics ofPeas and broad bean- Garden peas and broad beans *Leafy vegetables*—Beet leaf, fenugreek, coriander and lettuce.
PV	Scientific raising of nursery and seed treatment. Sowing and transplanting. Description of commercial varieties and hybrids. Demonstration on methods of irrigation, fertilizers and micronutrients application. Mulching practices, weed management. Use of plant growth substances in cool season vegetable crops. Study of nutritional and physiological disorders. Studies on hydroponics, aeroponics and other soilless culture. Identification of important pest and diseases and their control. Preparation of cropping scheme for commercial farms. Visit to commercial farm, greenhouse/ polyhouses. Visit to vegetable market. Analysis of benefit to cost ratio.

Tasks and Assignments:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ 5. Field experiments

Reference:

1. Bose TK &Som MG. (Eds.). 1986. Vegetable Crops in India. NayaProkash.
2. Bose TK, Som G &Kabir J. (Eds.). 2002. Vegetable Crops. NayaProkash. Bose TK, Som MG &Kabir J. (Eds.). 1993. Vegetable Crops. NayaProkash.
3. Bose TK, Kabir J, Maity TK, Parthasarathy VA &Som MG. 2003.Vegetable Crops. Vols. I-III. Naya Udyog.
4. Chadha KL &Kalloo G. (Eds.). 1993-94.Advances in Horticulture Vols. V-X. Malhotra Publ. House.
5. Chadha KL. (Ed.). 2002. Handbook of Horticulture. ICAR.
6. Chauhan DVS.(Ed.).1986.Vegetable Production in India. Ram Prasad & Sons.
7. Decoteau DR. 2000. Vegetable Crops. Prentice Hall.
8. Edmond JB, Musser AM &Andrews FS. 1951. Fundamentals of Horticulture. Blakiston Co.
9. Fageria MS, Choudhary BR & Dhaka RS. 2000. Vegetable Crops: Production Technology. Vol. II. Kalyani.
10. Gopalakrishanan TR. 2007. Vegetable Crops. New India Publ. Agency. HazraP&SomMG.(Eds.).1999.TechnologyforVegetableProductionandImprovement. NayaProkash.
11. Rana MK. 2008. Olericulture in India. Kalyani Publ.
12. Rana MK. 2008. Scientific Cultivation of Vegetables. Kalyani Publ.
13. Rubatzky VE &Yamaguchi M. (Eds.). 1997. World Vegetables: Principles, Production and Nutritive Values. Chapman & Hall.
14. Saini GS. 2001. AText Book of Oleri and Floriculture. Aman Publ. House.

15. Salunkhe DK &Kadam SS.(Ed.).1998. HandBook of Vegetable Science and Technology: Production, Composition, Storage and Processing. Marcel Dekker.
16. Shanmugavelu KG. 1989. Production Technology of Vegetable Crops. Oxford& IBH.
17. SinghDK.2007.Modern Vegetable Varieties and Production Technology. International Book Distributing Co.
18. Singh SP.(Ed.).1989.ProductionTechnologyofVegetableCrops.Agril.Comm. Res. Centre.
19. Thamburaj S & Singh N. (Eds.). 2004. Vegetables, Tuber Crops and Spices. ICAR.
20. Thompson HC & Kelly WC.(Eds.).1978.VegetableCrops.TataMcGraw- Hill.
21. Fundamentals of Vegetable Crop Production. Beena, Singh, K.P., Chand, Prem Nair. Scientific Publishers (2014)
22. Vegetable Crops (Horticulture Science Series). T.R. Gopalakrishnan. New India Publishing Agency (2007) 22. Disease of Vegetable Crops. Shagufta. APH Publishing (2012).

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	3	2	3	3	2
CO4	3	3	2	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	10	10	10	10	40
External	25	25	10	0	60
Total	**35**	**35**	**20**	**10**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2036	Growth and Development of 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	Acquire knowledge about the growth and development of plants in vegetable crops	Understand
CO2	Distinguish between primary and secondary growth in plant stems	Analyse
CO3	Understand how hormones affect the growth and development of vegetable crops	Understand

b. Syllabus

Units	**Content**
LI	*Introduction and phytohormones*—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.
LII	*Physiology of dormancy and germination*—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.
LIII	*Abiotic factors*—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.
LIV	*Fruit physiology*—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening. *Morphogenesis and tissue culture*—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.
PV	Preparation of plant growth regulator's solutions and their application. Experiments in breaking and induction of dormancy by chemicals; Induction of parthenocarpy and fruit ripening. Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in solanaceous vegetables. Growth analysis techniques in vegetable crops. Grafting techniques in tomato, brinjal, cucumber and sweet pepper

Task & Assignment:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Bleasdale JKA. 1984. *Plant physiology in relation to horticulture* (2nd Edition) MacMillan.
2. Gupta US. Eds. 1978. *Crop physiology*. Oxford and IBH, New Delhi.
3. Kalloo G. 2017. *Vegetable grafting*: Principles and practices. CAB International
4. Krishnamoorti HN. 1981. *Application growth substances and their uses in agriculture*. Tata McGraw Hill, New Delhi.
5. Leopold AC and Kriedemann PE. 1981. *Plant growth and development*, Tata McGraw-Hill, New Delhi.
6. Peter KV and Hazra P. (Eds). 2012. *Hand book of vegetables*. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
7. Peter KV. (Eds). 2008. *Basics of horticulture*. New India publication agency, New Delhi.
8. Rana MK. 2011. *Physio-biochemistry and Biotechnology of Vegetables*. New India Publishing Agency, Pritam Pura, New Delhi.
9. Saini et al. (Eds.). 2001. *Laboratory manual of analytical techniques in horticulture*. Agrobios, Jodhpur.
10. Wien HC. (Eds.). 1997. *The physiology of vegetable crops*. CAB International.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	2
CO2	3	3	3	3	2
CO3	3	3	3	2	2
CO4	3	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	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC13	Organic Vegetable 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	Appreciate the scope and scenario of organic vegetable production in India	Understand
CO2	Acquire knowledge about the organic vegetable production technology	Understand
CO3	Adopting production of organic vegetable crops as entrepreneur	Apply

