## BRIEF HISTORY OF THE PG PROGRAMME

The post graduate (PG) programme (2-year M.Sc. in Agriculture) was first initiated in the discipline of Agronomy in 1977. Thereafter, M.Sc. (Ag.) programmes were started in disciplines like Plant Protection in 1989, Agricultural Extension in 1990, Horticulture in 1997 and Soil Science and Agricultural Chemistry in 2002. M.Sc. (Ag.) in Genetics and Plant Breeding and M.Sc. in Poultry Science were also initiated in 2015-16 and 2016-17 academic session, respectively. M.Sc. (Ag.) in Plant Protection was amended to offer M.Sc. (Ag.) in Agril. Entomology and M.Sc. (Ag.) in Plant Pathology from the academic session 2017-18. Altogether a total of 80 seats are being offered in Masters Programme in Agriculture in eight disciplines (17 in Agronomy, 11 each in Agril. Extension, Horticulture, Soil Science & Agril. Chemistry, 7 each in Agril. Entomology, Plant Pathology and Genetics & Plant Breeding and 9 students in Poultry Science) during 2019-20 academic session. Twenty-five percent seats are filled through ICAR. The teaching programmes at PG level are being implemented following BSMA guideline of ICAR.

## M. Sc. (Ag.) ORDINANCE

**Preamble:** As per suggestions from the UGC, ICAR and the Academic Council, Visva-Bharati (vide Ref. No. Aca. S-19.2/174/2009-10 dt. 08.05.09 on introduction of Semester System including the Choice Based Credit System wherever possible) at the Post-graduate Level the New Ordinance has been set forth. The said ordinance has been amended in the meeting of Academic Council held on 14.11.2017 vide agenda No 17: Approval of amendment in M.Sc. (Ag.). The existing ordinance is given under.

**Contents**



**Notes:** Adhyaksha- Principal/ Dean; Bhavana- Institute of Agriculture; HOD- Head of the Department; BOS- Board of Studies; PPW- Plan of Post-graduate Work; ORW- Outline of Research Work; GP- Grade Point; OGPA- Overall Grade Point Average.

### 1. General:

a. There shall be subjects of studies for the Master of Science in Agriculture *i.e.* a) M. Sc. (Ag.) in Agronomy, b) M. Sc. (Ag.) in Soil Science and Agril. Chemistry, c) M. Sc. (Ag.) in Agril. Extension, d) M. Sc. (Ag.) in Plant Pathology, e) Agricultural Entomology f) Genetics and Plant Breeding and g) M. Sc. (Ag.) in Horticulture at Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan. Introduction of any new subject(s) of studies in PG Level at the Institute will be made in due course without modification of the ordinance Part-I: (Rules and regulations).

b. The Post-graduate Degree courses of two-year duration comprising four semesters will run under "Course and Credit System".
c. A candidate seeking admission to M. Sc. (Ag.) Programme is required to produce a certificate that he / she has passed the four-year B. Sc. (Ag.) Honours degree examination of Visva-Bharati or equivalent examination recognized by the ICAR and/or the UGC. The other eligibility criteria like percent of marks, OGPA etc. will be decided as per University guidelines, which may vary from time to time. However, for the ICAR nominated candidates, the eligibility criteria adopted by the ICAR will be followed as such.
d. The candidate admitted for admission to the M.Sc. (Ag.) Programme in various disciplines shall abide by the regulations regarding the course curricula and the academic standards as prescribed by the University from time to time.
e. The medium of instruction and examination shall be in English.
f. **Department and major field of specialization**: Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati offers Master's degree in the following programmes with major subjects in:

| M. Sc. (Ag.) in | Major subject (s) |
|---|---|
| Agronomy | Agronomy |
| Soil Science & Agricultural Chemistry | Soil Science and Agricultural Chemistry |
| Agricultural Entomology | Agricultural Entomology |
| Plant Pathology | Plant Pathology |
| Agricultural Extension | Agricultural Extension |
| Horticulture | Fruit Science / Vegetable Science |
| Genetics and Plant Breeding | Genetics and Plant Breeding |

g. The following subjects are also considered for minor and or supporting subjects in different M.Sc. Programmes
   i. Agricultural Statistics
   ii. Crop Physiology
   iii. Agricultural Engineering
   iv. Agricultural Economics

2. **Standing Committee (PG Programme):**
   a. A Standing Committee (PG Programme) shall be formed for examining the issues related to M. Sc. (Ag.) Programme of the Institute.
   b. The composition of the Standing Committee (PG Programme) shall be
      i. Chairman: A Senior Professor appointed by the Principal of the Institute.
      ii. Head(s) of the Department(s).

      a) Vice-Principal: may act as liaison to the Principal and other members.

b) Departments offering course in M. Sc. (Ag.) Programme will have their PG Coordinator *i.e.* Agronomy, Soil Science & Agricultural Chemistry, Agricultural Entomology, Plant Pathology, Agricultural Extension, Horticulture & Post Harvest Technology, Genetics and Plant Breeding, Agricultural Statistics, Crop Physiology, Agricultural Engineering and Agricultural Economics

c. Function of Standing Committee (PG Programme) may include:
   i. Looking after the general work of M. Sc. (Ag.) Programme of the Bhavana.
   ii. Reviewing academic standards including syllabus, examinations etc.
   iii. Looking after matters related to examinations, evaluation etc.

3. **PG Coordinator**:
   a. BOS / Departmental Committee of the concerned Department offering M. Sc. (Ag.) Programme(s), may select a faculty member as a PG Coordinator for each course.
   b. The PG Coordinator(s) will look after smooth running of M. Sc. (Ag.) Programme of the concerned Department (s).

4. **Academic Session and Semester Calendar**:

a. The duration of M. Sc. (Ag.) Programme(s) shall be of two academic years consisting of four semesters. The maximum allowable semesters for completion of any M. Sc. (Ag.) Programme is eight (8).

b. The academic year of M. Sc. (Ag.) Programme shall be in terms of two semesters in a year.

The odd semesters (*i.e.* First and Third) shall run in the first half of an academic year and even semesters (*i.e.* Second and Fourth) shall run in the second half of the same academic year. The broad schedule of two semesters is

| | |
|---|---|
| Odd semesters (I & III) | : July to December |
| Even semesters (II & IV) | : January to June |

c. The commencement of each semester in a particular academic year shall be decided by the Standing Committee (PG Programme) from time to time.

d. There shall be no semester break but summer and autumn recesses and enlisted holidays will be followed as prescribed by the University.

5. **Courses:**

a. Code: Each course shall bear a distinguishing code (three letters and three digits) that identifies the discipline from which it is being offered.

b. Code numbers:
   i. All Master's level courses shall ordinarily belong to 500-series.
   ii. Credit seminar shall be designated by Code No. 591
   iii. Master's research (Thesis) shall be designated by Code No. 599.

c. There shall be two types of courses, "**credit courses**" and "**non-credit courses**". Grade points obtained only in 'credit courses' will be considered for the classification of

results. Performance in non-credit courses including Thesis will be as "Satisfactory / Non-satisfactory"

d. There shall be four types of credit courses, "**only theory courses**", "**only practical courses**", "**composite courses**" and "**credit seminar**". The composite courses will consist of both theory and practical components.

e. The distribution of marks in various courses of M. Sc. (Ag.) shall be:

| | | | |
|---|---|---|---|
| i. | **For 'Only theory courses'** | | |
| | Semester Terminal Examination | : | 80 |
| | Internal Assessment | : | 20 |
| | **Total** | **:** | **100** |
| ii. | **For 'Only practical courses'** | | |
| | Semester Terminal Practical Examination | : | 80 |
| | Internal Assessment | : | 20 |
| | **Total** | **:** | **100** |
| iii. | **For 'Composite courses' i.e. Theory & Practical (70:30)** | | |
| | Semester Terminal Theory Examination | : | 50 |
| | Internal Assessment (Theory) | : | 20 |
| | Semester Terminal Practical Examination | : | 30 |
| | **Total** | **:** | **100** |
| iv. | **For 'Credit seminar'** | **:** | **100** |

f**. Internal assessment**:

Internal assessment will be done in the form of **Continuous Evaluation** having at least two tests of different forms (tutorial, class test as Objectives, essay, viva-voce, quiz type, assignment / term paper, class seminar, group discussion, interaction, small projects etc.) per course. The tests should be spread throughout the Semester but 15 days before the commencement of Terminal Examination. At least 50 % weightage should be on written form of tests. In case of the student who fails to appear in the Terminal examination of a given semester but appears in Internal Assessment (continuous evaluation) of the courses, marks of internal assessment of the student will remain valid during his/her next chances but if a student remains absent or scores low or nil marks even in internal assessment, he/she will not be permitted to reappear for internal assessment after the semester is over.

