ANNAMALAI UNIVERSITY

(Accredited with 'A+' Grade by NAAC)

FACULTY OF AGRICULTURE

(Accredited by ICAR)

DEPARTMENT OF HORTICULTURE

Academic Regulations and Syllabi

DOCTOR OF PHILOSOPHY IN VEGETABLE SCIENCE

Under Choice Based Credit System (CBCS) with Outcome based Education

2022-2023 Onwards

COMMON REGULATIONS FOR ALL Ph.D. PROGRAMMES OF FACULTY OF AGRICULTURE

(w.e.f. 2022-2023)

1. DEFINITIONS

1.1 An **"Academic year"** shall consist of two semesters.

1.2 **"Semester"** means an academic term consisting of 110 instructional days excluding final theory examinations.

1.3 **"Course"** means a unit of instruction to be covered in a semester having specific No., title and credits.

1.4 **"Credit hour"** means, one hour lecture plus two hours of library or homework or two and half hours of library/field practical per week in a semester.

1.5 **"Credit load"** of a student during a semester is the total number of credits registered by that student during that particular semester.

1.6 "**Grade Point"** of a course means the value obtained by dividing the percentage of marks earned in a course by 10 and the Grade Point is expressed on a 10 point scale and rounded off to two decimal places.

1.7 **"Credit Point"** means the grade point multiplied by corresponding credit hours.

1.8 **"Grade Point Average (GPA)"** means the quotient of the total credit points obtained by a student in various courses 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 scale and the GPA has to be corrected to two decimals.

1.9 **"Overall Grade Point Average (OGPA)"** means the quotient of cumulative credit points obtained by a student in all the courses 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.

2. SYSTEM OF EDUCATION

2.1 These rules and regulations shall govern the Ph.D. programmes leading to the award of Degree of Doctor of Philosophy in the concerned subject in the Faculty of Agriculture, Annamalai University. They shall come into force with effect from the academic year 2022-2023.

2.2 The semester system shall be followed for all the Ph.D. degree programmes. The duration of doctoral programmes is as follows:

2.2.1 The duration of the programme and the time for admission of thesis are counted from the date of provisional registration.

2.2.2 The minimum duration of the programme is three years and the maximum duration of the programme shall be seven years.

2.2.3 Break of study shall be granted up to a maximum period of one year and it can be done only after completing the course work. Such request shall be made in advance by scholar in writing with the recommendation of Supervisor, Head of the Department (HoD) and Dean, Faculty of Agriculture and it should reach the Director, Directorate of Academic Research (DARE). The orders for the break

of study shall be issued by the Director, DARE after assessing the need.

2.2.4 If prior permission is not sought and obtained, it will be considered as a case of discontinuation and action will be taken to cancel the registration of such scholars.

2.2.5 The scholars should remit the yearly fees during the break of study also.

3. PROGRAMMES OFFERED

The details of various Ph.D. programmes offered in the Faculty of Agriculture are as follows:

1. Agri- Business Management
2. Agricultural Economics
3. Entomology
4. Agricultural Extension Education
5. Agricultural Microbiology
6. Agronomy
7. Genetics and Plant Breeding
8. Horticulture in Fruit Science
9. Horticulture in Vegetable Science
10. Horticulture in Floriculture and Landscaping
11. Horticulture in Plantation, Spices, Medicinal and Aromatic plants
12. Plant Molecular Biology and Biotechnology
13. Plant Pathology
14. Seed Science and Technology
15. Soil Science and Agricultural Chemistry

4. ELIGIBILITY FOR ADMISSION

Candidates seeking admission to Ph.D. programme should satisfy the following requirements.

4.1 Candidates with two-year master's degree programmes from universities recognized by Annamalai University are eligible to apply for Ph.D. programmes of the university (Table 1).

4.2 Candidates who have undergone the programme under conventional system should possess not less than a second-class Master's degree. The candidates under trimester system should possess a minimum OGPA of 3.00 out of 4.00. For those under semester system 7.00 out of 10.00 is required for various Doctoral programmes.

Eligibility Criteria

Doctoral Degree Programmes	Eligibility
Agri Business Management	MBA in Agribusiness / MBA Agri Business Management
Agricultural Economics	M.Sc. (Ag.) in Agrl. Economics / Agricultural Marketing Management
Entomology	M.Sc. (Ag.) in Entomology / Agricultural Entomology
Agricultural Extension Education	M.Sc. (Ag.) in Agricultural Extension / Agricultural Extension and Communication / Agricultural Extension Education / Extension Education
Agricultural Microbiology	M.Sc. (Ag.) in Agricultural Microbiology
Agronomy	M.Sc. (Ag.) in Agronomy
Genetics and Plant Breeding	M.Sc. (Ag.) in Genetics and Plant Breeding
Horticulture in Fruit Science	M.Sc. (Hort.) / M.Sc. (Hort.) in Fruit Science
Horticulture in Vegetable Science	M.Sc. (Hort.) / M.Sc. (Hort.) in Vegetable Science

Horticulture in Floriculture and Landscaping	M.Sc. (Hort.) / M.Sc. (Hort.) in Floriculture and Landscape Gardening / Floriculture and Landscape Architecture / Floriculture and Landscaping
Horticulture in Plantation, Spices, Medicinal and Aromatic plants	M.Sc. (Hort.) / M.Sc. (Hort.) in Plantation, Spices, Medicinal and Aromatic Crops
Plant Molecular Biology and Biotechnology	M.Sc. (Ag.) in Plant Molecular Biology / Agricultural Biotechnology
Plant Pathology	M.Sc. (Ag.) in Plant Pathology
Seed Science & Technology	M.Sc. (Ag.) in Seed Science & Technology
Soil Science and Agricultural Chemistry	M.Sc. (Ag.) in Soil Science and Agricultural Chemistry

4.3 All research scholars shall undergo course work for two semesters as prescribed by the Department. Duration of the programme will be for three years.

4.3.1 The Ph.D. scholars shall report in the Department and sign every day in the attendance register. In order to promote quality research and training in cutting edge areas, the University may permit the scholar to conduct research in recognised universities/research institutes, after the completion of qualifying Viva voce examination.

4.3.2 Project staff/ fellow working in projects in the University, sponsored by Government of India/ Industries / Government of Tamil Nadu can also register.

4.3.3 Candidates in employment should be sponsored by their employer and should avail leave for the minimum duration of the programme and should be formally relieved from their duty to register.

4.3.4 Candidates who are selected under the national level fellowship programmes or by any recognized bodies and who satisfy the eligibility conditions as per the regulations shall apply in the respective discipline.

4.3.5 Admission to Foreign Students: Foreign students, who are selected under various scholarship schemes, either by the Ministry of Education and Culture or by the Ministry of External Affairs, will be given admission on the recommendation / sponsorship of the respective Ministry of Government of India. The other foreign students who seek admission should possess a research VISA issued by the Indian Embassies aboard and produce “No Objection Certificate” from the Ministry of Human Resource Development, Government of India, after clearance from the Ministry of External Affairs. They should also show proof for financial capability for staying, pursuing Ph.D. programme for three years.

5. MODE OF SELECTION

5.1 University shall issue notification for Ph.D. admission in starting of academic year.

5.2 The candidates desirous of registering for Ph.D. programme shall apply by filling all the relevant details mentioned in the online application form posted in the University website and submit completed application online before the due date as indicated in the notification issued from time to time.

5.3 Incomplete applications and applications with false information in any respect shall be summarily rejected without any intimation to the candidate.

5.4 The Departmental Research Committee (hereafter referred to as DRC) of concerned Department

shall screen the applications as per the eligibility norms and shall conduct the written test and interview only for eligible candidates.

5.5 The admission to Ph.D. students shall be based on the following criteria besides general eligibility.

5.5.1 An entrance test at post graduate level for 70 marks (70 multiple choice questions (MCQs), each question carrying one mark and duration of the test is 90 minutes followed by an interview that will have a weightage of 30 marks.

5.5.2 The candidates who secure 50% marks in entrance test and interview are eligible for admission.

5.5.3 A relaxation of 5 % marks (from 50 % to 45%) shall be allowed for the candidates belonging to SC/ST/OBC (non creamy layer)/ differentially able category.

5.5.4 Candidates with UGC- JRF / NET / ICAR/ICSSR qualified candidates and teacher fellowship holders are exempted from the Entrance test but they have to appear for the interview and evaluated for 100 marks.

5.6 Departmental Research Committee: The following is the constitution of the DRC. The members other than Head of the Department shall serve only for one academic year.

Designation	Members
Head of the Department	Convener
Two professors/ Senior Faculty nominated by the Vice-Chancellor in rotation	Members
One Associate Professor (in rotation)	Member
One Assistant Professor (in rotation)	Member

5.7 The DRC has the following functions

5.7.1 Selection of candidates for admission to the Ph.D. programme.

5.7.2 Facilitating research facilities in the Department.

5.7.3 Maintenance of research quality and quality of publications.

5.7.3 Sorting out any other research related issue of the Department.

5.8 If there is any dispute either in the constitution of functioning of the DRC, it shall be brought to the notice of the Director, DARE and the decision of the Vice-Chancellor shall be final.

5.9 The minutes of the DRC together with the list of selected candidates and their research supervisors along with recommendations of the Dean of the respective faculty will be placed before the Vice-Chancellor for approval.

6. ADMISSION

6.1 The selected candidates shall be issued admission cards and they will be admitted to Ph.D. programme in the respective Department based on his/her PG qualification, entrance and interview.

6.2 The provisional registration order for Ph.D. shall be issued to the candidates.

6.3 The scholar, supervisor, Research Advisor Committee members and examiners shall not be relatives to one another.

7. TUITION FEES AND OTHER FEES

7.1 The selected candidates shall pay the prescribed fees before the last date mentioned in the selection order, failing which they will forfeit the seats.

7.2 The yearly fees shall be paid by the scholars within the prescribed date till the scholar submits the thesis. The supervisors should monitor the regular payment of yearly fees by those scholars who are working under them.

7.3 The registration is liable for cancellation, if the research scholar has not paid the yearly fees within stipulated time.

7.4 Non-payment of yearly fees is a serious lapse on the part of the scholars. Explanation for non-payment of yearly fees shall be called for from the supervisors.

7.5 The various fees payable by the students will be decided by the university from time to time.

7.6 Admission to the hostel will be strictly restricted to the actual accommodation available and no associate will be allowed. A Ph.D. student may be allowed to stay in the hostel for a maximum of five years from the date of admission to the Ph.D. programme.

8. CREDIT GRADE POINT REQUIREMENTS

8.1 A student enrolled for Doctoral program is required to complete 100 credits inclusive of 75 credits of research to become eligible for the degree as detailed below:

Details	Credit Hours
Major Courses	12
Minor Courses	6
Supporting Courses	5
Seminar	2
Research	75
Noncredit Compulsory courses - Research and Publication Ethics (Contact hours: 2) MOOC (Contact hours: 2)	
Total	**100**

8.2 In a semester, a Ph.D. scholar can register a maximum of 15 credits excluding research. However, the research credits registered should not exceed 16 per semester. Semester-wise distribution of credits is given in the respective Ph.D. programmes.

8.3 Registration Card: A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate. The Supervisor, Ph.D. Coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean. The Dean shall approve the registration cards. The approved registration cards shall be maintained by the HoD, Supervisor and the student concerned. The list of courses registered by the students in each semester shall be sent by the Dean to the DARE for preparation of Report Cards.

8.4 The Ph.D. students should complete their course work within the first two semesters in Annamalai University campus.

8.5 Requirements for Ph.D. programme shall also include successful completion of Non-Credit

Compulsory Courses, thesis research in the major field of study and submission of thesis thereon.