b. Syllabus

Units	**Content**
LI	*Importance and principles*—Importance, principles, perspective, concepts and components of organic farming in vegetable crops
LII	*Organic crop production of vegetables*—Organic production of vegetable crops, viz., Solanaceous, Cucurbitaceous, Cole, root and tuber crops
LIII	*Managing soil fertility*—Managing soil fertility, mulching, raising green manure crops, weed management in organic farming system; Crop rotation in organic production; Processing and quality control of organic vegetable produce *Composting methods*—Indigenous methods of composting, Panchyagavvya, Biodynamics preparations and their application; ITKs in organic vegetable farming;
LIV	*Pest management for organic producers* - Weed management, Disease management, Insect pest management using biocontrol agents. Role of botanicals in the management of pests and diseases in vegetable crops *Certification and export*—Techniques of natural vegetable farming, GAP and GMP certification of organic products; Export- opportunity and challenges
PV	Methods of preparation and use of compost, vermicompost, biofertilizers and biopesticides; Soil solarisation; Use of green manures; Waste management; Organic soil amendments in organic production of vegetable crops; Weed, pest and disease management in organic vegetable production; Visit to organic fields and marketing centres

Task & Assignment:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Dahama AK. 2005. Organic farming for sustainable agriculture. 2nd Ed. Agrobios.
2. Gehlot G. 2005. Organic farming; standards, accreditation certification and inspection. Agrobios.
3. Pradeepkumar T, Suma B, Jyothibhaskar and Satheesan KN. 2008. Management of horticultural crops. New India Publ. Agency.

4. Shivashankar K. 1997. Food security in harmony with nature. 3rd IFOAMASIA, Scientific Conf. 1- 4 December, UAS, Bangalore
5. Lampkin NH &Padel S. 1992. The Economics of Organic Farming – An International Perspective. CABI.
6. Palaniappan and Annadurai. 2008. Organic Farming- Theory and Practise. Scientific Publ.
7. Rao S. 1977. Soil Microorganism and Plant Growth. Oxford & IBH

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	3	2	3	3	2
CO4	3	3	2	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	10	10	10	10	40
External	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC14	Breeding of Cross-Pollinated 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	Acquire knowledge about the breeding of cross-pollinated vegetable crops	Understand
CO2	Improve yield, quality, abiotic and biotic resistance, and important traits of cross-pollinated vegetable crops	Understand
CO3	Improve yield, quality, abiotic and biotic resistance, and important traits of cross-pollinated vegetable crops	Analyse

b. Syllabus

Units	**Content**
LI	Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (Introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act of *Cucurbitaceous crops*—Gourds, melons, cucumber, pumpkin and squashes.
LII	Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (Introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act of*Cole crops*—Cauliflower, cabbage, kohlrabi, broccoli and brussels sprouts.
LIII	Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (Introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act of*Root and bulb crops*—Carrot, radish, turnip, beet root and onion
LIV	Origin, botany, taxonomy, cytogenetics, genetics, types of pollination and fertilization, mechanism, sterility and incompatibility, breeding objectives, breeding methods (Introduction, selection, hybridization, mutation, polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, quality improvement, molecular markers and marker assisted breeding, and QTLs, PPV and FR act of*Tuber crops*—Sweet potato, tapioca, taro and yam *Leafy vegetables*—Beet leaf, spinach, amaranth and coriander.
PV	Floral mechanisms favouring cross pollination. Development of inbred lines; Selection of desirable plants from breeding population. Observations and analysis

	of various quantitative and qualitative traits in germplasm, hybrids and segregating generations; Induction of flowering, palynological studies, selfing and crossing techniques; Hybrid seed production of vegetable crops in bulk. Screening techniques for biotic and abiotic stress resistance in above mentioned crops. Demonstration of sib-mating and mixed population. Molecular marker techniques to identify useful traits in vegetable crops and special breeding techniques. Visit to breeding blocks.

Task & Assignment:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Allard RW. 1999. Principles of plant breeding. John Wiley and Sons.
2. Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
3. Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005. Plant genetic resources: horticultural crops. Narosa publ. house.
4. Fageria MS, Arya PS and Choudhary AK. 2000. Vegetable crops: breeding and seed production. Vol. I. Kalyani.
5. Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
6. Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. 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. Vols. I-III. CRC Press.
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 and III.Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509 p.
17. Prohens J and Nuez F. 2007. Handbook of Plant Breeding- Vegetables (Vol I and II), Springer, USA.
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.
21. Singh BD. 1983. Plant breeding. Kalyani Publishers, New Delhi.

22. Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International book distributing Co.
23. Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	3	2	3	3	2
CO4	3	3	2	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	10	10	10	10	40
External	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC15	Protected Cultivation of 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	Appreciate the scope and scenario of protected cultivation of vegetable crops in India	Understand
CO2	Acquire knowledge about the effect of abiotic factors on growth, flowering and production of vegetable crops	Understand
CO3	Gaining knowledge about the designing of various low cost protected structures	Understand
CO4	Adopting the raising of vegetable seedlings in low cost protected structures as entrepreneur	Analyse

b. Syllabus

Units	Content
LI	*Scope and importance*- Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high-cost polyhouses/ greenhouse structures.
LII	*Types of protected structure*- Classification and types of protected structures greenhouse/ polyhouses, plastic-non plastic low tunnels, plastic walk-in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system
LIII	*Abiotic factors*- Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables. *Nursery raising*- High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation.
LIV	*Cultivation of crops*- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures *Solutions to problems*- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.
PV	Study of various types of protected structure. Study of different methods to control temperature, carbon dioxide and light. Study of different types of growing media, training and pruning systems in greenhouse crops. Study of fertigation and nutrient management under protected structures. Study of insect pests and diseases in greenhouse and its control. Use of protected structures in hybrid seed production of vegetables. Economics of protected cultivation (Any one crop). Visit to established green/ polyhouses/ shade net houses in the region.