Within 15 days of conducting the Tests, the Course Leaders will submit marks in the prescribed form in duplicate to the HOD who will sign on both the copies, keep one copy for office use and forward the other copy to the Deputy Registrar (Examinations). The marks of the Internal Assessment should be displayed in the concerned Department for at least seven days before forwarding the same to the Deputy Registrar (Examination). Once the marks of the Internal Assessment are submitted to the Deputy Registrar (Examination) by the Department, the marks cannot be corrected or changed.

g. Marks scored in Internal Assessment are to be mentioned separately in the Mark sheet.

h. Courses:

i) **Major courses**: The discipline in which the student shall pursue major study in his/her Master's Programme.

ii) **Minor courses**: The discipline closely related to a student's major discipline. Split minors will be permissible.

iii) **Supporting courses**: It could be any discipline excluding major considered relevant for student's research work or necessary for building his/her overall competence.

iv) **Non-credit compulsory courses**: Courses are of general nature and are compulsory for M. Sc. (Ag.) Programme. Students' require to complete six courses as stated below:

| CODE | COURSE TITLE | CREDITS |
|---|---|---|
| PGS 501 | Library and Information Services | 0+1 |
| PGS 502 | Technical Writing and Communication Skills | 0+1 |
| PGS 503 (e-Course) | Intellectual Property and its management in Agriculture | 1+0 |
| PGS 504 | Basic Concepts in Laboratory Techniques | 0+1 |
| PGS 505 (e-Course) | Agricultural Research, Research Ethics and Rural Development Programmes | 1+0 |
| PGS 506 (e-Course) | Disaster Management | 1+0 |

i. One credit hour indicates one hour lecture or two hours practical work per week for the entire semester.

6. **Credit Requirements**:

a. A student is required to complete a minimum of 55 credits of which 35 credits shall be of course work and 20 credits shall be allocated for the research (Thesis) work. In addition six (6) non-credit compulsory courses as mentioned in 5 h iv are required to be completed.

b. A student's programme of studies shall not be more than 25 credits in any semester.

c. The total course and credit requirements for obtaining Master's Degree shall be:

| Particulars | Minimum Credits |
|---|---|
| **i) Course Work** | |
| **Major courses** | **20** |
| Minor courses | 09 |
| Supporting courses | 05 |
| Seminar | 01 |
| Research | 20 |
| **Total** | **55** |

d. In addition to above a candidate may be permitted to opt for required number of credits from optional major courses and minor or supporting courses as suggested the Chairman of Advisory Committee.

7. **Course Regulation**:

a. The courses to be offered in a particular academic year or semester shall be decided by the BOS /HOD based on available facilities and faculty strength.
b. Allotment of courses, designating faculties as Course Leader and Course Associates shall be decided by the BOS /HOD well in advance of the commencement of a semester. The Course Leader will be in rotation considering the workload of each teacher associated with a particular course.
c. Towards introduction of a new course or revision of course, University rules will be followed.
d. There shall be no rigid rule or guideline regarding the minimum number of students required for offering a course. The course will be offered even for a single student.
e. There shall be the provision of inviting the Guest Lecturers to deliver lecture on some highly specialized topics if required.

8. **Course Registration**: The students will have to submit their choices for course(s) for a particular Semester in writing (in prescribed format) to the HOD through the Major Advisor and PG Coordinator of concerned Department at least one week before the commencement of classes of the said Semester. Students intending to change the Course opted for once will be allowed to do so in the same process within 15 days after the initial Registration.

9. **Advisory Committee:**

a. The Advisory Committee consisting of at least three members from both major and minor subjects shall be constituted for each student.
b. Every student shall have a Major Advisor who shall be from the Major Field to which the student has been admitted. The Major Advisor shall function as the Chairman of the Advisory Committee.

c. The nomination for Chairman of the Advisory Committees of all newly admitted students shall be completed within four weeks of the first Semester by the HOD.
d. The Advisory Committee of the student should meet frequently to monitor the progress of the student.
e. A proposal for the formation of the students' Advisory Committee along with the Plan of Post-graduate Work (PPW) shall be forwarded in the prescribed proforma to the HOD for approval within six weeks from the date of admission of the student.
f. The Major Advisor will select other members of the student's Advisory Committee (with the knowledge and consent of the members concerned). Co-advisor shall be from the major field of study / specialization of the concerned Department; Member(s) one each from the Department(s) offering Minor Courses; and Member(s), from any discipline, if Major Advisor feels it necessary for the student's Thesis work.
g. Co-advisor will act as the Major Advisor of the concerned student if the original Chairman is not available due to one or more reasons (death, leaving the university, prolonged absence, ill health etc.)
h. Replacement of members of the Advisory Committee: The Chairman of the concerned student after consultation with the HOD can replace any member of the Advisory Committee due to one or more reasons as stated in Para 9. g above.
i. In case of newly admitted students, the HOD will discharge the functions of the Chairman of the Advisory Committee till the Chairman is selected as per procedure prescribed above.
j. A faculty member having a minimum of one year teaching/ research experience or Doctoral degree can be the Chairman of the Advisory Committee.

10. **Plan of Post-graduate Work (PPW):**

a. The programme of studies indicating the PPW of each student in prescribed format shall be finalized by his / her Advisory Committee to provide considerable latitude in the choice of courses, taking into account the requirement for research in that particular field.
b. The broad research topic of every student will be mentioned at the time of preparation of PPW. The Advisory Committee should finalize PPW within six weeks of the first Semester.

11. **The Outline of Research Work (ORW)**:

a. The ORW in prescribed format will have to be approved by the Advisory Committee and forwarded by the Chairman of the Committee to the HOD through the PG Coordinator.
b. The ORW will be presented in the Departmental Seminar for discussion and suggestions.

12. **Attendance:**

a. Candidates should have an average attendance of 75% in every Semester to be eligible to appear for the Terminal Examination of a given Semester. Candidates having 60% and more but less than 75% attendance may be allowed to appear in the Semester Examination after paying the requisite fine as decided by the University from time to time.

13. **Paper setting and Evaluation**:

a. In the Semester Terminal examination question papers for at least fifty percent of the courses in each semester shall be set externally but evaluated internally. But for practical courses / component, examination and evaluation will be made by the internal examiner (s).
b. For all the non-credit compulsory courses except Thesis, the paper setting as well as evaluation will be made internally.

14. **Examination and Regulation**:

a. Semester Terminal examinations for odd Semesters shall ordinarily be held in December while for even Semesters be held in the month of June in every academic year. Standing Committee (PG Programme) will fix the period of every Semester Terminal examination preferably at the beginning of the semester. It is also expected that the Semesters of all M. Sc. (Ag.) Programme in the Institute will commence at the same time.
b. The candidates shall be required to pass all the courses mentioned in his/her PPW. He/she also needs to complete required Thesis credit hours within the stipulated period i.e. not more than eight (8) Semesters.
c. Before appearing in the end semester theory and/or practical examinations (both theory and practical examinations for composite courses) the student must pass all the backlog paper(s).
d. There shall be the provision for **Review System** and the evaluation will be done internally. The BOS will recommend the names of three members (HOD and other two members excluding the first examiner) for Review Examination. In case the HOD has evaluated the course, Adhyksha will act as a member in the Board replacing the HOD.
e. The duration for semester Terminal examination of different courses shall be as follows:

| | | |
|---|---|---|
| i. For theory courses | : | 3 hours |
| ii. For practical courses | : | 3 hours or more |

f. The candidates appearing in each Semester Terminal examination of M.Sc. (Ag.) Programme shall: (i) produce a certificate from the HOD that he/she has attended at least 75 % of the in-campus classes. Relaxation, if any, will be guided by the University Ordinance; (ii) produce a certificate from HOD that his/her conduct has been good and that he/she is fit and proper candidate for the examination.
g. A student found adopting unfair means at the examination will be treated heavily and stringent action will be taken as per University rules.
h. No 'make up' examination shall be permitted in lieu of the missed Terminal theory and/or practical examination.
i. If a student fails to appear in any final theory and /or practical examination or does not secure pass marks in any course, he/she requires fresh registration for the course during the next available Semester with that course but the candidate has to complete the degree programme including all the repeat courses within eight (8) Semesters.
j. If a candidate is compelled to drop a Semester on medical ground he/she will be allowed to repeat in the next available Semester. However, he/she has to complete all the courses within eight (8) Semesters.

k. If a student has to drop a course on medical ground but having less than 75 % attendance the student shall be given 'I' grade, i.e. "incomplete", and will be allowed to repeat the course in the next available Semester. The 'I' grade shall be entered in the transcript also. In all other cases dropping of course will be declared 'Fail' in the course.