9. ATTENDANCE REQUIREMENT

9.1 One hundred per cent attendance is expected from each scholar. A student who fails to secure 80 per cent of attendance in each subject separately for theory and practical, shall not be permitted to appear for the final examination in that subject and shall be awarded 'E' (incomplete) and will be required to repeat the course whenever offered.

9.2 In respect of the student who has absented himself / herself for classes with or without valid reasons, that period will be treated as absence only and not as leave. Also, no attendance will be given for writing make up tests.

9.3 In case of new admission, for calculating 80 percent attendance in the first semester, the number of working days will be calculated from the date of joining of the students who are permitted to join late due to administrative reasons. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice - Chancellor on the recommendation of the Research Advisory Committee, HoD and Dean, Faculty of Agriculture on payment of condonation fee prescribed by the university.

9.4 Students absenting from the classes with prior permission of the HoD on official University business shall be given due consideration in computing attendance.

9.5 In respect of students who had absented for the mid-semester examination (MSE) on university business with prior permission of the HoD and Dean, Faculty of Agriculture, the makeup first test should be conducted ordinarily within 15 working days from the date of conduct of the first test.

9.6 The students who absent himself/herself for first test in a subject on genuine reasons shall be permitted on the recommendation of the course teacher / Research Supervisor and Head of the Department concerned. Missing examination should be completed within 15 working days from the date of respective examination on payment of missing examination fee prescribed by the university.

10. RESEARCH ADVISORY COMMITTEE

10.1 Each Ph.D. scholar shall have a Research Advisory Committee (RAC) to guide the scholar in carrying out his/her programme.

10.2 A Research Advisory Committee shall be constituted with the approval of the University for each candidate separately, immediately after his/her admission. The purpose of the RAC is to provide expert opinion on frontline research.

10.3 There shall be a Research Advisory Committee for every student consisting of not fewer than four members with the Supervisor as Chairperson. The Research Advisory Committee should have representatives from the major and minor fields. The Research Supervisor should convene a meeting of the Research Advisory Committee at least once in a semester. The research credit evaluation form should be communicated to the Head of Department and the Director, DARE for information.

10.4 Research Supervisor

10.4.1 Every scholar shall have a Research Supervisor (among the recognized guides), who will be appointed by the Vice-Chancellor on the recommendation of the DRC, Head of the Department and the Dean, Faculty of Agriculture. Research supervisors approved by the Vice-Chancellor only can be the guide for the students.

10.4.2 A teacher having Ph.D. with 5 years of service and PG teaching is eligible for teaching and

guiding Ph. D. scholars. A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates.

10.4.3 The research supervisors who wish to avail leave/lien/deputation beyond a period of six months shall propose a Co-supervisor in the concerned subject for the candidates registered with them and it may be intimated to the University well in advance. The final approval of the proposal rests with the Vice-Chancellor.

10.5 Functions of the RAC:

10.5.1 Discuss, advice and recommend on all matters connected with the scholar's research from admission till the completion of the programme.

10.5.2 Approve the topic of research and the synopsis.

10.5.3 Assess and approve the progress reports of Ph.D. scholars in the prescribed format and to report to the University on the fitness or otherwise of the candidate to proceed with his/her research work for the Ph.D.

10.5.4 If necessary, recommend and approve change of title of dissertation / thesis and change of Research Supervisor.

10.5.5 Conduct the pre-submission presentation (before the submission of synopsis) and to give a certificate to this effect to be submitted along with the synopsis.

10.6 The Research Advisory Committee will meet every semester

10.6.1 To scrutinize the research proposal / progress report submitted by the research scholar.

10.6.2 To assess the conduct of experiments / field work, peruse laboratory notebooks, data recording, analysis, and publication.

10.6.3 To review and endorse the annual progress report of the research scholar.

10.6.4 To approve the synopsis of the thesis.

10.6.4 The Chairperson will convene the Research Advisory Committee meetings with intimation to the Director, DARE through the Head of the Department.

10.7 Changes in RAC

The proposals for changes in the RAC are to be sent to the Director, DARE, through HOD and Dean for approval, if it is keenly felt that such changes are absolutely necessary.

10.8 Change of Research Supervisor

10.8.1 Change of Research Supervisor shall not be permitted as a routine. In exceptional cases, such change may be permitted, if valid reasons are provided by the candidates. The Committee headed by the Vice-Chancellor shall look into the request of the petitioner, if there is any conflict between the scholar and the research supervisor.

10.8.2 The Research Supervisor under whom the scholar has originally registered shall give a "No Objection Certificate" and the new proposed Research Supervisor should give a "Certificate of Willingness" to guide the candidate. The final decision will rest with the University. However, the Vice-Chancellor, on the recommendation of the RAC and Dean's Committee, has the right to assign a new research supervisor to the research scholar.

10.8.3 When the change of Research Supervisor is approved, the candidate shall work for a minimum of one year with the new Research Supervisor, if the topic of his/her research is different under the new supervisor, provided he/she fulfils the attendance requirements.

10.9 Change of Topic of Research

10.9.1 Change of the specific area of research may be permitted within one year from the date of admission and request must be submitted with the recommendations of the RAC. In such cases, the

minutes of the RAC meeting must include whether the course work undertaken by the research scholar is relevant to the new research area and the competence of the research supervisor in this field.

10.9.2 If the RAC is of the view that there is a major change in the specific area of research and is not relevant to the course work undertaken, the research scholar will have to go through the process of fresh examination pertaining to the area of research.

10.10 Absence of Member during Qualifying / Final Viva-Voce Examination

Under extra-ordinary circumstances if the qualifying / final viva-voce examination to Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Director, DARE in advance.

11. EVALUATION OF STUDENT'S PERFORMANCE

All students shall abide by the rules for evaluating the course work under the semester system of education, as prescribed from time to time by the University.

12. EXAMINATIONS

12.1 There will be two examinations viz., first test and final examination. Wherever the course has practical, there will be a final practical examination also.

12.2 The duration of first test will be of one and half an hour and final examinations in theory and practical will be conducted for three hours each.

12.2.1 The first test will be conducted by course teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Director, DARE through HOD within seven working days.

12.2.2 The question paper for the final examination will be set as per Bloom's taxonomy by the concerned course teacher in consultation with the Head of the Department.

12.2.3 There will be final examination separately for theory and practical which will be conducted by the University. Each final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and another will be among the senior faculty of the Department). The distribution of marks will be as indicated below:

S. No	Examination	Course with practical	Course without practical	Course without theory
1	First Test	30	30	30
2	Final theory	40	70	-
3	Final practical	30	-	70
	Total	**100**	**100**	**100**

The question paper model and distribution of marks for first test and final theory examinations are as follows:

First Test (30 marks) (1.5 hours duration)

1	Definitions/concepts	5 out of 7	(5 x 1)	5 marks
2.	Short notes	5 out of 7	(5 x 3)	15 marks
3	Essay type	2 out of 3	(2 x 5)	10 marks

Final Theory: Course without practical (70 marks) (3 hours duration)

1.	Short notes	5 out of 7	(5 x 4)	20 marks
2	Essay type	5 out of 7 (Four questions must represent K6 level of Bloom's taxonomy)	(5 x 10)	50 marks

Final Theory: Course with Practical (40 marks) (3 hours duration)

1.	Short notes	5 out of 7	(5 x 2)	10 marks
2	Essay type	5 out of 7	(5 x 6)	30 marks

12.3 Minimum Marks for Pass

12.3.1 The student should secure a minimum of 60 per cent marks separately in the theory and practical and an aggregate of 70 per cent to secure a pass in the subject. Each subject shall carry a maximum of 100 marks for purpose of grading. The grading will be done as grade point, i.e., the percentage of marks earned in a subject is divided by 10. The grade point is expressed on a 10 point scale upto two decimals.

12.3.2 Students who secure marks below 70 per cent in a subject will be awarded 'RA' grade and students without having the required minimum attendance of 80 per cent will not be allowed to write the final examination and they will be awarded 'E' grade. Students who secure 'RA' grade should appear for re-examination in the subsequent semester. If a student secured 'E' grade, he/she has to re-register and attend the course again during the next academic year.

12.4 Minimum GPA Requirement

A Ph.D. student, to continue his/her studies in the University, should maintain certain minimum Average Grade Point prescribed here under:

a. Earn a Grade Point of 7.00 for a pass in each subject.
b. For purpose of continuing as a student in the university, a candidate is required to earn a Grade Point Average of not less than 7.00 at the end of each semester.
c. A Ph.D. student may repeat the course (s) in which he/she gets a Grade Point below 7.50 and above 7.0 to improve the OGPA.

12.5 Re-Examination

12.5.1 Re-examination is permitted only for the final theory and practical examinations. The students who secure 'RA' grade are permitted to write the re-examinations as and when conducted with the permission of university.

12.5.2 The re-examination fee as prescribed by university per course is to be paid on or before the prescribed date. A student is permitted to write the final theory and practical examinations only two times during the course period of three years excluding the regular final examination.

12.5.3 In the event of a student who fails to secure a pass in the two re-examinations permitted, he/she has to re-register for the course along with juniors. The marks secured in first test will be retained and the student should produce the practical record during re-examination. The registration for the re-examination shall be done after first test on the date specified by the Director, DARE. Each registration is considered as an attempt even if the student absents for the examination.

12.6 Return of Valued Answer Papers

12.6.1 The valued answer papers of first test shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification.

12.6.2 The answer paper should be retained with the course teacher for six months and then disposed off. Evaluated final theory papers have to be retained up to six months by the Director, DARE after the conduct of examination and then disposed off.

13. SEMINAR

Seminar is compulsory for all students and each student should register and present two seminars each with 0+1 credits. A student can register only one seminar in a semester and only after successful completion of the first seminar, the student is permitted to register for the second seminar.

13.1 Seminar Topic

13.1.1 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 Research Supervisor in consultation with HOD within three weeks after commencement of the semester.

13.1.2 Under the guidance and supervision of the Research Supervisor of the RAC, the student should prepare a seminar paper containing not less than 50 typed and printed pages with a minimum number of 75 references covering the recent 10 years time after reviewing all the available literature and present the seminar after completion of 80% attendance in the semester in the presence of the HoD, RAC, staff and post-graduate students of the concerned department.

13.1.3 The circular on the presentation of the seminars may be sent to other Departments to enable those interested to attend the same. The Research Supervisor will monitor the progress of the preparation of the seminar and correct the manuscript.

13.1.4 The student will submit two copies of the corrected manuscript to the HOD through Research Supervisor before presentation. The student will incorporate the suggestions and carry out corrections made during the presentation and resubmit three fair copies to the HOD (one to Dept. library, the second to the Research Supervisor and the third for student) within 15 days after presentation.

13.1.5 The performance of the student in the credit seminar will be evaluated and grade point awarded by the HOD along with the RAC for 100 marks. Grade Point may be given based on the

following norm.

Details	Marks
Coverage of literature	40
Presentation	30
Use of audio-visual aids	10
Capacity to participate in discussion and answer the questions	20
Total	**100**

14.QUALIFYING EXAMINATION

Only those students who successfully complete the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of only Viva-voce examination. The qualifying examination should be conducted before fourth week from the commencement of the third semester.

14.1 Minimum requirement for qualifying Viva-voce Examination

The students who have completed all the courses and earned a grade point average of not less than 7.0 will be permitted to appear for the qualifying examination. Students who do not satisfy these requirements shall not be permitted to take up the qualifying examination. The qualifying examination will be conducted after the successful completion of course work.