Task & Assignment:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Chadha KL and Kalloo G. (Eds.). 1993-94. Advances in horticulture. Malhotra Pub. House.
2. Chandra S and Som V. 2000. Cultivating vegetables in green house. Indian horticulture 45:17-18.
3. Kalloo G and Singh K. (Eds.). 2000. Emerging scenario in vegetable research and development. Research periodicals and Book publ. house.
4. Parvatha RP. 2016. Sustainable crop protection under protected cultivation. E-Book Springer.
5. Prasad S and Kumar U. 2005. Greenhouse management for horticultural crops. 2nd Ed. Agrobios.
6. Resh HM. 2012. Hydroponic food production. 7thEdn. CRC Press.
7. Singh B. 2005. Protected cultivation of vegetable crops. Kalyani publishers, New Delhi
8. Singh DK and Peter KV. 2014. Protected cultivation of horticultural crops (1st Edition) New India publishing agency, New Delhi.
9. Singh S, Singh B and Sabir N. 2014. Advances in protected cultivation. New India publishing agency, New Delhi.
10. Tiwari GN. 2003. Green house technology for controlled environment. Narosa publ. house.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	3	2	3	3	2
CO4	3	3	2	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	10	10	10	10	40
External	10	12	20	18	60
Total	**20**	**22**	**30**	**28**	**100**

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC16	Breeding of Self-Pollinated 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	Acquire knowledge about the breeding of self-pollinated vegetable crops	Understand
CO2	Improve yield, quality, abiotic and biotic resistance and other important traits of vegetable crops	Understand
CO3	Understand how to start the breeding of self-pollinated vegetable crops	Understand

b. Syllabus

Units	**Content**
LI	Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act of Tuber crops: Potato.
LII	Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act of
LIII	Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act ofLeguminous vegetables-Garden peas, cowpea, French bean, Indian bean, cluster bean and broad bean
LIV	Origin, botany, taxonomy, wild relatives, cytogenetics and genetics, types of pollination and fertilization mechanism, sterility, breeding objectives, breeding methods (introduction, selection, hybridization, mutation and polyploidy), varieties and varietal characterization, resistance breeding for biotic and abiotic stresses, breeding for protected environment and quality improvement, molecular markers and marker's assisted breeding; QTLs, PPV and FR Act ofLeafy vegetables-Lettuce and fenugreek.
PV	Floral mechanisms favouring self and often cross pollination. Progeny testing and development of inbred lines. Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations. Palynological studies, selfing and crossing techniques. Hybrid seed production of vegetable crops in bulk. Screening techniques for biotic and abiotic stress resistance in above mentioned crops.

	Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding farms

Task & Assignment:

- ✓ Student PowerPoint Presentation on selected topic
- ✓ Assignment writing on selected topic
- ✓ Quiz and Group discussion
- ✓ Practical record submission and maintenance
- ✓ Field experiments

References:

1. Allard RW. 1999. Principles of plant breeding. John Wiley and Sons
2. Basset MJ. (Ed.). 1986. Breeding vegetable crops. AVI Publ.
3. Dhillon BS, Tyagi RK, Saxena S and Randhawa GJ. 2005, Plant genetic resources: horticultural crops. Narosa Publ. House.
4. Fageria MS, Arya PS and Choudhary AK. 2000, Vegetable crops: Breeding and seed production.Vol. I. Kalyani.
5. Gardner EJ. 1975. Principles of genetics. John Wiley and Sons.
6. Hayes HK, Immer FR and Smith DC. 1955. Methods of plant breeding. 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. Vols. I-III. CRC Press.
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, 509 p.
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, 634 p.
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. Singh PK, Dasgupta SK and Tripathi SK. 2004. Hybrid vegetable development. International Book Distributing Co.
22. Swarup V. 1976. Breeding procedure for cross-pollinated vegetable crops. ICAR

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	3	2	3	3	2
CO4	3	3	2	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	**10**	**10**	**10**	**10**	**40**
External	**10**	**12**	**20**	**18**	**60**
Total	**20**	**22**	**30**	**28**	**100**

FLORICULTURE AND LANDSCAPING

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2028	Commercial Production of Loose Flowers	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	Elucidate the aesthetic value and economic utility of ornamental loose flowers have become an integral part of social celebrations, religious offerings and adornments at home and work place duo; Illustrate modern hi-tech production techniques for loose flowers	Understand & Apply
CO2	Inspect pros and cons about physiological interventions and chemical regulations needed for off-season/year-round flower production	Analyze
CO3	Formulate knowledge about the modus-operandi of essential oil extraction from jasmine, tuberose, champaka etc. to make perfume, scents which have swelling demand	Create
CO4	Assess the immense entrepreneurial opportunities of loose flower production and a way forward to earn foreign exchange (import and export)	Skill

b. Syllabus

Units	Content
LI	Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shade nets, transplanting techniques.
LII	Soil and climate requirements, field preparation, systems of planting, precision farming techniques. Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM
LIII	Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation, crop physiology, crop-climate adaptation
LIV	Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agri Export Zones.
	Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).
PV	Botanical description of species and varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and

	fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets. Visits of IIHR, Bengaluru, TNAU, Coimbatore, KAU, Thrissur, BCKV, Kalyani, AAU, Jorhat

Task & Assignment:

Each student is required to submit the following:

- ✓ Submit detailed report of visit to some pioneer research institutions.
- ✓ Survey essential oil extraction units and markets using some model questionnaire
- ✓ Formulate detailed lab report (with relevant documentation) on botanical description of species and varieties.
- ✓ Survey the field to prepare model lay out for production of commercially viable loose flower crops.

References:

1. Arora JS. 2006. Introductory Ornamental Horticulture, Kalyani.
2. Bhattacharjee SK.2006.Advances in Ornamental Horticulture. Vol. I-VI. Pointer Publ.
3. Bose TK &Yadav LP. 1989. Commercial Flowers. Naya Prokash.
4. Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya Prokash.
5. Chadha KL & ChaudhuryB.1992. Ornamental Horticulture in India. ICAR.
6. ChadhaKL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ.House.
7. Lauria A &RiesVH.2001.Floriculture–Fundamentals and Practices. Agrobios.
8. Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios.
9. Randhawa GS & Mukhopadhyay A.1986. Floriculture in India. Allied Publ.
10. Sheela VL. 2007. Flowers in Trade. New India Publ. Agency.
11. Valsala Kumari PK, Rajeevan PK, Sudhadevi PK & Geetha CK. 2008. Flowering Trees. New India Publ. Agency.
12. De LC. 2013. Value Additions in Flowers and Orchids, Pointer Publ.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2029	Breeding of Ornamental Plants	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	Elucidates integrated Gene Management (Augmentation, Evaluation, Conservation, Utilization, mutation, recombination and natural selection) which resulted in several variations in flowers as well as legal protection procedures of plant variety innovation.	Understand
CO2	Makes clear understanding on several breeding constraints of different commercially viable ornamental flowers	Apply & Analyze
CO3	Enriches the knowledge on several breeding achievements of different commercially viable ornamental flowers	Apply & Analyze
CO4	Develops novel flower cultivars with improved floral quality and resistance/tolerance to abiotic stresses (eg. temperature [heat, cold], rains, salt concentration of soil etc.) by allele mining and discovery of new genes.	Skill