15**. Fees and other Charges:**

Student admitted to PG Programme shall pay examination fees (as per University guidelines) for each Semester Terminal Examination at the time of filling up of form for the purpose.

16. **Moderation:**

a. A Moderation Committee consists of at least three members may be appointed as per University rule but excluding an external moderator, shall do moderation of question papers for the Terminal Theory Examinations.

b. Separate Moderation Committee shall be formed for each M. Sc. (Ag.) Programme and that may act under the Chairmanship of HOD.

17. **Scrutiny:**

a. There shall be a Scrutiny Committee consisting of HOD and two other teachers of the Department to scrutinize the results of internal assessment, Terminal as well as Review examinations before finalization. The BOS of the concerned Department will approve the Committee.
b. Each PG Programme will have separate Scrutiny Committee that will act independently.

18. **Credit Seminar:**

a. Each student shall be required to deliver a Seminar during the course of studies on a topic relevant to the concerned discipline.
b. Code No. 591 shall be assigned for Credit Seminar.
c. PG Coordinator shall act as Seminar Leader. Otherwise, HOD of concerned Department himself or may select any faculty member as Seminar Leader.
d. Departmental students' Credit Seminar will be an open Seminar.
e. The Seminar Leader in consultation with the HOD shall fix the schedule for the Seminars.
f. The Seminar topic shall not be within the purview of the student's Thesis instead should cover a subject of topical interest.
g. Each student will prepare and distribute copies of 'Abstract' to the persons attending the Seminar. The Abstract (within 300 words) should precisely state the main theme of the talk.
h. **Seminar write-up:** The student shall prepare a full account (not normally exceeding 3000 words) on the topic covered in the seminar and submit to the Seminar Leader on or before the date of presentation of the Seminar.
i. **Seminar evaluation:** Seminar Leader and the members of the Advisory Committee will evaluate the performance of the students, taking into account all the relevant factors like, Introduction, Review of Literature, presentation of subject, capacity to draw general conclusion from literature and ability to answer questions raised and will award marks to the student.

**19. Comprehensive:**

a. Every student has to appear at Comprehensive Examination to be conducted by the Advisory Committee.
b. A candidate should be allowed for comprehensive examination after completion of 75% course work separately in major and minor subject(s) but before the submission of Thesis.
c. Written comprehensive examination consists of one paper in major courses and one paper in minor courses each of three hours duration having 100 marks.
d. Paper setting and evaluation will be done internally.
e. Qualifying marks will be 50% and grading will be Satisfactory/Unsatisfactory. If the performance of a student becomes unsatisfactory he/she has to appear again to a maximum of three more attempts within eight (8) Semesters. Repeat comprehensive test(s) shall be conducted at least with a gap of 30 days of the previous test.
f. The results of comprehensive examination shall be forwarded by the HOD to the Examination Section for record. The grade obtained will not be reflected in the Final transcript.

**20. Thesis:**

a. The thesis for the Master's Degree shall indicate student's potentialities for conducting research.
b. The topic of Thesis will be within the Major field of specialization under the Code No. 599.
c. The subject of the Thesis should be approved by the student's Advisory Committee and the HOD at the time of formation of the student's PPW and then ORW.
d. The Thesis shall be based on the results of the student's own work. A certificate to this effect from the Major Advisor shall accompany the Thesis.
**e.** The Thesis shall preferably follow the following: chapters on Introduction, Review of literature, Materials and Methods, Results, Discussion, Conclusion and Summary, Future scope of research and References.
f. **Thesis Seminar**: A student shall deliver a seminar on the research problem before the submission of Thesis and all the faculty members may be invited to participate in the discussion and make constructive suggestions on the Thesis.
g. **Thesis submission:** After fulfilling the prescribed courses, residential requirements and minimum semester requirements (4 Semesters) and successfully completing the research work to the level of full satisfaction, a student shall submit the Thesis.
h. The Chairman of the student's Advisory Committee shall ensure that all members of the Advisory Committee are duly consulted before submission of the manuscript of the Thesis.
i. Each student shall submit three copies of the Thesis within the date notified by concerned HOD, one copy to deposit to the Institute Library, another to the Departmental Library, third to the Major Advisor.
j. The Thesis shall accompany a certificate to the effect that the work has not been submitted in part or full for any other degree or diploma.
k. The candidate shall submit the Thesis to the concerned HOD along with "no dues certificate" and other formalities.
l. **Thesis Viva-Voce:** An External Examiner shall examine the Thesis. An arrangement for *viva voce* shall be made by the concerned Department by an Examination Committee consisted of External Examiner, HOD and the members of the Advisory Committee of the candidate. The student shall be awarded "Satisfactory" (*i.e.* pass) or "non-satisfactory" (*i.e.* fail) in Thesis Viva-Voce.

m. The grade obtained (*i.e.* Satisfactory / Non-satisfactory) shall be shown in the final transcript but shall not be included for the purpose of calculation of OGPA.
n. In case, the External Examiner suggests modification / re-submission, the student may be permitted to defend his/her thesis in final *viva-voce*, and as such of modifications as are finally agreed upon may be carried out after the *viva-voce*.
o. Re-examination: If a student fails (*i.e.* non-satisfactory) in Thesis he/she may be permitted to continue the work and/or rewrite the Thesis as per comments of the Examination Committee and resubmit it to the HOD with the recommendation of the Chairman of the Advisory Committee for permission to appear a second time. Re-examination shall not take place earlier than three months after the final semester examination but within eight (8) Semesters and as far as possible the Committee as previously constituted, will conduct it. No further re-examination is permissible and a student failing to secure 'satisfactory' grade a second time shall not qualify for the degree.

21. **Rights on Thesis:**
a. The Thesis submitted by a student shall become the property of the Institute.
b. Whenever, an extract from the Thesis is published, there should be an acknowledgement in the form of footnote stating that the results are from the Thesis submitted for the degree from the Institute of Agriculture, Visva-Bharati.
c. All patents, designs and inventions derived from the Thesis research work shall belong to the Institute which may, at its discretion, allow or direct any benefit thereon to be retained by or given to the author of the Thesis.
d. Copies of the Thesis submitted to the Institute Library or in the Departmental Library shall not be issued on loan for a period of two years from the date of submission.
e. In case where student does not take care to publish the Thesis work even after three years of completion of the degree, there stands no objection of the student to publish papers/ articles by the Chairman, Advisory Committee of the concerned student.

**22. Grading System:**
a. There will be a ten point grading system of evaluation with grade point (GP) equals to percent marks obtained divided by 10.
b. The conversion formula will be: Percent of marks = 10 x OGPA
c. Minimum requirement: Grade point (GP) of 5.00 for passing a course and an Overall Grade Point Average (OGPA) of 5.00 for completing the M. Sc (Ag.) Programme. A candidate failing to secure minimum OGPA (5.00) will not be considered for the award of degree and shall be declared as 'failed'. If a candidate fails to secure 40 % marks in Practical examination of composite course he /she will be declared as 'fail' in the concerned course.
d. A candidate failing to obtain minimum GP (5.00) in not more than three courses, in a Semester, will be allowed to repeat the failed course(s) afresh not more than two times in next available Semesters. A candidate failing in more than three courses in a Semester has to repeat the Semester. In any circumstance the student is to complete the degree Programme including all the repeat courses within the maximum of 08 Semesters.
e. Symbols to be used in the Semester Transcript:

| | | |
|---|---|---|
| I | = | Incomplete |
| S | = | Satisfactory |
| NS | = | Non-Satisfactory |

R = Repeat

Specialization of the candidate needs to be mentioned in the Semester Marksheet/Transcript.