14.2 Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the RAC in consultation with HOD before two months of the date of completion of the student's course work to the Director, DARE. One of them will be appointed as external examiner.

14.3 Qualifying Viva-Voce Examination

14.3.1 The evaluation should cover both the research problem and theoretical background to execute the project. This shall assess the aptitude of the student and suitability of the student for the given research topic.

14.3.2 The RAC shall conduct the qualifying viva-voce examination with one external member, who shall be a specialist in the subject from outside the university.

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

Communication of Results of Qualifying Examination

The Research Supervisor shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Director, DARE through HOD in the prescribed format.

14.5 **Failure /Absence in Qualifying Examination**

14.5.1 When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Director, DARE with the recommendation of the RAC and Head of the Department.

14.5.2 A student, who applies for re-examination should attend viva-voce. Re-examination shall not take place earlier than one month after the first examination. It will be conducted by the RAC as previously indicated.

14.5.3 If a student fails in the re-examination, further re-examination will be considered on the recommendation of the RAC, HoD and Dean, Faculty of Agriculture. If the student fails in the

qualifying examination, he/she is not permitted to register for further research credits in the next semester.

15. THESIS RESEARCH

15.1 Selection of Topic

15.1.1 The thesis research for the Ph.D. degree should be of the nature of a definite contribution to the subject and the results should be of sufficient importance to merit publication. The findings should have some practical utility or should lead to theoretical contribution.

15.1.2 The thesis shall be on a topic falling within the field of the major specialization and shall be the result of the student's own work. A certificate to this effect duly endorsed by the major advisor shall accompany the thesis.

15.2 Research Proposal

15.2.1 The research scholars shall present their broad area of research and submit a proposal to the Research Advisory Committee at the end of the first semester.

15.2.2 The research proposal has to be presented by the student in a meeting organized by the Head of the Department to get the opinion / suggestion of the faculties of the Department for improving it. Three copies of the research proposal in the prescribed format should be sent to the Director (DARE) through the Head of the Department for approval.

15.2.3 The distribution of research credit will be as follows:

Semester	Credit Hours
I Semester	0+2
II Semester	0+10
III Semester	0+16
IV Semester	0+16
V Semester	0+16
VI Semester	0+15
Total	**0+75**

15.3 Evaluation of Thesis Research

15.3.1 After assigning the research problem, for each semester, the student has to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the research programme has to be given to the student for carrying out the work during that semester.

15.3.2 Attendance register must be maintained in the department by HOD for all the students to monitor whether the student has 80% of attendance in research.

15.3.3 The student has to submit his/her research observation note book to the Research Supervisor, who 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.

15.3.4 After completion of 80% attendance for research and on or before the last day of the semester, the research scholars, shall submit Progress Reports in the prescribed format duly endorsed by the Research Advisory Committee to the Director, DARE until they submit their synopsis.

15.3.5 Failure to submit the progress reports shall entail automatic cancellation of registration.

15.3.6 The minutes of the meeting of the Research Advisory Committee along with enclosures will

be sent to the Director, DARE.

15.3.7 Candidates who are recipients of fellowships such as JRF/SRF directly from any of the funding agencies/ shall send the progress reports and the utilization certificates in the format prescribed by the respective funding agency through proper channel.

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

SITUATION – I

The student has completed the research credits as per the approved programme and awarded **SATISFACTORY** by the RAC. Under the said situation, the student can be permitted to register for fresh research credits in the subsequent semester. If the student is awarded **UNSATISFACTORY**, he/she has to re-register the same block of research credits in the subsequent semester.

SITUATION – II

The student who has not secured the minimum attendance of 80 per cent shall be awarded grade 'E'. The student has to re-register the same block of research credits for which 'E' grade was awarded earlier in the following semester with prior permission. Until the completion of re-registered credits, the student should not be allowed to register for fresh (first time) research credits.

SITUATION – III

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

- Failure of crop
- Non-incidence of pests or disease or lack of such necessary experimental conditions.
- Non-availability of treatment materials like planting materials chemicals, etc.
- Any other impeding / unfavorable situation for satisfying the advisory committee.
- Under the said situations, grade **EE** should be awarded.

  In the mark list, it should be mentioned that E grade or EE grade was awarded due to 'lack of attendance' or 'want for favourable experimental conditions'.

SITUATION – IV

When the student fails to complete the work even in the 'second time' registration, the student will be awarded **UNSATISFACTORY** and, in the mark, list the 'second time' should be mentioned.

For the registration of research credits for the third time, permission has to be obtained from the Dean based on the recommendation of the RAC, and HOD.

Permission for registration for the fourth time shall be given only by the University based on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture.

16. SUBMISSION OF THESIS

16.1 The research credits registered in the last semester should be evaluated only at the time of the submission of thesis, by the RAC. Students can submit the thesis at the end of the final semester.

16.2 If a student has completed the thesis before the closure of the final semester, the research supervisor can convene the RAC meeting and take decision on the submission of the thesis, provided the student satisfies 80 per cent attendance requirement.

16.3 The candidate shall be allowed to submit his/her thesis after the completion of stipulated period.

A grace period of 90 days may be allowed to submit the thesis after the prescribed duration. If the thesis is not submitted even after the grace period, the student shall pay the tuition fee for the ensuing year.

16.4 If a student is not able to submit the thesis within the grace period, the student has to re-register for the credits in the forthcoming semester. The student who re-registers the credits after availing of the grace period will not be permitted to avail of grace period for the second time. The Head of the Department can sanction the grace period based on the recommendation of advisory committee and a copy of the permission letter along with the receipt for payment of fine should accompany the thesis while submission.

16.5 Three copies of the thesis (in the approved format) shall be submitted together with the submission fee not later than three months after the submission of the synopsis.

16.6 No dues certificates from the Department and Central Libraries, Hostel, Stores, etc. must be submitted with the thesis copies. The Research Supervisor shall forward the thesis copies with the enclosures to the Director, DARE through the HOD and the Dean. A soft copy of the thesis in PDF format as prescribed by Shodhganga, shall also be submitted.

16.7 The Ph.D. scholars have to publish a minimum of two research papers in NAAS rated journals with 5 and above rating (for social science NAAS rated journals with 4 and above rating) / Scopus / Web of Science indexed journals at the time of publication of the papers. The synopsis will be accepted for processing only after showing evidences for publications of two such research papers.

16.8 The soft copy of the thesis shall be checked for plagiarism using Turnitin software. Beyond the percentage of reproduction prescribed by UGC, the thesis will not be accepted for valuation.

16.9 Pre-submission Presentation

16.9.1 The pre-submission presentation of the thesis is a requirement to enrich the scholar and to fine tune his/her research presentation. This presentation shall be conducted before the submission of the synopsis in the presence of the RAC, Supervisor/Co-Supervisor, HoD, Faculty members, Research Scholars and/or P.G. Students.

16.9.2 The scholar shall present the findings. The gathering may suggest ideas / references to be consulted / suggestions to improve the work.

16.9.3 A report on this event along with an attendance sheet shall be forwarded by the Research Supervisor with the endorsement of the RAC and HOD to the Director, DARE.

16.10 Submission of Synopsis

16.10.1 The submission of synopsis may be permitted 3 months before the completion of required duration on successful completion of course work.

16.10.2 The Research Scholar shall submit 3 copies of the synopsis approved by the Research Advisory Committee along with a soft copy to the Director, DARE through the Research Supervisor, the HOD and Dean of the respective Faculty.

16.10.3 Guidelines for the preparation of the synopsis are appended in Appendix I. Name of the candidate and name of the supervisor shall not be mentioned anywhere in the synopsis; enrolment number of the candidate alone shall be given. A model cover page for a synopsis is given in Appendix III.

16.11 Guidelines for Preparation of Thesis

16.11.1 The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to university with the

reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size.

16.11.2 The specification for the preparation of the thesis is given in Appendix II. A model cover page for a thesis is given in Appendix IV.

The thesis shall be typed on both sides of the page in order to save paper and postage. The thesis shall contain a Certificate from the guide (Annexure) specifying that the thesis submitted is arecord of research work done by the candidate during the period of study under him/her and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship or similar title.

16.11.3 A statement from the guide indicating the extent to which the thesis represents independent work on the part of the candidate should also be made. (Appendix V)

17. VALUATION OF THE THESIS

17.1 Panel of Examiners

17.1.1 The thesis submitted in partial fulfilment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the Research Supervisor of the RAC, HOD and Dean.

17.1.2 The external experts shall be chosen from a panel of at least five names of specialists separately from within the country and outside the country in the particular field, suggested by the Research Supervisor.

17.1.3 The external experts shall send their evaluation reports on the thesis directly to the Director, DARE along with the copy of the evaluated thesis. The Director, DARE on receipt of the reports from the two examiners will send them to the concerned Research Supervisor who is the convener of viva-voce board.

17.1.4 The Research Supervisor will send the consolidated report with his remarks to the Director, DARE through the Head of the Department. Based on the satisfactory reports of the evaluation, Viva-voce examination will be arranged.

17.1.5 After a student's thesis for Ph.D. degree is evaluated as indicated above, the thesis shall be finally accepted for the award only after the student satisfactorily completes the final Viva-voce examination.

17.1.6 The Viva-Voce board comprises the student's RAC with the addition of the external examiner who valued the thesis, and the HOD. If the HOD happens to be the Research Supervisor, the Dean, Faculty of Agriculture will nominate a senior member of the staff of the concerned Department as a member.

17.1.7 The candidate is expected to defend the thesis at the Viva-voce examination. The degree shall be awarded on the unanimous recommendation of the Viva-Voce board as **satisfactory** with regard to the thesis and the performance of the student in the final Viva-voce examination.

17.1.8 The recommendation of the Viva-Voce board shall be forwarded to the Director, DARE by the Research Supervisor through HOD and Dean which shall be signed by all members of the committee and the external examiner.

17.1.9 A candidate who is not successful (unsatisfactory) at the Viva–voce examination will be permitted to undergo the Viva-voce examination again within a period of three months

17.2 Revision and Resubmission of Thesis

17.2.1 If an examiner recommends change / further work, the thesis will be referred to the same examiner after compliance for his/her opinion. In case of rejection by any one of the examiners, the thesis will be sent to another examiner and his / her recommendation will be final.

17.2.2 If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva–Voce examination will be conducted by the viva-voce board.

17.3 Re-registration and Submission of Thesis

The minimum of 80% 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 of three years.

17.4 Extension of Time

17.4.1 Research scholars who do not submit the thesis within the stipulated period should apply for extension of time three months before the completion of three years. Extension of time and the fees to be paid will be considered by the Deans Committee, if the extension is duly recommended by the RAC, Head of the Department, and the Dean of the Faculty, such candidates will be eligible for extension of time for a maximum period of three years.

17.4.2 The scholar will have to enrol as fresh candidates if he/she fails to submit the thesis within the maximum extension period of three years when granted.

17.4.3 If a scholar requires a few more months after the expiry of the maximum extension period of three years for the submission of the thesis as per the evaluation of the RAC, duly recommended by the Head of the Department and the Dean of the Faculty, as an exceptional case, the Deans committee may consider for re-registration to enable the scholar to submit the thesis. In any case, the time granted shall not exceed six / twelve months.

17.5 Number of Chances

17.5.1 A candidate will not be permitted to submit a thesis for the degree on more than two occasions. However, it will be open to the Syndicate, if the Board of Examiners so recommend, to permit the candidate to submit a thesis on a third occasion.

17.5.2 Also, he / she will not be permitted to appear for the viva-voce examination on more than two occasions.

18. DISCONTINUANCE AND READMISSION

18.1 Students admitted to the Ph.D. degree who discontinue their studies before completing the degree with written permission from the university may be re-admitted to the degree programme, provided that the student should have completed the course work before such discontinuance. However, the period of such discontinuance should not exceed five years for Ph.D. Degree from date of admission.