b. Syllabus

Units	Content
LI	Principles - Evolution of varieties, origin, distribution, genetic resources, genetic divergence- Patents and Plant Variety Protection in India; seed production of flower crops**.**
LII	Breeding constraints in ornamental commercial flowers-rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium, petunia, hibiscus, bougainvillea, Tropical ornamentals (Heliconia, Alpinia, Anthurium, ornamental gingers), Flowering annuals (zinnia, cosmos, dianthus, snapdragon, pansy)
LIII	Breeding achievements made in commercial flowers-rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium, petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snapdragon, pansy) ornamental foliages– Introduction and selection of plants for waterscaping and xeriscaping
LIV	Genetic inheritance—of flower colour, doubleness, flower size, fragrance, post harvest life. Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants-- introduction, selection, domestication, polyploidy and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems
PV	Description of botanical features – Cataloguing of cultivars, varieties and species in flowers, floral biology, selfing and crossing, evaluation of hybrid progenies, seed production-Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, in vitro breeding in flower crops and ornamental plants. Visit to IARI, New Delhi, YSPUH&T, Solan, HAFRP, Ranchi, PAU, Ludhiana, DFR, Pune
Tasks and Assignments: Each student is required to submit the following:	

- ✓ Submit detailed report of visit to some pioneer breeding research institutions.
- ✓ Prepare & submit project report on development of mutants using suitable mutagens
- ✓ Formulate detailed lab report (with relevant documentation) on botanical description of species, cultivars and varieties.
- ✓ Submit the project report on cataloguing of botanical features of any one commercially vital ornamental plant.

Reference:

1. BhattacharjeeSK.2006.AdvancesinOrnamentalHorticulture.Vols.IVI.PointerPubl.
2. Bose TK & Yadav LP. 1989. Commercial Flowers. Naya Prokash.
3. Chadha KL & Choudhury B.1992. Ornamental Horticulture in India, ICAR.
4. ChadhaKL.1995.AdvancesinHorticulture.Vol.XII.MalhotraPublHouse.
5. Chaudhary RC. 1993. Introduction to Plant Breeding. Oxford & IBH. Singh BD. 1990. Plant Breeding, Kalyani.
6. Singh, A.K.2015. Breeding and Biotechnology of Flowers: Set of 2 Vols. Pointer Publ

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC17	Systematics of Ornamental Plants	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	Provides an in-depth knowledge of nomenclature, description of important genera and use of molecular techniques in systematics of flower crop	Understand
CO2	Assists to implement the acquired knowledge on unveiling the taxonomic identification of several novel ornamental genera.	Apply
CO3	Reinforces the capacity to choose appropriate plant identification's techniques	Analyze
CO4	Develops the ability of taxonomic descriptor based cataloguing of plants	Skill

b. Syllabus

Units	Content
LI	Nomenclature: History, origin, hotspots, classification and nomenclature systems.
LII	International systems: International Code, Treaties, International and National Organisations, Biodiversity Act, Identification features, descriptors, Red Book, Registration (NBPGR, PPVFRA, NBA).
LIII	Description of families of important genera Rosaceae, Asteraceae, Caryophyllaceae, Orchidaceae, Aracaceae, Liliacae, Acanthaceae, Palmaceae, Asparagaceae, Malvaceae, Musaceae, Oleaceae, Iridaceae.
LIV	Molecular techniques in modern systematics.
PV	Different nomenclature systems of plants; Floral biology and taxonomic description of rose, chrysanthemum, orchids, carnation, gerbera, anthurium, marigold, tuberose, Jasmine, China aster, lilium, gypsophila; Cyropreservation and tissue culture repository; Molecular techniques

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Project on taxonomic analysis of locally available known ornamental flora;
- ✓ Group discussion on new approaches on plant systematic.

Reference:

1. Bhattacharya B and Johri BM. 2004. Flowering Plants: Taxonomy and Phylogeny. Narosa Publ. House, New Delhi, India. pp.753.
2. Dutta AC. 1986. A Class Book of Botany. Oxford Univ. Press, Kolkata, India.
3. Pandey BP. 2013. Taxonomy of Angiosperms. S. Chand & Co. pp. 608.
4. Rajput CBS and Haribabu RS. 2014. Citriculture, Kalyani Publishers, New Delhi, India.
5. Spencer RR, Cross R and Lumley P. 2007. Plant Names. 3rd Ed. A Guide to Botanical Nomenclature. CSIRO Publ., Australia., 176 p.
6. Vasistha BB. 1998. Taxonomy of Angiosperms. Kalyani Publishers, New Delhi, India.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC18	Seed Production in Flower 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	Imparts basic knowledge about the importance of seed production in important flower crops	Understand
CO2	Development of seed grown ornamental flowering plants	Apply
CO3	Usefulness to utilize pre and post-sowing seed treatments which may be the key to successful growing of ornamentals.	Analyze
CO4	Imparts nitty-gritty of maintaining ornamentals' seeds' viability and the subsequent successful growing of them	Skill

b. Syllabus

Units	**Content**
LI	Scenario of Seed Industry: Scope, scenario and importance of seed production in flower crops. Constraints in flower seed production. Marketing and economics of flower seeds.
LII	Methods of hybrid seed production, agro-techniques for production of nucleus, breeder and certified seeds. Harvesting, seed processing, seed priming, seed chain, packaging and storage. Unit II: Population improvement: Mass selection, progeny selection; Use of incompatibility and male sterility, maintenance of variety and seed production in flower crops. Unit III: F1 hybrids: F1 hybrid seed production advantages, steps involved in hybrid seed production, pollination behavior and isolation, pollination management methods in production of F1/ hybrids in different flower crops
LIII	Seed certification and standards: Seed certification, Seed standards, seed act, plant breeders rights and farmers' rights, Bio safety, handling of transgenic seed crops, importing of seeds and OGL, trade barriers in seed business, sanitary and phytosanitaty issues, custom clearance and quarantine.
LIV	Hybrid seed production methods of Marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, Vinca, dianthus, sunflower, annual chrysanthemum, poppy, corn flower, rice flower.
PV	Seed production of open pollinated varieties; Seed production of cross pollinated varieties; Steps involved in hybrid seed production; Hybrid seed production in different flower crops like marigold, petunia, antirrhinum, zinnia, pansy, lupin, calendula, phlox, vinca, dianthus, sunflower, annual chrysanthemum, etc.; Visit to seed industry; Visit to quarantine facility.