**23. Residential Norms:**

a) Residential requirement shall mean presence of the student continuously in working days/hours in the Institute/University (class room for classes, laboratories for practical and/or research, farm for field work, library for collecting information or placed somewhere on duties etc.).

b) The minimum residential requirement shall be of four Semesters from the date of admission to the University. However, with the prior written permission of the HOD / Adhyaksha, PSB through the Chairman a student may be allowed to discontinue after completion of two consecutive Semesters and renew studies even after two Semesters. Completion of semester shall mean clearing of all examinations as scheduled. He /she has to pay annual fees for the University for retention of the studentship.

c) A student may be allowed for discontinuance only by one break and he/she shall have to complete all courses including submission of Thesis within eight semesters from the date of admission to the University, failing which his/her studentship shall be treated as cancelled.

d) A student appealing discontinuance for one or two semester(s) has to vacate hostel accommodation.

## ELIGIBILITY CRITERIA & INTAKE FOR ADMISSION TO M. Sc.(Ag.) COURSE

**POST-GRADUATE [M.Sc. (Ag.)]**

**COURSE CODE : MSC(AG)** **DURATION: 2 YEARS** **COURSE CODE NO: 72**

| Course | Code | Eligibility | | Intake Capacity | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | For general candidates | For OBC candidates | Gen | OBC | SC | ST | EWS | Total |
| Agronomy | 702 | 60% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 54% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 08 | 04 | 02 | 01 | 02 | 17 |
| Horticulture | 703 | 60% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours/B.Sc. (Hort.) Honours | 54% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours/B.Sc. (Hort.) Honours | 05 | 03 | 01 | 01 | 01 | 11 |
| Soil Science & Agricultural Chemistry | 704 | 60% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 54% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 05 | 03 | 01 | 01 | 01 | 11 |
| Agricultural Extension | 706 | | | 05 | 03 | 01 | 01 | 01 | 11 |
| Genetics and Plant Breeding | 707 | | | 03 | 02 | 01 | 00 | 01 | 07 |
| M.Sc. in Animal Science (Poultry) | 708 | 60% marks or equivalent OGPA in B.V.Sc. & A.H./B.Sc. (Ag.) / B.Sc. (Zoology) Honours | 54% marks or equivalent OGPA in B.V.Sc. & A.H./B.Sc. (Ag.) / B.Sc. (Zoology) Honours | 04 | 02 | 01 | 01 | 01 | 09 |
| Agricultural Entomology | 709 | 60% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 54% marks or equivalent OGPA in four years B.Sc. (Ag.) Honours | 03 | 02 | 01 | 00 | 01 | 07 |
| Plant Pathology | 710 | | | 03 | 02 | 01 | 00 | 01 | 07 |
| ICAR Quota within the Institute | | | | 09 | 05 | 03 | 01 | -- | 18 |

**Note:**

i) The eligibility criteria for SC and ST candidates shall be pass marks in the respective qualifying examinations. Other criteria will remain unchanged.

ii) Candidates seeking admission for M.Sc. (Ag.) /M.Sc. Courses report at the venues of the admission tests at least 90 minutes before the commencement of the Admission Tests.

iii) The Admission test for M.Sc. Agriculture /M.Sc. will cover subjects taught in B.Sc. (Ag.) Honours course or relevant subjects as decided by the departments concerned.

iv) However, for ICAR nominated candidates, the eligibility criteria adopted by ICAR will be followed as such.

**For Integrated Candidates:** There shall be a provision to get admission at the undergraduate courses of Palli-Siksha Bhavana for the integrated candidates from Visva-Bharati School system subject to fulfilment of Bhavana criteria.

**C. Modalities of selection for admission:**

1. The admission to different M.Sc. (Ag.) / M.Sc. courses will be made strictly on the basis of separate applications made for the subjects concerned.
2. PWD candidates are also eligible to apply. They should be able to independently carry out the following: (a) to handle different farm tools & implements, laboratory equipment etc. (b) to carry out practical classes (c) to attend RAWE &AIA and EL programmes which is also an integral part of B.Sc. (Hons.) Agriculture degree, at different villages and organizations (d) to follow classroom instructions and lessons normally. If any specialized aids are required, the expenditure for the same has to be borne by the candidate concerned. Candidates claiming reservation in any category must attach required proof/evidence along with application.
3. The qualifying mark in admission test M.Sc. (Ag.)/M.Sc. in different subjects shall be 30% for general candidates and 27% for OBC candidates who may not be applicable in case of SC and ST candidates.
4. All the original mark sheet and testimonials along with one set of self-attested photocopy are to be produces during the time of counselling /admission.
5. **Modality for preparing Merit Lists for M.Sc. (Ag.) /M.Sc. Courses:**
   Marks obtained in admission test out of 100

**D. Submission of Application Forms:**

## SYLLABUS OF PG PROGRAMME

## DEPARTMENT OF AGRONOMY

Courses offered by Department of Agronomy in the M. Sc.(Ag.) programme

| Course No. | Course Title | Credits | Semester |
|---|---|---|---|
| AGR 501* | Modern concepts in crop production | 3 + 0 | I |
| AGR 502* | Principles and practices of soil fertility and nutrient management | 2 + 1 | III |
| AGR 503 * | Principles and practices of weed management | 2 + 1 | I |
| AGR 504* | Principles and practices of water management | 2 + 1 | II |
| AGR 505 | Agrometeorology and crop weather forecasting | 2 + 1 | III |
| AGR 506 | Crop growth analysis and productivity modelling | 1 + 1 | III |
| AGR 507 | Agronomy of major cereals | 2 + 1 | II |
| AGR 508 | Agronomy of pulse crops | 2 + 1 | III |
| AGR 509 | Agronomy of oilseed crops | 2 + 1 | II |
| AGR 510 | Agronomy of fibre, sugar and tuber crops | 2 + 1 | I |
| AGR 511 | Agronomy of medicinal, aromatic and under-utilized crops | 2 + 1 | III |
| AGR 512 | Agronomy of fodder and forage crops | 2 + 1 | II |
| AGR 513 | Agrostology and agro-forestry | 2 + 1 | II |
| AGR 514 | Cropping systems and sustainable agriculture | 2 + 0 | II |
| AGR 515 | Dryland farming and watershed management | 2 + 1 | I |
| AGR 516 | Principles and practices of organic farming | 1 + 1 | II |
| AGR 517 | Crop ecology and geography | 2 + 0 | II |
| AGR 591 | Credit seminar | 0+1 | IV |
| AGR 599 | Master's Research (Thesis) | 0+20 | I to IV |

* core courses

**AGR 501 : Modern concepts in crop production** 3 + 0

**Objectives:**

To teach the basic concepts of soil management and crop production

**Syllabus:**

**Theory**

UNIT I

Crop growth analysis in relation to environment; agro-ecological zones of India, Crop distribution.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming and resource conservation technology including modern concept of tillage; rainfed farming; determining the nutrient needs for yield potentiality of crop plants, concept of balanced nutrition and integrated nutrient management; precision agriculture.

**Learning Outcome:**

Students will get basic idea about crop growth analysis, principles and modern concepts of crop production.

**AGR 502: Principles and practices of soil fertility and nutrient management** 2+1

**Objective**s:

To impart knowledge of fertilizers and manures as sources of plant nutrients and to appraise integrated approach of plant nutrition and sustainability of soil fertility.

**Theory**

UNIT I

Soil fertility and productivity – factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming – basic concepts and definitions.