18.2 After completion of course work and qualifying examination, a student is eligible to discontinue temporarily his research program only once within 5 years for Ph. D. program. If the discontinuation period exceeds two semesters, the student has to forego the research credits already registered and register afresh with revised program.

18.3 In the case of field experiments or laboratory experiments in which continuity is essential for

research and if a student temporarily discontinues in the middle without completing the experiments, then the entire experiment should be repeated, even if the discontinuation period does not exceed two semesters.

18.4 A student joining the studies, after discontinuation should pay the fees of the existing semester.

Ph. D. (Hort.) Vegetable Science

Semester wise Distribution of Credit

Semester	Major Course	Minor Course	Supporting Course	Seminar	Research	Total credit	Noncredit Compulsory course
I	6	3	2	1	2	**15**	-
II	6	3	3	1	10	**22**	-
III	-	-	-	-	16	**16**	Research and Public Ethics
IV	-	-	-	-	16	**16**	**MOOC**
V	-	-	-	-	16	**16**	-
VI	-	-	-	-	15	**15**	-
Total credit	**12**	**6**	**5**	**2**	**75**	**100**	**-**

Distribution of Courses

Course code	Course Title	Credit hour (Theory +Practical)
	Major Courses	12
VSC 601*	Recent trends in vegetable production	3(3+0)
VSC 602*	Advances in breeding of vegetable crops	3(3+0)
VSC 603	Abiotic stress management in vegetable crops	3(2+1)
VSC 604	Seed certification, processing and storage of vegetable crops	3(2+1)
VSC 605	Breeding for special traits in vegetable crops.	3(2+1)
	Minor Course	6
VSC 606	Bio diversity and conservation of vegetable crops	3(2+1)
VSC 607	Biotechnological approaches in vegetable crops	3(2+1)
VSC 608	Advanced laboratory techniques for vegetable crops.	3(1+2)
	Supporting Courses	5
COM 601	Advances in Computer Applications	2(1+1)
STA 601	Advances in Designs of Experiments	3(2+1)
	Seminar	
VSC 691	Doctoral Seminar – I	1(0+1)
VSC 692	Doctoral Seminar – II	1(0+1)
	Research	**75**
VSC 694	Doctoral Research	0+2
VSC 695	Doctoral Research	0+10
VSC 696	Doctoral Research	0+16
VSC 697	Doctoral Research	0+16
VSC 698	Doctoral Research	0+16
VSC 699	Doctoral Research	0+15
	Non credit compulsory courses	
NGC 611	Research and Publication Ethics – Contact hours: 2	-
NGC 612	**MOOC – Contact hours: 2**	-

Semester wise Distribution of Courses

Sl. No	Courses	Credit Hours
I	**First Semester**	
1	Major Courses	6
2	Minor courses	3
3	COM 601 Advances in Computer Application	1+1
4	VSC 691 Seminar	0+1
5	VSC 694 Research	0+2
	Total credits	**0+14**
II	**Second Semester**	
1	Major Courses	6
2	Minor courses	3
3	STA 601 Advances in Designs of Experiments	2+1
4	VSC 692 Seminar	0+1
5	VSC 695 Research	0+10
	Total credits	**0+23**
III	**Third Semester**	
1	Research and Public Ethics*	2+0
2	VSC 696 Research	**0+16**
IV	**Fourth Semester**	
1	MOOC*	2+0
2	VSC 697 Research	**0+16**
V	**Fifth Semester**	
1	VSC 698 Research	**0+16**
VI	**Sixth Semester**	
1	VSC 699 Research	**0+15**
	Grand total	**100**

*Non credit compulsory course.

DEPARTMENT OF HORTICULTURE

Ph. D. (Hort.) Vegetable Science

PROGRAMME OUTCOME

PO 1 – The scholar will acquire knowledge on crop improvement, production technologies, biotechnology and postharvest technologies pertaining to vegetable crops with special reference to advancement in research.

PO 2 – The scholar will gain skills in approaching research problems and define research methodology for problems solving research in the field of vegetable science.

PO 3 – The scholar will be able to do individual research works in vegetable crops.

PO 4 – The scholar will become eligible to work in research programmes offered by national and international organizations and in teaching vegetable science.

PO 5 – The scholar will be able to develop expertise in scientific writing and publication of a research outcome.

VSC - 601 RECENT TRENDS IN VEGETABLE PRODUCTION (3+0)

Learning objectives

- To update the students with latest developments and trends in production technology of vegetable crops.
- To impart knowledge about present status and prospects of vegetable cultivation.
- To gain knowledge about Hi-Tech nursery management.
- To learn about the modern concept in water & Weed Management.
- To acquire Knowledge and skill about the recent trends in nutrient management.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; climate and soil as critical factors in vegetable production; choice of varieties; nursery management; modern concepts in water and weed management; physiological basis of growth, yield and quality as influenced by chemicals and growth regulators; role of organic manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing.

Unit-I: Solanaceous and malvaceous vegetables

Tomato, brinjal, chilli, sweet pepper, potato and bhendi.

Unit-II: Cole crops and cucurbits

Cabbage, cauliflower, knol-khol, sprouting broccoli and cucurbits.

Unit-III: Leguminous vegetables and green leafy vegetables.

Peas and beans, amaranthus and drumstick

Unit-IV: Root crops and bulbs

Carrot, beet root, radish and onion.

Unit-V: Tuber crops

Sweet potato, tapioca, dioscorea, elephant foot yam and taro

Lesson plan

1. Present status and prospects of vegetable cultivation; nutritional and medicinal values;
2-3. Tomato
4-5. Brinjal
5. Chilli
6-7. Sweet pepper
8. Potato
9-10. Bhendi
11-12. Cabbage
13-14. Cauliflower

15. Knolkhol
16. Sprouting broccoli
17. Pumpkin
18. Ash gourd
19. Bitter gourd
20. Ridge gourd
21. Bottle gourd
22. Snake gourd
23. Cucumber
24. Watermelon
25. **First Test**
26. Muskmelon
27. Pointed gourd
28. Turnip
29. Peas
30. French bean
31. Cluster bean
32. Vegetable Cowpea
33. Amaranthus
34. Drumstick
35-37. Carrot
38. Beet root
39. Radish
40-41. Onion
42. Aggregatum onion
43. Tapioca
44. Sweet potato
45. Dioscorea
46. Elephant foot yam
47. Containerized culture for year round vegetable production
48. Low-cost polyhouse; net house production; crop modelling,
49. Crop modelling, Organic gardening.
50. Vegetable production for pigments, export and processing.
51. **Final examination**

COURSE OUTCOME

After successful completion of this course, the students are exposed to **CO 1**: Advanced technology in vegetable production.
CO 2: Prospects and scope of vegetable production.
CO 3: Modern concepts in water & weed management
CO 4: Methods to combat the nutritional disorders in vegetable crops.
CO 5: Low cost- effective techniques for protected cultivation of vegetable crops.

CO - PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	2	3	2	2
CO 2	3	1	2	1	1
CO 3	3	2	2	1	1
CO 4	3	1	2	2	1
CO 5	3	2	2	2	2

References

1. Bose TK & Som NG. 1986. Vegetable Crops of India. Naya Prokash.
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6. Gopalakrishnan TR. 2007. Vegetable Crops. New India Publishing Agency.
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E-Resources

1. https://www.agribunt.com/article-13.php
2. https://www.avrdc.org/index.php?id=143
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VSC- 602 ADVANCES IN BREEDING OF VEGETABLE CROPS (3+0)

Learning objectives

- The student can able to understand genetics and cytogenetics principles applied in crop breeding techniques
- The student can apply traditional and molecular breeding methods for the enhancement of vegetable crops.
- Interpret about genetic diversity, germplasm resources and conservation,
- The student can able to gain knowledge regarding government policies, industry needs and consumer preferences which can affect the vegetable crop improvement programs.
- Design and present a vegetable breeding research project that meets specific short-term and long-term goals.

Theory

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance for the following crops

Unit- I: Solanaceous and Malvaceous vegetables

Tomato, brinjal, chilli, capsicum and okra

Unit- II: Cucurbitaceous vegetables

All gourds, melons, perennial cucurbits

Unit- III: Fabaceous & Cruciferous vegetables

Peas, beans, cabbage, cauliflower, knol khol and turnip

Unit- IV: Root & tuberous vegetables

Carrot, radish, beetroot, tapioca, potato, sweet potato and elephant foot yam

Unit- V: Leafy and bulbous vegetables

Amaranthus, moringa, spinach, palak, lettuce, onion and garlic

Lesson plan

Evolution, distribution, cytogenetics, genetic resources, genetic divergence, types of pollination and fertilization mechanisms, sterility and incompatibility, anthesis and pollination, hybridization, inter-varietal, interspecific and inter-generic hybridization, heterosis breeding, inheritance pattern of traits, qualitative and quantitative, plant type concept and selection indices, genetics of spontaneous and induced mutations, problems and achievements of mutation breeding, ploidy breeding and its achievements, *in vitro* breeding; breeding techniques for improving quality and processing characters; breeding for stresses, mechanism and genetics of resistance, breeding for salt, drought; low and high temperature; toxicity and water logging resistance, breeding for pest, disease, nematode and multiple resistance in the following crops:

1. Introduction about crop improvement in Solanaceous and Malvaceous vegetables

2. Crop improvement in Tomato
3-4. Crop improvement in Brinjal
5-6. Crop improvement in Chilli
7-8. Crop improvement in Sweet Pepper
9-10. Crop improvement in Bhendi
11. Introduction about crop improvement in Cucurbitaceous vegetables
12-13. Crop improvement in Ash gourd
14-15. Crop improvement in Ridge gourd
16-17. Crop improvement in Snake gourd
18-19. Crop improvement in Watermelon
20-22. Crop improvement in Muskmelon
23. Crop improvement in Perennial Cucurbitaceous vegetables – Pointed gourd
24. Crop improvement in Perennial Cucurbitaceous vegetables – Ivy gourd
25. First Test
26. Crop improvement in Perennial Cucurbitaceous vegetables – Chow- Chow
27. Introduction about crop improvement in Fabaceous and Cruciferous vegetables
28. Crop improvement in Peas
29. Crop improvement in Beans
30. Crop improvement in Cabbage
31. Crop improvement in Cauliflower
32. Crop improvement in Knol-Khol
33.Crop improvement in Turnip
34.Crop improvement in Carrot
35.Crop improvement in Radish
36. Crop improvement in Beet root
37-38. Crop improvement in Tapioca
39-40. Crop improvement in Sweet Potato
41. Crop improvement in Elephant foot yam
42-43. Crop improvement in Potato
44. Crop improvement in Amaranthus
45. Crop improvement in Spinach
46. Crop improvement in Palak
47. Crop improvement in Lettuce
48-49. Crop improvement in Onion
50. Crop improvement in Garlic
51. **Final examination**

COURSE OUTCOME

The scholar will be able to
CO 1: Understand the pollination behavior and fertilization mechanisms of vegetables.
CO 2: Understand the screening techniques for improving vegetables.
CO 3: Know how to design breeding experiments
CO 4: Understand hybridization techniques of vegetables
CO 5: Gain knowledge regarding government policies

CO - PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	**3**	**2**	**2**	**2**	**2**
CO 2	**3**	**2**	**3**	**3**	**1**
CO 3	**3**	**2**	**2**	**3**	**1**
CO 4	**3**	**2**	**1**	**3**	**2**
CO 5	**1**	**1**	**1**	**1**	**1**

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3. www.agritech.tnau.ac.in
4. https://www.iihr.res.in
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VSC 603 ABIOTIC STRESS MANAGEMENT IN VEGETABLE CROPS (2+1)

Learning objective

- To update knowledge on the recent research trends in the field of abiotic stress management in vegetable crops.
- To update knowledge on the recent research trends in the field of biotic stress management in vegetable crops.
- To update knowledge regarding vegetable production under stress
- To gain knowledge about various types of environmental stresses and their impact on vegetable production
- To teach management practices to mitigate abiotic and biotic stresses in vegetable production.