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Project on growing of easily grown ornamentals by means of seeds;
- ✓ Report on visit at department of seed certification and organic certification of Gov. of Tamil Nadu

Reference:

1. Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
2. Bose TK, Yadav LP, Pal P, Parthasarathy VA and Das,P. 2003. Commercial Flowers. Vol. I & II. Naya Udyog, Kolkata, India.
3. Davies, Fred T Jr., Geneve RL, Wilson SB, Hartmann HT. Kester DL. 2018. Hartmann and Kester's Plant Propagation: Principles and Practices. Pearson Publ.9th Edition.
4. Larson RA and Armitage AM. 1992. Introduction of Floriculture. International Book Distributing Co., Lucknow, India.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC19	Turf Grass Management	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	Elucidate the prospects of landscape industry	Understand
CO2	Illustrate various techniques for establishment of turf	Apply & Analyze
CO3	Inspect chemical and biological properties of soil pertaining to turf grass establishment	Apply & Analyze
CO4	Assess establishment and maintenance of turfs for playgrounds using array of improved methods	Skill

b. Syllabus

Units	Content
LI	Prospects of landscape industry; site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties o f soil pertaining to turf grass establishment. Turf grasses-Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement- Adaptation; Turfing for roof gardens.
LII	Preparatory operations; Growing media used for turf grasses - Turf establishment methods, seeding, sprigging / dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing. Turf management, Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing-mowing equipment, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs, Grass-weed interaction.
LIII	Making of different sports arenas: Establishment and maintenance of turfs for playgrounds, viz., golf, football, hockey, cricket, tennis, rugby, residential and public parks, turfing of Govt. and Corporate office gardens, event specific preparation, turf colourants.
LIV	Automation: Exposure to different tools, gadgets, machinery used in turf industry.
PV	Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices – mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics. Visit of IARI, New Delhi.

Tasks and Assignments:
Each student is required to submit the following:

- ✓ Submit detailed report on visit to some IT parks, model cricket and golf grounds, airports, corporate & Govt. organization.
- ✓ Submit project reports on preparation for turf establishment
- ✓ Formulate detailed lab report (with relevant documentation) on identification of turf grasses.
- ✓ Survey turf economics using some model questionnaire.

Reference:

1. Nick-Christians 2004. Fundamentals of Turf grass Management.
2. Jain, Ritu and Janakiram, T. 2017. Turfing and Turf Management, NIPA, New Delhi.
3. Aldous D.1999. International Turf Management Handbook. CRC Press. pp.368.
4. Beard JB. 1972. Turf Grass Science and Culture. Pearson. 1st edition, pp. 672.
5. Chawla SL, Patil S, Patel MA, Patel RB and Patel RM. 2013. Turf grass Management. Publised by NAU, Navsari.
6. Emmons R. 2007. Turf grass Science and Management. Cengage Learning Publ. 4th edition, pp. 592.
7. Turgeon AJ. 1980. Turf grass Management. Reston Publ. Inc.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC20	Value Addition in Floriculture	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	To understand the avenues for value addition in floriculture	Understand
CO2	Preparation of different value added products from flowers	Apply
CO3	Improvises the outlook regarding ornamental plants	Analyze
CO4	Develops entrepreneurial acumen and Imbibes the skills for making various value added products	Skill

b. Syllabus

Units	Content
LI	Introduction: Importance, opportunities and prospects of value addition in floriculture; national and global scenario; production and exports, supply chain management.
LII	Value addition of flower crops: Dry flower making including pot pourries, their uses and trade; extraction technology, uses, sources and trade in essential oils; aroma therapy; pigment and natural dyes extraction technology, sources, uses and trade.
LIII	Neutraceuticals from petals: Pharmaceutical and neutraceutical compounds from flower crops; petal embedded hand-made paper making and uses, preparation of products like gulkand, rose water, gulroghan, attar, pankhuri.
LIV	Floral arrangements: Floral craft including bouquets, garlands, flower arrangements, etc. tinting (artificial colouring) of flower crops; Women empowerment: Women empowerment through value added products making.
PV	Dry flower making including pot pourries; extraction technology, uses, sources and trade in essential oils; Pigment and natural dyes extraction technology; Pharmaceutical and neutraceutical compounds from flower crops; Preparation of products like gulkand, rose water, gulroghan, attar, pankhuri; Petal embedded handmade paper making; Floral craft including bouquets, garlands, flower arrangements, etc.; Tinting (artificial colouring) of flower crops.

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Project work on development of dehydrated ornamental flowers.
- ✓ Exposure visits to regional dry flower enterprises.

Reference:

1. Bhattacharjee SK and De LC. 2004. Advances in Ornamental Horticulture Vol. V, Pointer publishers, Jaipur.
2. Gary L. McDaniel. 1989. Floral design and arrangement. A Reston Book. Prentice hall. New Jersey.
3. Lauria A and Victor HR. 2001. Floriculture – Fundamentals and Practices. Agrobios.
4. Lesniewicz Paul. 1994. Bonsai in your home. Sterling publishing Co, New York.
5. Prasad S and Kumar U. 2003. Commercial Floriculture. Agrobios.
6. Randhawa GS and Mukhopadhyay A. 2000. Floriculture in India, Allied publishers, India.
7. Reddy S, Janakiram T, Balaji T, Kulkarni S and Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