UNIT II

Criteria of essentiality of plant nutrients; essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

Preparation and use of farm yard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates; their composition, availability and crop responses; recycling of organic wastes and residue management, role of organic matter in maintenance of soil fertility.

UNIT IV

Commercial fertilizers, composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; SSNM, nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; relative performance of organic manures and inorganic fertilizers; economics of fertilizer use; integrated nutrient management; use of fertilizers in intensive cropping systems.

**Practical**

Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils. Determination of total N, P, K and S in plants. Interpretation of interaction effects and computation of economic and yield optima

**Learning Outcome:**

Students will get basic idea about importance of essential elements, nutrient use efficiency and methods of soil nutrient management

**AGR 503: Principles and practices of weed management 2+1**

**Objectives:**

To familiarize the students about the weeds, herbicides and methods of weed management.

**Syllabus:**

**Theory**

UNIT I

Weed biology and ecology, classification, crop-weed competition including allelopathy; principles and methods of weed management; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological, application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure – activity relationship, factors affecting the efficiency of herbicides, herbicide formulations, mixtures, herbicide resistance and management, herbicide rotation, adjuvants, antidotes and protectants, degradation of herbicides in soil, plants and environment; herbicide resistance in crops and weeds, weed management through bio-herbicides, myco-herbicides and allelochemicals; application of biotechnology in weed management.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed management, quarantine regulations of weed management.

UNIT V

Integrated weed management; cost; benefit analysis of weed management.

**Practical**

Identification of important weeds of different crops, Preparation of a weed herbarium, Weed survey in crops and cropping systems, Crop weed competition studies, Calculation of herbicidal requirement, Preparation of spray solutions of herbicides for high and low-volume sprayers, Use of various types of spray pumps and nozzles and calculation of swath width, Economics of weed control, Herbicide residue analysis in plant and soil, Bioassay of herbicide residue, Precautionary measures in herbicide use.

**Learning Outcome:**

Students will get basic idea about weeds, herbicides and methods of management

**AGR 504 : Principles and practices of water management 2+1**

**Objectives:**

The course fulfils the comprehensive knowledge on irrigation water management; the course brings out different aspects of irrigation, drainage, and quality of irrigation water.

**Syllabus:**

**Theory**

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water relations; water retention by soil, soil moisture characteristics; moisture conservation, soil water movement in soil and plants; soil-water-plant relationships; concept of evaporation and evapotranspiration; different approaches of ET determination; development of crop water deficit, plant response to water stress, crop adaptation to water deficit, morpho-physiological effect of water deficit, crop plant adoption to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; principles and methods of irrigation; concepts of irrigation scheduling; different approaches of irrigation scheduling, depth and micro-irrigation system; fertigation; management of water in controlled environments and poly houses.

UNIT IV

Water management of the corps (rice, wheat, sugarcane, potato, mustard, sesame and mung) and cropping systems; quality of irrigation water and management of saline water for irrigation; irrigation and water use efficiency; fertilizer use in relation to irrigation.

UNIT V

Excess of soil water and plant growth; water management in problem soils, drainage requirement of crops and methods of field drainage; water table in relation to crop production, rain water harvesting, storage and recycling.

**Practical**

Determination of soil water by thermo-gravimetric and volumetric methods; Measurement of soil water potential by using tensiometer, pressure plate and membrane apparatus; Determination of evapo-transpiration by Blaney-Criddle and Thornthwaite; Measurement of evaporation by USWB class A pan evaporimeter; Soil moisture characteristics curves; Water flow measurement using different devices; Determination of irrigation requirement; Calculation of irrigation efficiency; Determination of infiltration rate; Laying out fields for irrigation by border strip, check basin and furrow methods; Determination of quality of water; Determination of saturated/unsaturated hydraulic conductivity; Field drainage.

**Learning Outcome:**

Students will be benefitted by this course for deciding irrigation scheduling for crops, crop planning according to the availability of water sources; the course will help the students by handling different instruments of irrigation water management; it will be helpful to ameliorate the problem soil and water for raising crops; students can gather knowledge to check soil and water losses.

**AGR 505 : Agrometeorology and crop weather forecasting 2+1**

**Objectives:**

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

**Syllabus:**

**Theory**

UNIT I

Agro meteorology – aim and development in relation to crop environment; composition of atmosphere, distribution of atmospheric pressure and wind.

UNIT II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies.

UNIT III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation; measures of atmospheric temperature and relative humidity, vapor pressure and their relationships; evapo-transpiration and meteorological factor; determining evapo-transpiration.

UNIT IV

Modification of plant environment; artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon, weather hazards, drought monitoring and planning for mitigation.

UNIT V

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

**Practical**

Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure; Measurement of solar radiation outside and within plant canopy; Measurement/estimation of evapo-transpiration by various methods; Measurement/estimation of soil water balance; Rainfall variability analysis; Determination of heat-unit requirement for different crops; Measurement of crop canopy temperature; Measurement of soil temperatures at different depths; Remote sensing and familiarization with agro-advisory service bulletins; Study of synoptic charts and weather reports, working principle of automatic weather station; Visit to solar observatory.

**Learning Outcome:**

Students will get basic idea about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

**AGR 506 : Crop growth analysis and productivity modelling 1+1**

**Objectives:**

To teach students regarding system approach through growth analysis of crop plants for achieving higher yield.

**Syllabus:**

**Theory**

UNIT I

Crop growth analysis : concept, CGR, RGR, RLGR, NAR, LAD, LAI; validity and limitations in interpreting crop growth and development.

UNIT II

Canopy architecture, light interception and utilization, energy use efficiency optimum LAI, critical and ceiling LAI.

UNIT III

Photosynthetic system, factors influencing transport and partitioning of photosysnthate; source-sink relationships.

UNIT IV
Concept of plant ideotypes, characteristics of ideotype for rice, Maize, Arhar; Physiological basis of yield variation of Rice, Potato, Sugarcane.

UNIT V
Crop growth models – empirical models testing and yield prediction.

**Practical**
Plant sampling for measurement of biomass, LAI, LAD, CGR, NAR; Measurement of light interception, light extinction coefficient and critical LAI; Preparation of growth curves based on growth analysis data; Study of crop growth and productivity modeling based on crop growth analysis data.

**Learning Outcome:**
Students will get basic idea about how to measure growth analysis of crop and crop ideotype.

**AGR 507 : Agronomy of major cereals 2+1**

**Objectives**:
To teach the crop husbandry of cereals.

**Syllabus:**

**Theory**
Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirement, nutrition, quality components, handling and processing of the produce for maximum production of

UNIT I
*Rabi* cereals (wheat, barley, *boro* rice)

UNIT II
*Kharif* cereals (Rice, maize)

**Practical**
Phenological studies at different growth stages of crop; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Working out growth indices (CER, CGR, RGR, NAR, LAD) and competition functions (aggressiveness, relative crowing coefficient, monetary yield advantages and ATER) of prominent intercropping systems of different crops; Preparation of rice nurseries; Planning and layout of field experiments; Intercultural operations in different crops; Judging of physiological maturity in different crops; Determination of cost of cultivation of different crops; Working out harvest index of various crops; Study of seed production techniques in various crops; Visit of field experiments on cultural, fertilizer, weed

and water management aspects; Visit to nearby villages for identification of constraints in crop production.

**Learning Outcome:**

Students will get basic idea about crop husbandry of cereals

**AGR 508 : Agronomy of pulse crops 2+1**

**Objectives:**

To teach the crop husbandry of pulse crops.

**Syllabus:**

**Theory**

Origin and history, area and production, economic importance, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for the maximum production of

UNIT I

*Rabi* pulses (chickpea, pea, lentil and lathyrus)

UNIT II

Summer and *Kharif* pulses (pigeon pea, mung bean, urdbean and cowpea)

**Practical**

Phenological studies at different growth stages of pulse crops; Estimation of crop yield on the basis of yield attributes; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Working out growth indices (LAI, CGR, RGR, NAR, LAD) aggressiveness, relative crowding coefficient, monetary yield advantages and ATER of prominent intercropping systems of different crops; Nodulation studies; Planning and layout of field experiments; Judging of physiological maturity in different pulse crops; Intercultural operations in different pulse crops; Determination of cost of cultivation of different pulse crops; Working out harvest index of various pulse crops; Study of seed production techniques in various pulse crops; Visit of field experiments on cultural, fertilizer, weed and water management aspects; Visit to nearby villages for identification of constraints in pulse production.