Theory

Unit -I: Stress, types and classification

Environmental stress and its types, soil parameters including pH, classification of vegetable crops based on susceptibility and tolerance to various types of stress; root stock, use of wild species, use of anti-transpirants.

Unit –II: Mechanisms of stress in vegetable crops

Mechanism and measurements of tolerance to drought, water logging, soil salinity, frost and heat stress in vegetable crops.

Unit –III: Environmental factors related to stress

Soil-plant-water relations under different stress conditions in vegetable crops production and their management practices.

Unit -IV: Production techniques of vegetables - I

Techniques of vegetable growing under water deficit, water logging, salinity and sodicity.

Unit –V: Production techniques of vegetables - II

Techniques of vegetable growing under high and low temperature conditions, use of chemicals in alleviation of different stresses.

Practical

Identification of susceptibility and tolerance symptoms to various types of stress in vegetable crops, measurement of tolerance to various stresses in vegetable crops, short term experiments on growing vegetable under water deficit, water-logging, salinity and sodicity, high and low temperature conditions, and use of chemicals for alleviation of different stresses.

Lesson plan

1. Stress – definition and classification - Environmental stress and its types
2. Nutrient stress and oxidative stress
3. Classification of vegetable crops based on susceptibility and tolerance to various types of stress
4. Influence of root stock in stress alleviation - use of wild species
5. Use of antitranspirants in management of stress
6. Drought - toxicity symptoms- mechanisms governing tolerance- physiological and biochemical

factors with stress-impact on vegetable crops - approaches and advances in management of drought

7. Flooding - toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management of flooding
8. Soil salinity- toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management of saline soil
9. Sodicity- toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management of sodic soil
10. Frost - toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management of frost
11. Heat stress- toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management of heat stress
12. Temperature and Radiation stress-- toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management
13. Nutrient stress and oxidative stress - toxicity symptoms- mechanisms governing tolerance- physiological and biochemical factors with stress-impact on vegetable crops - approaches and advances in management
14. Soil-plant-water relations under drought condition in vegetable crops production and their management practices.
15. Soil-plant-water relations under flooded condition in vegetable crops production and their management practices.
16. Soil-plant-water relations under in vegetable crops production and their management practices.
17. **First Test**
18. Soil-plant-water relations under sodic condition in vegetable crops production and their management practices.
19. Soil-plant-water relations under frost condition in vegetable crops production and their management practices.
20. Soil-plant-water relations under heat stress condition in vegetable crops production and their management practices
21. Techniques of vegetable growing under water deficit condition
22. Techniques of vegetable growing under water logged condition
23. Techniques of vegetable growing under saline soil
24. Techniques of vegetable growing under sodic soil
25. Techniques of vegetable growing under frost condition
26. Techniques of vegetable growing under heat stress condition
27. Techniques of vegetable growing under high and low temperature conditions,
28. Use of chemicals in alleviation of drought condition
29. Use of chemicals in alleviation of flooded condition
30. Use of chemicals in alleviation of saline condition
31. Use of chemicals in alleviation of sodic condition
32. Use of chemicals in alleviation of frost condition

33. Use of chemicals in alleviation of heat stress and drought condition
34. **Final examination**

Practical

1. Identification of susceptibility and tolerance symptoms to drought in vegetable crops
2. Identification of susceptibility and tolerance symptoms to flooding in vegetable crops
3. Identification of susceptibility and tolerance symptoms to salinity in vegetable crops
4. Identification of susceptibility and tolerance symptoms to sodicity in vegetable crops
5. Identification of susceptibility and tolerance symptoms to frost condition in vegetable crops
6. Identification of susceptibility and tolerance symptoms to heat stress in vegetable crops
7. Identification of susceptibility and tolerance symptoms to nutrient stress in vegetable crops
8. Measurement of tolerance to drought in vegetable crops
9. Measurement of tolerance to flooding in vegetable crops
10. Measurement of tolerance to salinity in vegetable crops
11. Measurement of tolerance to sodicity in vegetable crops
12. Measurement of tolerance to frost condition in vegetable crops
13. Measurement of tolerance to heat stress in vegetable crops
14. Short term experiments on growing vegetables under water deficit
15. Short term experiments on growing vegetables under salinity and sodicity
16. Use of chemicals for alleviation of different stresses
17. Use of chemicals for alleviation of different stresses

Course outcome

CO 1- Acquire the knowledge about effect of different abiotic stress on production of vegetables.

CO 2- To update knowledge on recent research trends in the field of environmental stress management in vegetables.

CO 3- Gain understanding about technique of vegetable growing under high stress condition.

CO 4- To gain knowledge on use of chemicals and anti-transpirants to alleviate different type of abiotic stresses.

CO 5- To gain skill on the management practices to mitigate abiotic stress in vegetable crops.

CO – PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	2	1	2	1
CO 2	3	2	1	1	1
CO 3	3	2	1	1	1
CO 4	3	2	1	2	1
CO 5	3	3	2	3	2

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VSC - 604 SEED CERTIFICATION PROCESSING AND STORAGE OF VEGETABLE CROPS (2+1)

Learning objective

- To educate the recent trends in the seed processing of vegetable crops.
- To educate the recent trends in the seed storage of vegetable crops.
- To educate the recent trends in the seed certification of vegetable crops.
- To educate the recent trends in the marketing of seeds of vegetable crops.
- To know about policy and seed act related to seed production

Theory

Unit -I: Seed certification and Standards

Seed certification- objectives - organization of seed certification - minimum seed certification standards of vegetable crops - field inspection - specification for certification.

Unit –II: Seed processing equipments

Seed processing - study of seed processing equipments - seed cleaning and upgrading - Seed packing and handling - equipment used for packaging of seeds - procedures for allocating lot number. principles and procedures of field inspection, seed sampling,testing and granting certification

Unit -III: Factors governing seed storage

Pre-conditioning - seed treatment – benefits - types and products - general principles of seed storage-advances in methods of storage (open, bulk, controlled, germplasm, cryopreservation) - quality control in storage - storage containers - seed longevity and deterioration – sanitation - temperature and relative humidity control.

Unit –IV: Seed testing

Seed testing; ISTA rules for testing – moisture - purity germination - vigor test - seed sampling - determination of genuineness of varieties - seed viability - seed health testing; seed dormancy and types of dormancy - factors responsible for dormancy.

Unit -V: Seed Marketing

Seed marketing - demand forecast - marketing organization - economics of seed production; farmers' rights - seed law enforcement - seed act and seed policy.

Practical

Seed sampling, purity, moisture testing, seed viability, seed vigor tests, seed health testing, seed cleaning, grading and packaging; handling of seed equipment and processing machines; seed treatment methods, seed priming and pelleting; field and seed inspection, practices in rouging, seed storage, isolation distances, biochemical tests, visit to seed testing laboratories and processing plants, mixing and dividing instruments, visit to seed processing unit and warehouse visit and know about sanitation standards.

Lesson plan

1. Seed certification objectives
2. Organization of seed certification
3. Minimum seed certification standards of vegetable crops
4. Field inspection

5. Specification for certification
6. Seed processing
7. Study of seed processing equipments
8. Seed cleaning and upgrading
9. Seed packing and handling
10. Equipment used for packaging of seeds
11. Procedures for allocating lot number
12. Pre-conditioning of seeds
13. Seed treatment, benefits, types and products
14. General principles of seed storage
15. Advances in methods of storage
16. Quality control in storage
17. **First Test**
18. Storage containers, seed longevity and deterioration
19. Seed sanitation
20. Role of temperature and relative humidity control in seed storage
21. Seed testing: ISTA rules for testing
22. Moisture, purity, germination, vigor test
23. Seed sampling
24. Determination of genuineness of varieties
25. Seed viability
26. Seed health testing
27. Seed dormancy and types of dormancy
28. Factors responsible for dormancy
29. Seed marketing: demand forecast
30. Marketing organization
31. Economics of seed production
32. Farmers' rights: PPVFRA
33. Seed law enforcement and Seed act and seed policy
34. **Final examination**

Practical

1. Seed sampling and analysis of seed for physical and genetic purity
2. Moisture testing
3. Seed viability
4. Seed vigor tests
5. Seed health testing
6. Seed cleaning, grading and packaging
7. Handling of seed testing equipment and processing machines, mixing and dividing instruments
8. Seed treatment methods, seed priming and pelleting
9. Field and seed inspection
10. Practices in rouging
11. Seed storage
12. Isolation distance
13. Biochemical tests
14. Visit to seed testing laboratories and processing plants
15. Visit to seed processing unit and warehouse

16. Standards of field sanitation
17. Standards of field sanitation

Course outcome

CO 1- The students will acquire knowledge on seed certification.
CO 2- The students will get exposed to principles and procedure of field inspection.
CO 3-The students will understand the principles of seed processing.
CO 4- Will gain comprehensive knowledge on seed storage.
CO 5- The students will get equipped to overcome the problems due to seed aging, seed deterioration, loss of vigour & viability.

CO – PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	1	1	1	1
CO 2	3	2	1	1	1
CO 3	3	1	2	3	1
CO 4	2	2	1	2	1
CO 5	3	2	2	3	1

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VSC – 605 BREEDING FOR SPECIAL TRAITS IN VEGETABLE CROPS (2+1)

Learning objective

- The present course enables the students to understand the consumption levels of vegetables.
- To understand the basics and principles of breeding programmes in vegetables.
- To impart knowledge on bioactive properties of vegetables.
- To identify the methods that contributes towards lowering the risk of cardiovascular diseases.
- This course also helps to know the breeding programmes and scientific studies on bioactive compounds of vegetables.

Theory

Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and colour content.

Unit –I:

Brassica group, Carrot and Beetroot

Unit -II:

Tomato, Brinjal, Peppers and Potato

Unit –III:

Green leafy vegetables, Legume crops and Okra

Unit -IV:

Cucurbitaceous vegetable crops and Edible Alliums

Unit -V:

Bio fortification in vegetable crops, genetic engineering for improvement of quality traits in vegetable crops, bioavailability of dietary nutrients from improved vegetable crops, bioavailability of dietary nutrients from improved vegetable crops and impact on micronutrient malnutrition, achievements and future prospects in breeding for quality traits in vegetables.

Lesson plan

Important nutrient constituents in vegetables and their role in human diet. Genetics of nutrients. Genetic and genomic resources for improving quality traits in vegetables, breeding strategies for developing varieties with improved nutrition for market and industrial purposes. Molecular and biotechnological approaches in breeding suitable cultivars of different crops for micronutrients and colour content.