8. Salunkhe K, Bhatt NR and Desai BB. 2004. Postharvest biotechnology of flowers and ornamental plants. Naya Prokash, Kolkata.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2037	Commercial Production of Cut Flowers	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Elucidate the aesthetic value and economic utility of ornamental cut flowers have become an integral part of social celebrations and adornments at home and work place duo.	Understand
CO2	Illustrate modern hi-tech production techniques for cut flowers	Apply
CO3	Inspect pros and cons about physiological interventions and chemical regulations needed for off-season/year-round cut flower production	Analyze
CO4	Assess the post-harvest techniques and immense entrepreneurial opportunities of cut flowers production and a way forward to earn foreign exchange (import and export)	Skill

b. Syllabus

Units	**Content**
LI	Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India-Patent rights, nursery management, media for nursery, special nursery practices.
LII	Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soiled contamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering
LIII	Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes. Significance of *Life Cycle Assessment* (*LCA*) in commercial cut flowers production, Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation of cut flower crops - Cutrose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.
LIV	Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage &transportation, marketing, export potential, institutional support, Agri Export Zones. Crops: Cutrose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.
PV	Botanical description of varieties, propagation techniques, mist chamber operation, training and pruning techniques, practices in manuring, drip and fertigation, foliar nutrition, growth regulator application, pinching, disbudding, staking, harvesting techniques, post-harvest handling, cold chain, project preparation for regionally important cut flowers, visit to commercial cut flower units

	and case study. Visit of NRC on Orchids, Sikkim, UAS, Dharwad, NAU, Navsari, Gujarat, KAU, Thrissur, IIHR, Bengaluru, TNAU, Coimbatore, private companies in Bengaluru, Pune, BCKV, Kalyani, AAU, Jorhat.

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Submit detailed report of visit to some pioneer research institutes.
- ✓ Submit report of case studies made on visit to some commercial cut flower units
- ✓ Formulate detailed lab report (with relevant documentation) on botanical description of species and varieties of vital commercial cut flowers.
- ✓ Project preparation on post-harvest management techniques of regionally important cut flowers.

Reference:

1. Arora JS. 2006. Introductory Ornamental horticulture. Kalyani. Bhattacharjee SK.2006.Advances in Ornamental Horticulture. Vols.I-VI. Pointer Publ.
2. Bose TK &Yadav LP. 1989. Commercial Flowers. NayaProkash.
3. Bose TK, Maiti RG, Dhua RS &Das P. 1999. Floriculture and Landscaping. NayaProkash.
4. Chadha KL & Chaudhury B. 1992. Ornamental Horticulture in India. ICAR.
5. Chadha KL.1995.Advances in Horticulture.Vol.XII. Malhotra Publ. House.
6. Lauria A &RiesVH.2001.Floriculture–Fundamentals and Practices. Agrobios.
7. Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios.
8. Randhawa GS & Mukhopadhyay A.1986. Floriculture in India. Allied Publ.
9. Reddy S, Janakiram B, Balaji T, Kulkarni S &Misra RL.2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.
10. De LC. 2013. Value Additions in Flowers and Orchids, Biotech Publishing, Jodhpur

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOR2038	Ornamental Gardening and Landscaping	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Elucidate the importance to enter the green industry as well as provide additional professional developmental opportunities	Understand
CO2	Illustrate benefits of professional organizations in the green industry, identification and safe use of equipment, chemicals and tools	Apply
CO3	Inspect and prescribes sustainable options in horticulture which benefit the environment while maintaining productivity and economic viability	Analyze
CO4	Applies horticultural skills and knowledge to operate various business entities found in the horticultural industry	Skill

b. Syllabus

Units	**Content**
LI	Landscape designs, types of gardens, History o f Landscape Gardening, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens. Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates. Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.
LII	Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, boggarden, sunken garden, rock garden, clockgarden, colour wheels, temple garden, sacred groves.Bioaesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, waterscaping, xeriscaping, hardscaping, Ecological landscaping and its state-of-the-art in India.
PIII	Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens, Visit of LalBagh, Bengaluru, IARI, New Delhi
Tasks and Assignments: Each student is required to submit the following: ✓ Submit detailed report of visit to some model landscaped gardens. ✓ Prepare & submit project report on landscaping for different situations. ✓ Formulate reports on case studies made on commercial landscape gardens. ✓ Survey various parks and botanical gardens using some model questionnaire.	
Reference:	

1. Bose, T. K, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping.NayaProkash.
2. Lauria A &Victor HR. 2001. Floriculture–Fundamentals and Practices Agrobios.
3. Nambisan KMP.1992. Design Elements of Landscape Gardening. Oxford & IBH.
4. Randhawa GS &Mukhopadhyay A. 1986.Floriculture in India. Allied Publ.
5. Sabina GT & Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency.
6. Valsalakumari et al. 2008. Flowering Trees.New India Publ. Agency.Woodrow MG.1999.Gardening in India.Biotech Books.
7. Roy, Rup Kumar. 2012 Fundamentals of Garden Designing: A Colour Encyclopedia. NIPA, New Delhi
8. Tiwari AK. 2016. Fundamentals of Ornamental Horticulture and Landscape Gardening, NIPA, New Delhi
9. Misra RL and Misra S. 2012.Landscape Gardening. Westville Publishing House, New Delhi

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	3	3	2	3
CO3	2	3	3	3	2
CO4	3	2	3	3	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 – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC21	Nursery Management in Ornamental Plants	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	Develops thorough understanding of nursery management and its importance in flower crops.	Understand
CO2	Empower the students with the knowledge to start an enterprise	Apply
CO3	Facilitates the appropriateness of principles and practices of propagation and nursery management for Ornamental plants.	Analyze
CO4	Hone adequate skill in propagation and management	Skill

b. Syllabus

Units	Content
LI	Scenario of nursery industry and sexual propagation: Importance and present scenario and status of nursery industry in India and in the world, life cycles in plants, Propagation methods, Factors influencing seed germination of flower crops, dormancy, seed quality, packing, storage, certification, testing. Hormonal regulation of germination and seedling growth.
LII	Asexual propagation: Methods of asexual propagation, rooting of soft and hard wood cutting under mist. Role of Plant growth regulators. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principles and methods, budding and grafting – selection of elite mother plants. Stock, scion and inter stock, relationship – Incompatibility.
LIII	Micropropagation: Micro-propagation – principles and concepts, commercial exploitation in flower crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules.
LIV	Growing structures: Growing structures like mist chambers, tunnels, lath house, net house, growing media types, soil less culture and containers. Automation in nursery management; Sanitary and phyto-sanitary issues: Nursery – types, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, PPV&FR act and Quarantine system in India. Important quarantine pests and diseases, sanitary and phyto-sanitary issues threats to nursery Industry; Standards: Nursery standards, Hi-tech nurseries, garden centers.
PV	Anatomical studies in rooting of cutting and graft union; Identification and production of plug plants, seedlings and saplings; Preparation of growing media and use of PGRs; Practice of propagation through specialized structures cuttings, layering, budding and grafting; Case studies; Micropropagation of ornamental crops and hardening; Visit to tissue culture labs and nurseries; Economics.
Tasks and Assignments:	