**Learning Outcome**:

Students will be enriched with the knowledge of pulse crops cultivation; course will be supported to aware about the importance of pulse crop in sustainable crop production.

**AGR 509 : Agronomy of oilseed crops 2+1**

**Objectives:**

To teach the production technology of oilseed crops.

**Syllabus:**

**Theory**

Origin and history; area, production and productivity; classification; improved varieties; adaptability; climate, soil and water requirement; crop nutrition; weed management, cultural practices; quality component; handling and processing of the produce and the value added products.

UNIT I

*Rabi* oilseeds – Rapeseed and mustard, linseed, sunflower and safflower.

UNIT II

*Kharif* oilseeds – Groundnut, sesame, castor and soybean.

**Practical**

Planning and layout of field experiments; Judging of physiological maturity in different crops and working out harvest index; Working out cost of cultivation of different oilseed crops; Estimation of crop yield on the basis of yield attributes, formulation of cropping schemes for various farm sizes and calculation of cropping intensities; Study of seed production techniques of various oilseed crops; Interculture operations in different oilseed corps; Determination of oil content in oilseeds and computation of oil yield; Formulation of cropping schemes.

**Learning Outcome:**

Students will get basic idea about crop husbandry of oilseeds

**AGR 510 : Agronomy of fibre, sugar and tuber crops 2+1**

**Objectives:**

To teach the crop husbandry of fibre and sugar crops.

**Syllabus:**

**Theory**

Origin and history; area and production, economic importance, classification, improved varieties, adaptability; climate, soil, agro techniques, cropping systems, quality component; handling and processing of the produce, constraints in production.

UNIT I

Fibre corps – jute, cotton, mesta, sisal, sunhemp.

UNIT II

Sugar crops – Sugarcane and sugar-beet.

UNIT III

Tuber crop : Potato

**Practical**

Planning and layout of field experiments; Preparation of sugarcane setts, sett treatment and methods of planting, tyinig and propping of sugarcane; Determination of cane maturity and calculation of purity percentage, recovery percentage and sucrose content in cane juice, phenological studies at different growth stages of crop; Intercultural operations in different crops; Working out growth indices (LER, CGR, RGR, NAR, LAD), aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems; Judging of physiological maturity in different crops and working out harvest index; Working out cost of cultivation of different crops; Estimation of crop yield on the basis of yield components; Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities; Estimation of quality of fibre of different fibre crops; Study of seed production techniques in various crops; Visit to field experiments on cultural, fertilizer, weed and water management aspects; Visit to nearby villages for identification of constraints in crop production; Production of seeding materials.

**Learning Outcome:**
Students will get basic idea about crop husbandry of fibre, sugar and tuber crops

**AGR 511 : Agronomy of medicinal, aromatic and under-utilized crops 2+1**

**Objectives:**
To apprise students about different medicinal, aromatic and under-utilized crops, their package of practices and processing.

**Syllabus:**
**Theory**
UNIT I
Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses.

UNIT II
Climate and soil requirement; cultural practices; yield and important constituents of medicinal plants (Rauwolfia, Poppy, *Aloe vera*, Satavar, *Stevia*, Kalmegh, Black pepper, Brahmi, Mango ginger, Ekangi and Turmeric).

UNIT III
Climate and soil requirements; cultural practices, yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Geranium and Lavander).

UNIT IV
Climate and soil requirements; cultural practices; yield of under-utilized crops [Grain Amaranth, Bhringaraj (Wedelia), Broom grass, Fennel, Jowan (Trachyspermum), Senna (Cassia), Butterfly pea (Clitoria), Thankuni (Centella), Mehedi, Latkan and Sabai grass].
**Practical**

Identification of crops based on morphological and seed characteristics; Raising of herbarium of medicinal, aromatic and under-utilized plants; Quality characters in medicinal and aromatic plants; Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants.

**Learning Outcome:**

Students will get basic idea about crop husbandry of medicinal, aromatic and under-utilized crops

**AGR 512 : Agronomy of fodder and forage crops 2+1**

**Objectives:**

To teach the crop husbandry of different fodder and forage crops along with their processing.

**Syllabus:**

**Theory**

UNIT I

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like sorghum, oats, cowpea, rice bean, berseem, clusterbean, maize, dinanath.

UNIT II

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses – napier, panicum, cenchrus and stylo.

UNIT III

Year round fodder production and management, preservation and utilization of forage crops.

UNIT IV

Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage, use of physical and chemical enrichments and biological methods for improving nutrition and value addition of poor quality fodder.

UNIT V

Economics of forage cultivation, uses and seed production techniques.

**Practical**

Practical training of farm operations in raising fodder crops; Canopy measurement, yield and quality estimation, like crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder

and forage crops; Anti-quality components like HCN in sorghum and such factors in other crops; Hay and silage making and economics of their preparation.

**Learning Outcome:**

Students will get basic idea about crop husbandry of fodder and forage crops

**AGR 513 : Agrostology and agro-forestry 2+1**

**Objectives:**

To teach crop husbandry of different fodder, forage and agroforestry crops/trees along with their proceedings.

**Syllabus:**

**Theory**

UNIT I

Agrostology : definition and importance; grassland ecology – principles, community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

UNIT II

Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation – natural pastures, cultivated pastures; common pasture grasses.

UNIT III

Agroforestry: definition and importance; agroforestory systems, agri-silviculture, silvipasture, agrisilvipasture, agrihorticulture, aqua-silviculture, alley cropping and energy plantation.

UNIT IV

Crop production technology in agro-forestory and agrostology system; silvipastoral system : meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination and nursery management in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

**Practical**

Preparation of charts and maps of India showing different types of pastures and agro-forestry systems; Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry; Seed treatment for better germination of farm vegetation; Methods of propagation/planting of grasses and trees in silvipastoral system; Fertilizer application in strip and silvipastroal systems; After-care of plantation; Estimation of protein content in loppings of important fodder trees; Estimation of calorie value of wood of important fuel trees ; Estimation of total biomass and fuel wood; Economics of agro-forestry; Visit to importance agro-forestry research stations.

**Learning Outcome:**

Students will get basic idea about agrostology and agro-forestry

**AGR 514 : Cropping systems and sustainable agriculture 2+0**

**Objectives:**

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

**Theory**

UNIT I

Cropping systems : definition, indices and importance; classification of cropping systems according to type of rotation, degree of commercialization, water supply, enterprises, land use assessment.

UNIT II

Production potentials of different cropping systems, Interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping, yield advantage in intercropping systems.

UNIT III

Simulation models for intercropping; soil nutrient in intercropping; preparation of different cropping system models; evaluation of different cropping systems.

UNIT IV

New concept and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

UNIT V

Concept of sustainability in cropping systems; efficient farming systems.

UNIT VI

Concerns of natural resources and their management; modern agriculture and sustainability; LEIA vs. HEIA; LEISA; agrobio-diversity and sustainable agriculture; diversification in cropping systems and its importance; IWM and INM in cropping system for sustainable crop production.

**Learning Outcome:**

Students will get basic idea about sustainability and cropping system

**AGR 515 : Dryland farming and watershed management 2+1**

**Objectives:**

To teach the concept of dryland farming, how to harvesting of rain water and its proper utilization for crop production. To give idea about contingency crop planning, water shed management, mulching and use

**Syllabus:**

**Theory**

UNIT I

Definition, concept of dryland farming; dryland farming vs rain-fed farming; significance and dimensions of dryland framing in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, drought syndrome, effect on plant growth; crop planning including contingency, crop diversification, varieties, cropping systems, conservation cropping for erratic and aberrant weather conditions.

UNIT III

Physiology of moisture stress and drought resistance, drought avoidance, drought management; mid-season corrections for aberrant weather conditions.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage and agriculture; precipitation-collection, conservation and utilization; techniques of moisture conservation in situ to reduce evapo-transpiration (mulching and anti-transpirants), runoff control to increase infiltration, time lines and precision key factors timely sowing, precision in seeding, weed control; fertilizer placement, top dressing and foliar application.