1. Crop improvement for special traits in Cabbage
2. Crop improvement for special traits in Cauliflower
3. Crop improvement for special traits in Brussels sprout
4. Crop improvement for special traits in Sprouting Broccoli
5. Crop improvement for special traits in Kale
6. Crop improvement for special traits in Kohlrabi
7. Crop improvement for special traits in Carrot
8. Crop improvement for special traits in Radish
9. Crop improvement for special traits in Beet root

10-12. Crop improvement for special traits in Tomato

13. Crop improvement for special traits in Brinjal
14. Crop improvement for special traits in Chilli
15. Crop improvement for special traits in Sweet pepper
16. Crop improvement for special traits in Potato
17. **First Test**
18. Crop improvement for special traits in Spinach
19. Crop improvement for special traits in Lettuce
20. Crop improvement for special traits in Palak
21. Crop improvement for special traits in Drumstick
22. Crop improvement for special traits in French beans, Garden beans and Broad beans
23. Crop improvement for special traits in Garden peas
24. Crop improvement for special traits in Okra
25. Crop improvement for special traits in Melons
26. Crop improvement for special traits in Gourds
27. Crop improvement for special traits in Onion
28. Crop improvement for special traits in Garlic
29. Bio fortification in vegetable crops
30. Bio availability of dietary nutrients from improved vegetable crops and impact on micronutrient malnutrition.
31. Achievements and future prospects in breeding for quality traits in vegetables
32. Genetic engineering for improvement for quality traits in vegetable crops
33. Crops bio availability of dietary nutrients from improved vegetable crops
34. **Final examination**

Practical schedule

1. Identification and characterization of Brassica species for breeding purposes.
2. Hybridization techniques in the Brassica group for improving yield and quality.
3. Breeding methods for disease resistance in Carrot and Beetroot.
4. Breeding strategies for pest and disease resistance in Tomato.
5. Cross-breeding techniques in Brinjal for high-yield and quality improvement.
6. Selection and hybridization for fruit quality traits in Peppers.
7. Potato breeding for tuber quality and disease resistance.
8. Breeding for nutritional enhancement in Green Leafy Vegetables.
9. Hybridization and selection for disease resistance and yield in Legume crops.
10. Okra breeding for resistance to abiotic stresses such as drought and salinity.
11. Hybridization techniques for improving fruit quality in Cucurbitaceous crops.
12. Breeding for disease resistance in Cucurbitaceous vegetables.
13. Breeding techniques for enhancing bulb size and quality in Edible Alliums.
14. Biofortification strategies to increase micronutrient content in vegetable crops.
15. Genetic engineering techniques for quality trait improvement in vegetables.
16. Evaluation of bioavailability of dietary nutrients in biofortified crops.
17. Case studies on the impact and future prospects of breeding for quality traits in vegetable crops.

Course outcome

CO 1- Acquire the knowledge on breeding programmes of vegetable crops.
CO 2- Understand the knowledge on recent development in breeding for improved nutritional quality in vegetable crops.

CO 3- Students able to understand the bioactive properties of vegetables.
CO 4- Students able to understand the contribution of breeding of vegetables towards human health.
CO 5- Incorporate the knowledge on breeding programmes and scientific studies on bioactive compounds of vegetables.

CO – PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	**3**	**2**	**2**	**2**	**1**
CO2	**3**	**2**	**2**	**2**	**2**
CO3	**3**	**1**	**3**	**1**	**1**
CO4	**3**	**1**	**2**	**2**	**1**
CO5	**3**	**1**	**1**	**2**	**1**

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VSC – 606 BIODIVERSITY AND CONSERVATION OF VEGETABLE CROPS (2+1)

Learning objective

- To understand the goals, issues and current status of biodiversity and conservation of vegetable crops.
- To gain knowledge about collection, maintenance and characterization of germplasm.
- To impart comprehensive knowledge about germplasm exchange quarantine and intellectual property rights germplasm exchange.
- To know about GIS application in horticultural mapping and spatial analysis of field data.
- To gain knowledge about different strategies to conserve the germplasm in the present context.

Theory

Unit -I: Importance of biodiversity and methods of conservation

Biodiversity and conservation- issues and goals- centres of origin of cultivated vegetables- primary and secondary centres of genetic diversity- present status of gene centres-exploration and collection of germplasm- conservation of genetic resources- *in situ* and *ex situ* germplasm conservation- problem of recalcitrancy- cold storage of seeds- tissue culture-cryopreservation- pollen and seed storage- inventory of germplasm.

Unit –II: Role of National Institutes in conservation and plant quarantine

Introduction of germplasm- plant quarantine- role of national institutes in conservation-TBGRI- NBPGR- etc- intellectual property rights- regulatory horticulture-plant variety protection authority- maintenance of core group using traditional knowledge for plant conservation. IPRS, Breeders rights, Farmers rights, PPV and FR act. GIS and documentation of local bio diversity, geographical indications.

Unit –III: Bio diversity of tropical vegetable crops

Biodiversity of major tropical vegetable crops- Tomato- Brinjal- Chilli- Okra-Amaranthus- Cluster bean- Vegetable Cowpea- Cucurbits- Melons- Moringa- Dolichos bean-Broad bean

Unit -IV: Biodiversity of temperate vegetable crops

Biodiversity of major- temperate vegetable crops- Cabbage- Cauliflower- Knol Khol-Turnip- Brussels sprout- Chinese cabbage- Carrot- Beet root- Radish

Unit -V: Bio diversity of under exploited minor vegetable crops

Under exploited minor vegetable crops- present status and scope- their origin-distribution- biodiversity- conservation and utilization of minor vegetable crops.

Practical

Documentation of germplasm- maintenance of passport data and other records of accessions- field exploration trips- exercise on *ex situ* conservation- cold storage- pollen or seed storage- cryopreservation- visits to national gene bank and other centres of pgr activities- core sampling- germplasm characterization using molecular techniques.

Lesson plan

1. Bio diversity- introduction, principles, goals and issues in conservation

2. Genetic diversity- occurrence and distribution
3. Exploration, collection, characterization, documentation and cataloguing of germplasm
4. Present status of national and international gene banks
5. Role of national institutes in conservation – TBGRI, NPBGR etc.,
6. Germplasm exchange, material transfer agreement and current quarantine protocols
7. Methods for *ex situ* conservation of germplasm and *in situ* conservation of germplasm
8. Use of GIS and documentation of local bio diversity
9. GIS application in horticultural mapping
10. Impact of climate change on bio diversity
11. IPRS, Breeders right, Farmers rights, PPV, FR Act.
12. Benefits of GI protection.
13. Intellectual property rights, plant variety protection authority
14. Status of bio diversity of Tomato
15. Status of bio diversity of Brinjal
16. Status of bio diversity of Chilli
17. **First Test**
18. Status of bio diversity of Okra
19. Status of bio diversity of Amaranthus
20. Status of bio diversity of Cluster bean
21. Status of bio diversity of Vegetable cow pea

22-23. Status of bio diversity of Cucurbits 24-

25. Status of bio diversity of Melons
26. Status of bio diversity of Moringa
27. Status of bio diversity of Dolichos bean and Broad bean
28. Status of bio diversity of Cabbage and cauliflower
29. Status of bio diversity of Knol khol and Turnip
30. Status of bio diversity of Brussels sprout and Chinese cabbage
31. Status of bio diversity of Carrot, Beet root and Radish
32. Under exploited minor vegetable crops- present status and scope
33. Minor vegetables- origin, distribution- bio diversity, propagation, conservation and utilization.
34. **Final examination**

Practical

1. Field exploration trips- exercise in collection and characterization
2. Visit to field germplasm unit and documentation of germplasm
3. Practices in maintenance of passport data
4. Practical study on *ex situ* conservation methods
5. Practical study on *in situ* conservation methods
6. Methods of seed storage for short and long term conservation
7. Methods of conservation using vegetative propagules
8. *In vitro* conservation protocols
9. Study of species diversity in horticultural cropping system
10. Visit to regional conservation centres
11. Visit to tropical and temperate vegetable farms
12. Characterization of tomato germplasm
13. Characterization of brinjal germplasm
14. Characterization of okra germplasm
15. Identification of minor vegetable crops and their description
16. Use of molecular tools for characterizing species diversity

17. Estimating extend of diversity through collection and analysis of data

Course outcome

CO 1- The student would be expected to learn about the significance of germplasm.
CO 2- To appreciate about present status of gene centre, germplasm availability and data base of vegetable crops in India.
CO 3- To gain understanding about germplasm characterization using a standard DUS test protocol.
CO 4- To appreciate various techniques used in the conservation of germplasm.
CO 5- To acquire knowledge about benefits of GI protection and GI tagged fruit varieties in India.

CO – PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	2	2	2	2
CO 2	2	2	1	2	1
CO 3	2	2	2	3	2
CO 4	3	2	2	2	1
CO 5	3	2	2	2	1

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VSC - 607 BIOTECHNOLOGICAL APPROACHES IN VEGETABLE CROPS (2+1)

Learning objectives

- To provide an insight into the basic principles of biotechnology
- To impart knowledge on various techniques of biotechnology and their applications.
- To impart knowledge on genetic engineering techniques
- To gain information regarding the molecular markers and their thrust in Horticultural biotechnology

Theory

Unit –I: Importance, history and scope of biotechnology

Importance and scope of biotechnology – in vegetable crop improvement. In vitro culture, micropropagation, anther culture, pollen culture, ovule culture, embryo culture, endosperm culture.

Unit–II: Techniques of tissue culture -I

Somatic embryogenesis - somaclonal variation and synthetic seed production, protoplast isolation, culture, manipulation and fusion. Somatic hybrids and cybrids and their application in vegetable improvement programme.

Unit–III: Techniques of tissue culture -II

Blotting techniques, DNA fingerprinting-Molecular markers/DNA based markers and role. RFLP, AFLP, RAPD, SSR, SNPs, DNA probes. QTL mapping. MAS and its application in vegetable crop improvement. Allelemining by TILLING and Eco-TILLING.

Unit–IV: Genetic Engineering and Molecular techniques

Plant genetic engineering - Scope and importance, Concepts of cisgenesis, intragenesis and transgenesis. Gene cloning, direct and indirect methods of gene transfer. Role of RNAi based gene silencing in vegetable crop improvement. Bio-safety issue, regulatory issues for commercial approval.

Unit–V: Genetic Engineering and Molecular Techniques

Concepts and methods of next generation sequencing (NGS) – Genome sequencing, transcriptomics, proteomics, metabolomics, Genome editing (ZFN, TALENS and CRISPER) Crops: Solanaceous crops, Cole crops, Cucurbitaceous crops, Root vegetables, Garden pea, Onion, Potato and Leafy vegetables.