Each student is required to submit the following:

- ✓ Project work on growing of locally grown ornamental foliage(s) under simulated nursery condition;
- ✓ Report on exposure visits to local nurseries

Reference:

1. Adriance GW and Brison FR. 2000. Propagation of Horticultural Plants. Biotech Books, New Delhi, India.
2. Bose TK, Mitra SK and Sadhu M K. 1991. Propagation of Tropical and Subtropical Horticultural Crops. Naya Prokash, Kolkata, India.
3. Chadha KL, Ravindran PL and Leela Sahijram. 2000. Biotechnology in Horticulture and Plantation Crops. Malhotra Publ. House, New Delhi, India.
4. Davies Fred T Jr., Geneve RL, Wilson SB, Hartmann HT and Kester DL. 2018. Hartmann and Kester's Plant Propagation: Principles and Practices. Pearson Publ. 9th Edition.
5. Peter KV. 2008. Basics of Horticulture. New India Publ. Agency, New Delhi, India.
6. Rajan S and Baby LM. 2007. Propagation of Horticultural Crops. New India Publ. Agency, New Delhi, India. pp. 251.
7. Singh SP. 1989. Mist Propagation. Metropolitan Book Co., New Delhi, India.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC22	CAD for Landscaping	2	-	1	3

a. Course Outcome (CO)

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

	Course Outcome	**Level**
CO1	Elucidate importance & applications of CAD in landscape garden designing	Understand
CO2	Illustrate 2D (AUTOCAD) & 3D (ARCHICAD) drawing techniques	Apply
CO3	Inspect dimension concepts & detail of design tools for landscape preview	Analyze
CO4	Assess plotting and accessories for designing using AUTOCAD & ARCHICAD organization tools	Skill

b. Syllabus

Units	**Content**
LI	Applications of CAD in landscape garden designing- 2D drawing by AUTOCAD- 3D drawing by ARCHICAD- 3D drawing by 3D MAX software- creating legends for plant and non-plant components basics of photoshop software in garden designing - 2D drawing methods- AUTOCAD basics- coordinate systems in AUTOCAD LT 2007- point picking methods- toolbars and icons- file handling functionsmodifying tools- modifying comments- Isometric drawings- drafting objects**.**
LII	Using patterns in AUTOCAD drawing- dimension concepts- hyperlinking-script making- using productivity tools- e-transmit file- making sample drawing for outdoor and indoor garden by AUTOCAD 2D drawing techniques- drawing web format design- making layout - 3D drawing methods- ARCHICAD file system- tools and infobox- modification tools- structural elements- GDL objects (Grid dimensional Linking)- creation of garden components through ARCHICAD. ARCHICAD organization tools- dimensioning and detailing of designs- attribute settings of components- visualization tools for landscape preview- data management- plotting and accessories for designing- inserting picture using photoshop- making sample drawing for outdoor and indoor gardens.
PIII	Practices in point picking methods- using tool bars and icons- using modifying tools and modifying comments- isometric drawings- using productivity tools- drawing designs by AUTOCAD for home garden- institutional garden and special types of garden- using tools and info-box for 3D drawing- creation of garden components with ARCHICAD- organization- dimensioning- detailing and visualization tools with archicad- using photoshop package for 3D picture insertion- drawing designs with ARCHICAD for home garden- interior garden designing- it parks- corporates- theme parks and ecotourism spots-making sample drawing for indoor gardens.
Tasks and Assignments: Each student is required to submit the following:	

- ✓ Submit sample drawing designs for outdoor and indoor gardens using CAD.
- ✓ Formulate a lab report (with relevant documentation) on 3D drawing tools
- ✓ Survey one popular CAD company using some model questionnaire

Reference:

1. Christine Wein-Ping Yu, 1987. Computer-aided Design: Application to Conceptual Thinking in Landscape Architecture. Agrobios Publishing Company, Jodhpur.
2. David Byrnes. 2010. Auto CAD 2010 for DUMMIES. Wiley Publishing Inc., UK.
3. Donnie Gladfelter. 2016. Auto CAD 2016 and Auto CAD LT. 2016. Autodesk Official Press, Wiley India.
4. Farin Gerald, E., Josef Hoschek and Myung-Soo Kim. 2002. Handbook of computer aided geometric design. Elsevier, Amsterdam.

c. Mapping of Program Outcomes with Course Outcomes

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

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 – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC23	Protected Cultivation in Flower 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	Understanding the principles, theoretical aspects and developing skills in protected cultivation of flower crops.	Understand
CO2	Utilization of knowledge on types, design and principles of protected structures	Apply
CO3	Thorough understanding of principles of microclimate management and crop management.	Analyze
CO4	Develop the required skills for designing a greenhouse as well as acquire skills on microclimate management, production management	Skill

b. Syllabus

Units	Content
LI	Prospects and types of protected structures: Prospects of protected floriculture in India; Types of protected structures – Glasshouse/ polyhouse, shade net houses, mist chambers, lath houses, orchidarium, fernery, rain shelters, etc.; Principles of designing and erection of protected structures; Low cost/ Medium cost/ High cost structures; Location specific designs; Structural components; Suitable flower and foliage plants for protected cultivation
LII	Control of environment: Microclimate management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation, water harvesting.
LIII	Intercultural operations and crop regulation: Containers and substrates, media, soil decontamination, layout of drip and fertigation system, water and nutrient management, IPM and IDM, Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation in different ornamental flowering crops - Rose, Chrysanthemum, Carnation, Gerbera, Orchids, Anthuriums, Lilium, Limonium, Lisianthus, heliconia, Cala lily, Alstromeria
LIV	Automation and standards: Automation in greenhouses, sensors, solar greenhouses and retractable greenhouses, GAP/ Flower labels, Export standards, EXIM policy, APEDA regulations for export, Non-tariff barriers.
PV	Study of various protected structures; Design, layout and erection of different types of structures; Practices in preparatory operations, growing media, soil decontamination techniques; Microclimate management; Practices in drip and fertigation techniques, special horticultural practices; Determination of harvest indices and harvesting methods; Postharvest handling, packing methods; Economics of cultivation, Project preparation; Project Financing guidelines; Visit to commercial greenhouses
Tasks and Assignments: Each student is required to submit the following: ✓ Assignments & group seminars		