UNIT V

Definition, concept, Objectivess, approach, components and problems of watershed management; steps in implementation of watershed; development of cropping systems for water shed areas.

**Practical**

Seed soaking, seed treatment with chemicals, seed germination, seeding depth and crop establishment in relation to soil moisture contents; Effect of plant density, thinning, leaf removal under moisture stress condition on crop growth; Study of the salient features of a model watershed; methods of measurement and determination of run-off; Estimation of stress index through plant analysis like proline, chlorophyll, relative leaf water content, chlorophyll stability index; Spray of anti-transpirant and their effects on crops; Practical utility of mulches, their mode of application and effects on soil and crop growth; Water use efficiency; Preparation of crop plans for different drought conditions; Study of field

experiments relevant to dryland farming. Visit to dryland research stations and watershed projects.

**Learning Outcome:**
Students will be highlighted about the crop production under dry land situation; students will be given idea about rainfall pattern, importance of rain water harvesting and run off water storage etc; it will be helpful to prepare crop planning under rainfed, dryland condition.

**AGR 516 : Principles and practices of organic farming 1+1**
**Objectivess:**
To study the principles and practices of organic farming for sustainable crop production.
**Theory**

UNIT I
Organic farming – concept and definition, its relevance to India and global agriculture and future prospects.

UNIT II
Land and water management – land use, minimum tillage, shelter zones, hedges, pasture management, Agroforestry, organic farming and water use efficiency.

UNIT III
Organic farming and soil fertility management, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT IV
Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT V
Management of weeds, diseases and inse
0ct pests by non-chemical materials, use of biological agents, fire, water, pheromones and bio-pesticides.

**Practical**
Aerobic and anaerobic methods of making compost; Making of vermicompost; Effect of use of biofertilizers, techniques of treating legume seeds with *Rhizobium* cultures, use of *Azotobacter, Azospirillum* and PSB cultures in field; Visit to organic farms; Quality standards,

inspection, certification and labeling and accreditation procedures for farm produce from organic farms; Preparation and use of different bio-products for weed management, seed preservation, rodent and insect repelling and bird scaring.

**Learning Outcome:**

Students will get basic idea about organic farming

**AGR 517: Crop ecology and geography 2+0**

**Objectives:**

To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

**Theory**

UNIT I

Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II

Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III

Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV

Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT V

Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

UNIT VI

Agro-climatic zones and agro-ecological regions in India, Geographic distribution of crop plants, factors determining crop distribution – agro-climatic, socio-economic and infrastructure development, access to processing, preservation and marketing; Shifts of ecosystems, extent and result; Changes in flora and fauna and their management strategies; Impact of short duration HYVs and hybrids on shift in agro-ecosystems.

**Learning Outcome:**

To get basic knowledge about crop ecology, ecosystem, magro-ecological regions, and adaptation of crops to different agro-climatic conditions.

## SYLLABUS: DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

### Course offered by Department of Soil Science and Agricultural Chemistry

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| SSC-501* | Soil physics | 2+1 | I |
| SSC-502* | Soil fertility and fertilizer use | 3+1 | I |
| SSC-503 * | Soil chemistry | 2+1 | I |
| SSC-504* | Soil mineralogy, genesis, classification and survey | 2+1 | I |
| SSC-505* | Soil biology and biochemistry | 3+1 | I |
| SSC-506 | Soil erosion and conservation | 2+1 | II |
| SSC-507 | Radioisotopes in soil and plant studies | 1+0 | II |
| SSC-508 | Soil, water and air pollution | 2+1 | II |
| SSC-509 | Analytical techniques and instrumental Methods in soil and plant analysis | 1+2 | II |
| SSC-510 | Chemistry of pesticides | 1+1 | II |
| SSC-511 | Management of problem soils | 2+1 | III |
| SSC-512 | Fertilizer technology | 1+1 | III |
| SSC-513 | Land degradation and restoration | 1+0 | III |
| SSC- 591 | Credit seminar | 0+1 | IV |
| SSC- 599 | Master's Research (Thesis) | 0+20 | I to IV |

*CORE COURSE

**SSC-501 Soil physics (2+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on different aspects of soil physics like soil textural classes, particle size distribution analysis, specific surface, soil consistence; dispersion, soil compaction, soil strength, swelling, soil structure, soil aggregation, soil crusting, soil conditioners, soil water potential, soil water retention,

movement, hydraulic conductivity, hydrologic cycle, field water balance, soil air, soil thermal properties etc

**Syllabus:**

**Theory**

Soil Physics as a branch of Soil Science, Soil as a three-phase system, volume and mass relationships of soil constituents. Soil texture, textural classes, particle size distribution analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts. Soil structure - genesis, types, characterization and management of soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation. Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential. Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum. Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

**Practical**

Particle size distribution analysis by pipette and international methods; Measurement of Atterburg limits; Aggregate analysis - dry and wet; Measurement of soil-water content by different methods; Measurement of soil-water potential by using tensiometer and gypsum blocks; Determination of soil-moisture characteristic curve and computation of pore-size distribution; Determination of hydraulic conductivity under saturated and unsaturated conditions; Determination of infiltration rate of soil; Determination of aeration porosity and oxygen diffusion rate; Soil temperature measurements by different methods; Estimation of water balance components in bare and cropped fields.

**Learning Outcome:**

Students will acquire both theoretical and practical knowledge on various soil physical properties, their influence on plant growth, their management etc.

**SSC-502 Soil fertility and fertilizer use (3+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on different aspects of soil fertility and fertilizer use like essential nutrient elements, chemistry and transformation of nutrient elements and their management, soil test methods and fertilizer recommendations, soil test crop response correlations and response functions, fertilizer use efficiency, site-specific nutrient management, plant need based nutrient management; integrated nutrient management, soil fertility evaluation techniques, soil quality etc.

**Syllabus:**

**Theory**

Soil fertility and soil productivity; factors affecting soil fertility; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Criteria of essentiality of elements in plant nutrition. Mitcherlich's equation, Spillman's equation and baule unit; essentials of plant growth. Chemistry and transformation of nutrient elements including micronutrients in soil and their role in plant nutrition-their sources, forms, retention behaviour and movement; correction of micronutrient deficiencies in plants. Common soil test methods for fertilizer recommendations; quantity–intensity relationships; soil test crop response correlations and response functions. Principles of fertilizer application and residual effects of fertilizers and organic manures; Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

**Practical**

Extraction and determination of available plant nutrients in soil; Soil fertility evaluation by chemical and biological methods; Analysis of plants for essential elements

**Learning Outcome:**

Students will acquire both theoretical and practical knowledge on various aspects of soil fertility, soil fertility management and fertilizer use.

**SSC-503 Soil chemistry (2+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on different aspects of soil chemistry like soil water chemistry; dynamic nature of soil; thermodynamics, chemical equilibria, electrochemistry and chemical kinetics, soil colloids, surface charge characteristics of soils; fractionation of soil organic matter, clay-organic interactions, ion exchange processes in soil, cation, anion and ligand exchange, sorption-desorption, chemistry of acid soils, salt affected soils and their management, chemistry and electrochemistry of submerged soils etc.

**Syllabus:**

**Theory**

Modern concept of soil; Chemical (elemental) composition of the earth's crust and soils. Soil as a disperse system. Concept and importance of soil solution; chemistry of soil water; dynamic nature of soil; soil and plant nutrition. Thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions. Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity,

soil acidity reclamation. Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils.

**Practical**

Determination of CEC and AEC of soils; Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter; • Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method; Potentiometric and conductometric titration of soil humic and fulvic acids; (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Ä (E4/E6) values at two pH values; Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm; Construction of adsorption envelope of soils by using phosphate/fluoride/sulphate and ascertaining the mechanism of the ligand exchange process involved; Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method; Determination of lime requirement of an acid soil by buffer method; Determination of gypsum requirement of an alkali soil

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on various aspects of soil chemistry or different soil chemical properties.

**SSC-504 Soil mineralogy, genesis, classification and survey (2+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on soil mineralogical properties, soil forming processes; weathering of rocks and mineral transformations; modern systems of soil classification, soil taxonomy; soil classification, soil survey techniques soil mapping, land capability classification etc.