Practical

Tissue culture laboratory organization – aseptic manipulation – culture media preparation – inoculation of explants for clonal propagation – shoot tip, meristem – callus initiation and multiplication – sub-culturing techniques – regeneration of plants – techniques of anther and ovule culture – somaclonal variation – *in-vitro* mutation – selection for abiotic stresses – development of protocols for mass multiplication – project development for establishment of commercial tissue culture laboratory

Lesson plan

1. Biotechnological approaches in vegetable crop improvement
2. Anther, Pollen, Ovule & Embryo culture in vegetable crops
3. Endosperm and meristem culture in vegetable crops
4. Wide hybridization and embryo rescue techniques in vegetable crops

5. Somatic embryogenesis in vegetable crops
6. Somaclonal variation for vegetable crop improvement
7. Micro-grafting in vegetable crops
8. Protoplast isolation, culture and fusion in vegetable crops
9. Somatic hybrids and their application in vegetable crop improvement
10. Biotechnological approaches in vegetable crop improvement
11. Isolation of secondary metabolites in *in vitro* culture of vegetable crops
12. Cryopreservation and its application in vegetable crops
13. Synthetic seed production in vegetable crops
14. Importance and application of Blotting techniques
15. Importance and application of DNA finger printing
16. Importance of molecular markers
17. **First Test**
18. Application of DNA based markers in vegetable crops-I
19. Application of DNA based markers in vegetable crops-II
20. Importance of QTL mapping in vegetable crop improvement
21. MAS and its application in vegetable crop improvement.
22. Allele mining by TILLING and Eco-TILLING.
23. Plant genetic engineering - Scope and importance
24. Concepts of cisgenesis, intragenesis and transgenesis.
25. Application of transgenics in development of varieties for resistance
26. Application of transgenics in development of varieties for quality improvement
27. Gene cloning techniques
28. Application of genome editing in vegetable crop improvement
29. Role of RNAi based gene silencing in vegetable crop improvement.
30. Bio-safety, regulatory issues for commercial approval.
31. Concepts and methods of next generation sequencing (NGS)
32. Transcriptomics in vegetable crop improvement
33. Proteomics and Metabolomics in vegetable crops
34. **Final examination**

Practical

1. Introduction to micropropagation
2. Invitro shooting and rooting
3. Pollen culture method
4. Ovule culture method
5. Embryo culture method
6. Synthetic seed production
7. Induction of *invitro* mutation
8. Hardening of plantlets
9. Isolation of DNA from economically important vegetable crop varieties
10. Quantification and amplification of DNA
11. DNA profiling
12. Protein profiling
13. Use of molecular markers for characterization
14. Genetic transformation techniques
15. Genome editing procedures
16. Visit to commercial TC units
17. Project preparation for establishment of low, medium and high cost tissue culture laboratories

Course outcome

CO 1- To understand about somatic embryogenesis and their application in vegetable crop improvement.
CO 2-The student will learn different biotechnological tool used in the crop improvement.
CO 3- To know the role of RNAi based gene silencing in vegetable crop improvement.
CO 4- To learn concepts and advanced methods of tissue culture technology.
CO 5- The student would be expected to learn biotechnical advancement in vegetable crops.

CO - PO Mapping matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	2	2	1	1
CO 2	3	2	2	2	2
CO 3	3	2	2	3	2
CO 4	3	3	3	3	3
CO 5	3	2	2	3	2

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VSC – 608 ADVANCED LABORATORY TECHNIQUES FOR VEGETABLE CROPS (1+2)

Learning objective

- To familiarize with the laboratory techniques for analysis of vegetable crops.
- To understand the safety measures and laboratory maintenance.
- To know the qualitative and quantitative analysis method.
- To gain the knowledge on basic chromatographic techniques.
- To gain comprehensive knowledge on sensory analysis technique.

Theory

Unit -I: Safety measures and laboratory maintenance

Safety aspects and upkeep of laboratory, sampling procedures for quantitative analysis, determination of proximate composition of horticultural produce. Standard solution, determination of relative water content (RWC), physiological loss in weight (PLW), calibration and standardization of instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.

Unit -II: Destructive and non-destructive analysis methods

Refractometry, spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars and starch in food crops.

Unit -III: Chromatographic analysis

Basic chromatographic techniques, GC, HPLC, GCMS, Electrophoresis techniques, ultra filtration. Application of nuclear techniques in harvested produce.

Unit -IV: Microscopic analysis

Advanced microscopic techniques, ion leakage as an index of membrane permeability, determination of biochemical components in horticultural produce.

Unit -V: Sensory analysis

Importance of ethylene, quantitative estimation of rate of ethylene evolution, using gas chromatograph (GC). Sensory analysis techniques, control of test rooms, products and panel.

Practical

Accurate quality analysis of vegetables warrants stringent measurement protocols besides requisite instruments/ tools and laboratory facilities. Consequently, a specialized course for practicals is designed for imparting basic and applied training on physical and biochemical assessment of the vegetable produce.

Lesson plan

1. Safety measures and laboratory maintenance
2. Sampling procedures for quantitative analysis.
3. Determination of proximate composition of horticultural produce.
4. Standard solutions, relative water content (RWC)
5. Physiological loss in weight (PLW)
6. Instruments, textural properties of harvested produce, TSS, Specific gravity, pH and acidity.
7. Destructive analysis methods – Refractometry, Spectrophotometry.
8. Non-destructive analysis methods.

9. **First Test**
10. Chromatographic analysis – GC, HPLC, GCMS
11. Electrophoresis techniques, ultra filtration
12. Nuclear techniques in harvested produce.
13. Introduction on Advanced microscopic techniques
14. Membrane permeability, biochemical components in horticultural produce.
15. Sensory analysis- Importance of ethylene
16. Rate of ethylene evolution- using gas chromatograph (GC) and Sensory analysis techniques
17. **Final examination**

Practical

1. Safety measures in labs and handling of chemical substances.
2. Common laboratory equipments.
3. Calibration and cleanliness of volumetric glass wares.
4. Methods of expressing strength off solutions
5. Preparation of primary standard solutions and buffer solutions
6. Preparation of standard solutions for nutrient analysis of soil, plant and water.
7. Preparations of different agro-chemical doses for field experiments, preparation of buffer solutions.
8. Handling of instruments
9. Determination of moisture
10. Determination of relative water content
11. Determination of physiological loss in weight
12. Calibration and standardization of instruments
13. Textured properties of harvested produce
14. Determination of TSS,PH,Acidity.
15. Determination of Fibre
16. Determination of protein
17. Determination of Starch Index (SI)
18. Determination of specific gravity for maturity assessment
19. Detection of adulterations in fresh products
20. Detection of adulterations in processed products
21. Introduction on destructive and non-destructive analysis methods
22. Non-destructive determination of colour
23. Non-destructive determination of ascorbic acid
24. Non-destructive determination of vitamins
25. Non-destructive determination of carotenoids
26. Non-destructive determination of sugars and starch
27. Introduction on chromatographic and microscopic analysis
28. Study of basic chromatographic techniques
29. Study of GC, HPLC and GCMS
30. Study of Electrophoresis techniques and Ultra filtration
31. Introduction on advanced microscopes
32. Use of advanced microscope – Fluorescent microscope
33. Use of advanced microscope – Scanning electron microscope
34. Use of advanced microscope – phase contrast microscope

Course outcome

CO 1- The students would be expected to develop skills and expertise on upkeep of

laboratories and methods to operate research equipment's.
CO 2- To make aware on safety measure to be taken and upkeep of laboratory.
CO 3- To gain knowledge on principles and methods of destructive and non-destructive analysis.
CO 4- To gain skill on chromatographic and microscopic analysis
CO 5- To acquire skill on handling of research instruments.

CO –PO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	**2**	**2**	**1**	**2**	**1**
CO 2	**2**	**1**	**1**	**2**	**1**
CO 3	**3**	**2**	**2**	**2**	**1**
CO 4	**3**	**2**	**2**	**2**	**1**
CO 5	**2**	**1**	**2**	**2**	**1**

References

1. AOAC International. 2003. Official methods of analysis of AOAC international. 17th Ed. Gaithersburg, MD, USA, associated of analytical communities, USA.
2. Clifton M and Pomeranz Y. 1988. Food analysis – Laboratory experiments. AVI publications, USA.
3. Linskens HF and Jackson JF. 1995. Fruit analysis. Springer.
4. Leo ML. 2004.Handbook of food analysis, 2nd Ed. Vols. I-III, USA.
5. Pomrenz Y and Meloan CE. 1996. Food analysis – theory and practice. CBS, USA.
6. Ranganna S. 2001. Handbook of analysis and quality control for fruit and vegetable products. 2nd Ed. Tat-McGraw-Hill, New Delhi.
7. Thompson AK. 1995, Postharvest technology of fruits and vegetables. Blackwell sciences. USA.

E-Resources

1. https://www.agr.shizuola,ac.jp
2. https://www.syngenta-us.com
3. https://videleaf.com
4. https://www.iihr.res.in
5. https://cbseacademic,nic.in

COM 601 ADVANCES IN COMPUTER APPLICATIONS (1+1)

Course Objective

- To acquaint the students with open source tool, Latex typesetting language, Python and its usage in the industry

Theory

Unit I Introduction to Latex:

Introduction to Latex – What is Latex – Document Structure, Start Text works, Title, Section, Table of content – Typesetting Text, Font Effects, Coloured Text, Font Size, List, Comments & Spacing, Special Charcters.

Unit II Packages and Classes in Latex:

Inserting Equations – Mathematical Symbols – Table of Content – Generating New Command – Figure handling numbering, List of figure, List of Tables. Packages – Geometry, Hyperref, amsmath, amssymbol – Classes – Article, Book, report - The BibTex file – Inserting Bibliography – Citing – References.

Unit III MS Access:

MSACCESS: Database, concepts and types - Uses of DBMS in Agriculture; creating database.

Unit IV Introduction to Python:

Python Introduction, Technical Strength of Python, Introduction to Python Interpreter and program execution, Using Comments, Literals, Constants, Python's Built-in Data types, Numbers (Integers, Floats, Complex Numbers, Real, Sets), Strings (Slicing, Indexing, Concatenation, other operations on Strings), Accepting input from Console, printing statements, Simple 'Python' programs.

Unit V Using Databases in Python:

Database Programming: Connecting to a database, Creating Tables, INSERT, UPDATE, DELETE and READ operations, Transaction Control, Disconnecting from a database.

Lecture Schedule

1. Introduction to Latex.
2. Document Structure.
3. Classes.
4. Typesetting Text.
5. Inserting Equations
6. Packages and Mathematical Symbols.
7. List of figure.
8. List of Tables.
9. **First Test**
10. Bibliography and References.
11. MS Access Concepts of Database, Creating Database.
12. DBMS in Agriculture.
13. Introduction to Python.
14. Built-in Data types.

15. Strings.
16. Python Console.
17. Database in Python.
18. **Final examination**

Practical Schedule

1. Installation of Latex
2. Basic Latex commands
3. Latex Compilation, Page Layout
4. Building a Latex document, Previewing first.tex
5. Addition of some text in the.tex file, Finding the error and fixing it
6. Type setting of mathematics
7. Writing equations, matrix
8. Two figure next to each other, Formation of table
9. Typesetting with a new chapter heading, List of figures, List of tables
10. Citation, Bibliography, printing your document
11. MSACCESS: Creating Database, preparing queries and reports
12. MSACCESS: Demonstration of Agri-information system
13. Introduction to Python, Working with Data
14. Program Organization, Functions, and Modules, Classes and Objects
15. Inside the Python Object System
16. Testing, Debugging Practice Packages
17. Software Development Practice Packages

Course Outcome:

CO 1: Problem solving and programming capability
CO 2: Analyse common problems using Latex
CO 3: Learn categories of programs
CO 4: Construct and execute basic programs in Python
CO 5: Use external libraries and packages with Python

CO-PO Mapping Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	**3**	**3**	**1**	**1**	**2**
CO 2	**3**	**3**	**2**	**1**	**2**
CO 3	**3**	**3**	**2**	**2**	**3**
CO 4	**3**	**3**	**2**	**3**	**3**
CO 5	**3**	**3**	**2**	**3**	**3**

Suggested Reading

1. Introduction to Latex by Tobias Oetiker
2. LaTeX: A Document Preparation System, 2nd Edition By Leslie Lamport
3. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley, 2015
4. Python Programming- A modular Approach (with Graphics, database, Mobile and Web Applications by Sheetal Taneja and Naveen Kumar, Pearson.
5. Head First Python by Paul Berry, O’Reilly

e- Resources

1. https://www.overleaf.com/learn/latex/Bibliography_management_with_bibtex
2. https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management.
3. https://wiki.python.org/moin/PythonBooks.
4. https://devfreebooks.github.io/python/
5. https://www.digitalocean.com/community/books/digitalocean-ebook-how-to-code-in-python.