- ✓ Report submission on exposure visits at different regional commercial floriculture greenhouses

Reference:

1. Bhattacharjee SK. 2018. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ. Reprint, pp. 2065.
2. Bose TK, Maiti RG, Dhua RS and Das P. 1999. Floriculture and Landscaping. Naya Prokash, Kolkata, India.
3. Bose TK and Yadav LP. 1989. Commercial Flowers. Naya Prokash, Kolkata, India.
4. Chadha KL and Bhattacharjee SK. 1995. Advances in Horticulture: Ornamental Plants. Vol. XII, Parts 1 & 2. pp.533-574, Malhotra Publ. House, New Delhi, India.
5. Lauria A and Victor HR. 2001. Floriculture-Fundamentals and Practices.Agrobios Publ., Jodhpur.
6. Nelson PV. 2011. Green House Operation and Management. Pearson Publ. 7th edition, pp. 624.
7. Prasad S and Kumar U. 2003. Commercial Floriculture. Agrobios Publ., Jodhpur.
8. Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ. Reddy S,
9. Janakiram T, Balaji T, Kulkarni S and Misra RL. 2007. Hi- Tech Floriculture. Indian Society of Ornamental Horticulture, New Delhi, India

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

SEMESTER – III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
HOREC24	Indoor Plants and Interiorscaping	2	-	1	3

a. Course Outcome (CO)

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

Course Outcome		Level
CO1	To facilitate deeper understanding of the benefits of indoor plants, selection, designing and their management.	Understand
CO2	Implementation of deep understanding and knowledge of principles affecting indoor cultivation including vertical gardens	Apply
CO3	Enhances the ability to choose situation-specific green components for indoor gardening	Analyze
CO4	Develops required skills in interiorscaping and entrepreneurial acumen	Skill

b. Syllabus

Units	Content
LI	Importance and scope: Importance and scope of indoor plants and Interiorscaping, Indoor plants and Indoor air quality;
LII	Classification and principles: Factors affecting growth, development and flowering of Indoor plants. Classification of indoor plants based on light, temperature, humidity and pollution tolerance, Description and cultivation of various indoor plants. Principles of Interiorscaping, Role in pollution mitigation.
LIII	Cultural operations: Containers and substrates, preparation of growing media, propagation, training, grooming, nutrition, management of disease, pests and weeds. Maintenance of plants including repotting, foliar nutrition, light exposure and plant rotation. Media standards, Nursery and Export standards for potted plants, Nursery standards.
LIV	Special gardens: Special gardens including miniature gardens and plant stand. Presentations like dish, terrarium, bottle gardens, hanging baskets, window boxes and Bonsai; Vertical gardens: Vertical gardens- History, planting material, structures, containers, substrate, water and nutrient management, supplemental lighting; Marketing: Marketing channels, Business models including plant rentals.
PV	Identification of important house plants; Media and containers; Propagation; Cultural operations, maintenance and economics of indoor plants; Models for Interiorscaping; Familiarization with different indoor gardens; Making of terrariums, bottle garden, dish garden and their economics; Making of vertical gardens and economics; Exposure visits

Tasks and Assignments:

Each student is required to submit the following:

- ✓ Project report on selection of indoor plants for classroom purpose;

✓ Preparation of report on visit of some interiorscaped corporate sectors (with relevant documentation)
Reference: 1. Barbara P. 2005. The Complete Houseplant Survival Manual. Storey Publ., New Adams. 2. Randhawa GS and Mukhopadhyay A. 1986. Floriculture in India. Allied Publ. Wallach C. 1995. Interior Decorating with Plants. McMillan Seed Production Co. Inc., New York.

c. Mapping of Program Outcomes with Course Outcomes

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

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	20	15	15	10	60
Total	**30**	**25**	**25**	**20**	**100**

End Semester Question Paper pattern

CENTRAL UNIVERSITY OF TAMIL NADU
EXAMINATION FOR THE DEGREE OF
MASTER OF SCIENCE (HORTICULTURE)
ACADEMIC SESSION 2023-24
INTERANAL EXAMINATION

Course code–Course Name
Month Year | TIME: …. HOURS | TOTAL MARKS: 60

INSTRUCTIONS TO CANDIDATES

1. This paper has TWO (2) 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)
   Essay (5 questions)

   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)

3. Each question in **Part A** carries 1 (ONE) mark and **Part B** carries 2 (TWO) marks for Descriptive type;10 (TEN) marks for Essay type.

4. While answering **Part B** questions, **draw neatly labelled diagrams** wherever appropriate.

5. The scanned copy of the answer script must be mailed as per the instruction to course teacher immediately after the completion of examination

Registration No.: ……..

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

QUESTION PAPER

Time: 3.0 hour Maximum Marks: 60

Part – A

Answer *ALL* the questions (10 x 1 = 10 Marks)

Question nos: 1 to 10
TEN questions – TWO questions from each unit- only MCQ

Part – B

Answer *ALL the* questions (5 x 3 = 15 Marks)

Question nos: 11-15
FIVE questions – ONE question from each unit

Part – C

Answer *FIVE* questions (5 x 7 = 35 Marks)

Question nos: 16-20
FIVE questions – ONE question from each unit with internal choice (either or type)

It can be a question with seven marks or with sub-divisions

For example

16. I…….. **(7 Marks)**

(Or)

16. II (a) ……---------- **(4 Marks)**

(b) …… **(3 Marks)**

List of courses which cater the needs employability, entrepreneurship, skill development, local, national, global development, professional ethics, gender, human values, environment, sustainability are give below as link.

Link:
https://drive.google.com/drive/folders/1n6gLLLnG78bZJ597qLwAZw8_bVb3Wghj?usp=sharing