STA 601 ADVANCES IN DESIGN OF EXPERIMENTS (2+1)

Course Objective

- To acquaint the students to understand the concepts of statistical hypothesis, design of experiments, statistical methods, data collection, analysis and interpretation of results and to acquire Multivariate Statistical Analysis skills.

Theory

Unit–I: Sampling Techniques

Concept of sampling: Sampling vs complete enumeration. Planning of sample survey. Sampling from a finite population. Simple random sampling. Inverse sampling. Stratified sampling. Cluster sampling. Systematic sampling. Multistage sampling. Double sampling. Ratio and regression method of estimation. Non-sampling errors. Concept and levels of measurement. Non-parametric tests - Sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal-Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

Unit–II: Statistical Methods

Classification, tabulation and graphical representation of data. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial, Normal distributions and their applications. Concept of sampling distribution: t, chi-square and F distributions. Tests of significance based on normal, t, chi-square and F distributions.

Unit–III: Correlation and Regression Analysis

Correlation, Rank correlation, Correlation ratio, Intra-class correlation. Test of significance of correlation coefficient. Coefficient of determination.- Path analysis - Regression analysis, Partial and multiple correlation and regression. Estimation of parameters. Predicted values and residuals. Introduction to multivariate analytical tools. Test of hypothesis on means, Multivariate analysis of variance and covariance, Cluster analysis, Classification by linear discriminant function, Canonical correlations, Principal components, Factor analysis, multi-dimensional scaling and Correspondence Analysis. Hierarchical clustering. Principal component analysis.

Unit–IV: Experimental Designs

Need for design of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom - Completely randomized design, randomized block design and Latin square design.

Unit–V: Factorial Experiments

Factorial experiments : Layout and analysis of factorial experiments – complete block design – split – plot design : strip-plot design : split split –plot design. Resolvable block designs and their applications. Randomization procedure, analysis and interpretation of results. Analysis of covariance. Missing plot technique and its application to RBD, LSD. Factorial experiments (symmetrical as well as asymmetrical). Factorial experiments with control treatment. Groups of experiments. Transformation of data. Current trends in design

of Experiments.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution. Correlation and regression analysis. Fitting of orthogonal polynomial regression. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests. Analysis of data obtained from CRD, RBD, LSD. Analysis of Covariance, Analysis of factorial experiments without and with confounding, Analysis with missing data. Split plot and strip plot designs. Groups of experiments, Transformation of data. Exercises on various Non-parametric tests; Random sampling, Use of random number tables, Simple random sampling, Determination of sample size, Exercises on Inverse sampling, Stratified sampling, Cluster sampling and Systematic sampling, Estimation using Ratio and regression estimators, Estimation using Multistage design and Double sampling.

Lecture Schedule

1. Classification, tabulation and graphical representation of data.
2. Descriptive statistics.
3. Theory of probability. Random variable and mathematical expectation.
4. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial.
5. Normal distributions and their applications.
6. Concept of sampling distribution: t, chi-square and F distributions.
7. Tests of significance based on normal, t, chi-square and F distributions.
8. Correlation, Rank correlation, Correlation ratio.
9. Intra-class correlation. Test of significance of correlation coefficient.
10. Coefficient of determination.
11. Path analysis.
12. Regression analysis.
13. Partial and multiple correlation and regression.
14. Estimation of parameters. Predicted values and residuals.
15. Introduction to multivariate analytical tools.
16. Test of hypothesis on means, Multivariate analysis of variance and covariance.
17. **First Test**
18. Cluster analysis, Classification by linear discriminant function.
19. Canonical correlations, Principal components.
20. Factor analysis, multi- dimensional scaling and Correspondence Analysis.
21. Hierarchical clustering.
22. Principal component analysis.
23. Need for design of experiments, characteristics of a good design.
24. Basic principles of designs - randomization, replication and local control.
25. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom.
26. Completely randomized design, randomized block design and Latin square design.
27. Factorial experiments: Layout and analysis of factorial experiments.
28. Complete block design – split – plot design.
29. Strip-plot design: split –plot design.
30. Resolvable block designs and their applications.
31. Randomization procedure, analysis and interpretation of results.

32. Analysis of covariance. Missing plot technique and its application to RBD, LSD, Factorial experiments (symmetrical as well as asymmetrical).
33. Factorial experiments with control treatment. Groups of experiments. Transformation of data.
34. **Final examination**

Practical schedule

1. Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests.
2. Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval.
3. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution.
4. Correlation and regression analysis.
5. Fitting of orthogonal polynomial regression.
6. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests.
7. Analysis of data obtained from CRD, RBD, LSD.
8. Analysis of Covariance.
9. Analysis of factorial experiments without and with confounding, Analysis with missing data.
10. Split plot and strip plot designs. Groups of experiments, Transformation of data.
11. Exercises on various Non-parametric tests.
12. Random sampling, Use of random number tables, Simple random sampling, Determination of sample size.
13. Exercises on Inverse sampling, Stratified sampling.
14. Cluster sampling and Systematic sampling.
15. Estimation using Ratio and regression estimators.
16. Estimation using Multistage design and Double sampling.
17. Practical Examination.

Course Outcome

CO 1: Gaining knowledge on basic and recent concepts of statistical methods
CO 2: Proficiency in data Collection, analysis and interpretation of results
CO 3: Understanding the testing of statistical hypothesis
CO 4: Knowledge on multivariate statistical analysis
CO 5: Design of experiments in agricultural field and data for analysis

CO – PO Mapping Matrix

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	1	1	1
CO 2	3	3	2	1	2
CO 3	3	3	2	1	2
CO 4	3	3	1	1	3
CO 5	3	3	1	1	2

Suggested Reading

1. Agarwal, B. L. 2003, Basic Statistics, New Age International. New Delhi.
2. Anderson, T.W. 1958. *An Introduction to Multivariate Statistical Analysis.*

John Wiley, New Delhi.
3. Bansil, P.C. 2002. *Agrl. Statistics*. CBS Publishers. New Delhi.
4. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. 1994. *Time Series Analysis: Forecasting and Control*. Pearson Education, Delhi.
5. Campbell, R.A. 1974. *Statistics for Biologists.* Cambridge University Press. New York.
6. Cochran, W.G. and Cox, G.M. 1957. *Experimental Design.* John Wiley and Sons Inc. New York.
7. Das, M. N. and Giri, N.C. 1986. *Design and Analysis of Experiments.* New Age International. New Delhi
8. Federer, W.T. 2002. *Statistical Design and Analysis of Intercropping Experiments.*
   Springer-Verlag. New York
9. Gomez and Gomez. 1984. *Statistical procedure for Agrl. Research.* Wiley-interscience. New York
10. Gupta, S.P. 2004, Statistical Methods, S. Chand and Sons. New Delhi. Singh R and Mangat N.S. 1996. *Elements of Survey Sampling*. Kluwer Academic Publishers.

NGC 611-RESEARCH AND PUBLICATION ETHICS (2+0)

Learning Objectives:

- To impart knowledge on research ethics, academic conduct and Integrity.
- To sensitize the scholars about their responsibilities to science, society and eco-system.
- To equip the scholars with techniques and skills to avoid ethical misconduct.
- To provide hands on experience in the use various software tools in research and publication process.
- To acquaint participants with tools and techniques popularly utilized for ensuring academic standards, avoiding plagiarism, and promoting high impact publication.

Theory

Unit-1: Philosophy, Ethics & Scientific Conduct

Introduction to philosophy: definition, nature and scope, concept, branches - Ethics**:** definition, moral philosophy, nature of moral judgments and reactions - Ethics with respect to science and research - Intellectual honesty and research integrity - Scientific misconducts**:** Falsification, Fabrication, and Plagiarism (FFP) - Redundant Publications**:** duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data

Unit- 2: Publication Ethics

Publication ethics: definition, introduction and importance - Best practices/ standard setting initiatives and guidelines: COPE, WAME, etc. - Conflict of Interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, complaints and appeals - Identification of publication misconduct, complaints and appeals - Predatory publication and journals

Unit- 3: Open Access Publishing

Open access publication and initiatives - SHERPA/RoMEO Online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder / journal suggestion tool viz. JANE, Elsevier Journal Finder, Springer Journal Suggestion, etc.

Unit -4: Publication Misconduct

Group Discussions - Subject specific ethical issues, FFP, authorship - Conflicts of interest - Complaints and appeals: examples and fraud from India and abroad - Software tools - Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

Unit -5: Databases and Research Metrics

Databases - Indexing databases - Citation databases: Web of Science, Scopus, etc., - Research Metrics (Journal) - Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score - Research Metrics (Author) - Metrics: h- Index, i10 index, altimetric.

Lecture schedule

1. Introduction to the philosophy: definition, nature and scope,

2. Concept, branches of Philosophy
3. Ethics: definition, moral philosophy, rational and non-rational approaches to ethical issues
4. Nature of moral judgments and reactions
5. Research Process-Research ethics and Guiding principles-Research Ethics Committee-Animal Ethics Committee-Approval
6. Intellectual honesty and research integrity
7. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)-
8. Factors facilitating scientific misconducts
9. Ethics and Trust: Anonymity, Confidentiality, Conflicts of interest/role/values/ ownership and Competing interest
10. Literature search- Print, Online, key words- boolean search- Inflibnet-E-databases
11. Fundamentals of manuscript preparation
12. Technical writing skills
13. Publication ethics: definition, introduction and importance
14. Best practices/ standard setting initiatives and guidelines: COPE, WAME, etc
15. Publication misconduct: definition, Authorship-Redundant publications:
16. Duplicate and overlapping publication, Salami slicing
17. **First test**
18. Selective reporting and misrepresentation of data
19. Violation of publication ethics, authorship and contributor ship
20. Identification of publication misconduct, complaints and appeals: examples and fraud from India and abroad-
21. UGC and University guidelines and Punishment
22. Software tools - Use of Reference Management Tools to avoid plagiarism and automation of bibiliography
23. Software tools - Use of plagiarism software like Turnitin, and Urkund
24. Other open source software tools
25. How to publish in scholarly journals?- Open access publication and initiatives-
26. UGC- CARE List-Predatory publication journals
27. Databases -Indexing databases
28. Citation databases: Web of Science, Scopus, etc
29. Journal Metrics- (c) Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
30. SHERPA/RoMEO Online resource to check publisher copyright & self-archiving policies
31. Software tool to identify predatory publications developed by SPPU
32. Journal finder / journal suggestion tool viz. JANE, Elsevier Journal Finder, Springer Journal Suggestion, etc.
33. How to share the publications and know the impact? And Author Metrics: Author ID-OrcidID- h- Index, i10 index, altmetrics
34. **Final examination**

Course Outcomes:

CO 1: Will be able to identify the ethical issues in research process based on the concept of philosophy and ethics.

CO 2: Will be able to avoid scientific misconduct like fabrication, falsification and fraud in the research process by following the recommended guidelines.

CO3: Will be able to use tools like Reference Management, Journal Identification, Open Access, Plagiarism Checker and avoid misconduct.

CO4: Will be able to communicate the research findings in approved journals with high journal metrics and also improve the author metrics.

Suggested Reading

1. Barbara H. Stanley, Joan E. Sieber and Gary B. Melton.1996. Research Ethics: A Psychological Approach. University of Nebraska Press
2. Jeffrey A. Gliner, George A. Morgan and Nancy L. Leech.2009. Research Methods in Applied Settings: An Integrated Approach to Design and Analysis. Routledge; 2nd edition
3. Joel Lefkowitz. 2017. Ethics and Values in Industrial-Organizational Psychology. Routledge
4. Sidney Hook, Paul Kurtz, and Miro Todorovich.1977. The Ethics of Teaching and Scientific Research. Prometheus Books