**Syllabus:**

**Theory**

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism. Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils. Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils. Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness. Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps. Landform – soil relationship; major soil groups of India with special reference to West Bengal; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

**Practical**

Identification and quantification of minerals in soil fractions; Morphological properties of soil profile in different landforms- determination of soil texture by feel method, studies on soil structure, colour, pH (colorimetric method), consistence; Classification of soils using soil taxonomy; Grouping soils using available data base in terms of soil quality.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on genesis of soil, mineralogy of soil, classification of soil and soil survey techniques.

**SSC-505 Soil biology and biochemistry (3+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on various aspects of soil biology and soil biochemistry like soil microbial ecology; soil microbial biomass; microbial interactions; phyllosphere; soil enzymes, biochemical composition and biodegradation of soil organic matter; humus formation, biogas and manures production using organic wastes, preparation and preservation of farmyard manure, animal manures, compost, vermicompost., biofertilizers etc.

**Syllabus:**

**Theory**

Soil biota; soil microbial ecology; types of organisms in different soils; soil microbial biomass; microbial interactions; un-cultivable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes – origin, activities and importance; soil characteristics influencing growth and activity of microflora. Biochemical composition and biodegradation of soil organic matter, carbohydrates, protein, lipid and nucleic acids; humus formation; cycles of important organic nutrients. Organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost. Biofertilizers-definition, classification, specification, method of production and role in crop production.

**Practical**

Determination of soil microbial population; Soil microbial biomass; Elemental composition, fractionation of organic matter and functional groups; Decomposition of organic matter in soil; Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification, $N_2$ fixation, S oxidation, P solubilization and mineralization of other micronutrients.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on various aspects of soil biology and soil chemical properties.

**SSC-506 Soil erosion and conservation (2+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on soil erosion problems in India, forms/types, factors and effect of soil erosion; factors affecting water erosion; estimation of water erosion; types, mechanism and factors affecting wind erosion; various erosion control measures, soil conservation planning, watershed management, use of remote sensing in assessment and planning of watersheds etc.

**Syllabus:**

**Theory**

History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI30 index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation. Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country. Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout. Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands. Watershed management - concept, objectives and approach; water harvesting and recycling; run-off and flood control in watershed management areas; safe drainage of excess water; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; catchment and concentrate areas and their treatments for improving efficiencies; use of remote sensing in assessment and planning of watersheds.

**Practical**

Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, infiltration and run-off ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index; Computation of kinetic energy of falling rain drops; Computation of rainfall erosivity index (EI30) using rain gauge data; Visits to areas having watersheds, water harvesting and erosion control structures.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on factors affecting soil erosion, types and mechanism of soil erosion, effect of soil erosion on plant growth and soil erosion control measures or techniques.

**SSC-507 Radioisotopes in soil and plant studies (1+0)**

**Objectives:**

The students are expected to gain knowledge on nature, properties and decay principles of radioisotopes and nuclear radiations; radiation monitoring, neutron moisture meter, mass spectrometry, auto radiography, isotopic dilution techniques for soil and plant research; use of stable isotopes etc.

**Syllabus:**

**Theory**

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter. Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography. Isotopic dilution techniques used in soil and plant research; use of stable

isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating. Doses of radiation exposure, radiation safety aspects, regulatory aspects, collection, storage and disposal of radioactive wastes

**Learning Outcome:**

Students will acquire knowledge on nature, properties and decay principles of radioisotopes and their use in soil, plant studies.

**SSC-508 Soil, water and air pollution (2+1)**

**Objectives:**

The students are expected to gain knowledge on nature, sources, extent of soil, water and air pollution; their effects on soil nutrients availability, plant and human health and their remediation/amelioration.

**Syllabus:**

**Theory**

Soil, water and air pollution problems associated with agriculture, nature and extent. Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal. Pesticides – their classification, behavior in soil and effect on soil microorganisms. Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health. Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide. Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

**Practical**

Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants; • Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents; Heavy metals in contaminated soils and plants; Management of contaminants in soil and plants to safeguard food safety; Air sampling and determination of particulate matter and oxides of Sulphur; Visit to various industrial sites to study the impact of pollutants on soil and plants

**Learning Outcome:**

Students will acquire knowledge on soil, water and air pollution; their effects on soil nutrients availability, plant and human health and their remediation/amelioration.

**SSC-509 Analytical techniques and instrumental methods in soil and plant analysis (1+2)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on analytical techniques and instrumental methods used soil and plant analysis.

**Syllabus:**

**Theory**

Chemical analysis-concept of chemical analysis. Volumetric analysis-principles of acid-base titration, neutralization indicators; redox titration-permanganometry, dichrometry, iodometry, use of redox indicators; precipitation titration, argentometric titration, use of adsorption indicators; complexometric titration, metal ion indicators, concept of masking and demasking reactions. Principles of conductometry and potentiometric titrations. Principles of colorimetry, flame photometry, and atomic absorption spectrophotometry. Radiotracer technique and its methodology

**Practical**

Preparation of solutions for standard solutions; Titrimetric analysis- acid-base, redox, complexometric, potentiometric and precipitation titrations; Use of pH meter, conductivity meter, visible, ultraviolet and infrared spectrophotometer, atomic absorption spectrophotometer, flame-photometer; Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn; B and Mo; analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods.

**Learning Outcome:**

Students will acquire knowledge on analytical techniques and instrumental methods used soil and plant analysis.

**SSC-510 Chemistry of pesticides (1+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on various types of pesticides, their fate and behaviour in soil, plant and water bodies, impact of pesticide residues on environment, pesticide contamination of food, biodegradation of pesticides, effect of pesticides on microbial activity and so on.

**Syllabus:**

**Theory**

Classification of pesticides with respect to chemical composition, chemistry of some commonly used pesticides; Fate and behaviour of pesticides in soil, plant and water bodies. Pesticide residues and their impact on environment, pesticide contamination of food. Mineralization and metabolism of pesticides, bound pesticides. Effect of concentration on pesticide transport, retention and leaching. Biodegradation of pesticides, effect on microbial activity, microbial adaptation. Toxicological properties of pesticides and nutrient transformations, precautions in pesticide use. Biotechnology in pest management.

**Practical**

Estimation of active ingredients in different pesticides by chemical methods; Extraction, isolation and purification of pesticide residues on soil and plants. Techniques of GC and HPLC analysis of pesticide residues, Immuno asays, ELISA test.

**Learning Outcome:**

Students will acquire knowledge on chemistry of pesticides, their impact on environment, pesticide contamination of food, biodegradation of pesticides etc.

**SSC-511. Management of problem soils (2+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on area, distribution, characteristic, impact on plant growth and reclamation/management of various problem soils like saline, sodic, saline-sodic, acid soil and others.

**Syllabus:**

**Theory**

Area and distribution of problem soils-acidic, saline, sodic and physically degraded soils: origin and basic concept of problem soils and factors responsible.

Morphological features of saline and saline-sodic soils; characterization of salt-affected soils; soluble salts, ESP, pH; physical, chemical and microbiological properties; Management of salt-affected soils; quality of irrigation water; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality; management of brackish water for irrigation. Salt tolerance of crops- mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dryland soils. Acid soils- nature of soil acidity, sources of soil acidity; effect on plant growth; lime requirement of acid soils; management of acid soils. Agronomic practices in relation to problem soils; cropping pattern for utilizing poor quality ground waters.

**Practical**

Characterization of acid, acid sulphate, salt-affected and calcareous soils. Determination of cations ($Na^+$, $K^+$, $Ca^{++}$ and $Mg^{++}$) in ground water and soil. Determination of anions ($Cl^-$, $SO_4^{--}$, $CO_3^{---}$ and $HCO_3^-$) in ground water and soil. Lime and gypsum requirements of acid sodic soils.

**Learning Outcome:**

Students will acquire knowledge on various problem soils and their reclamation and management.

**SSC-512 Fertilizer technology (1+1)**

**Objectives:**

The students are expected to gain theoretical as well as practical knowledge on manufacturing process for different fertilizers, secondary and micronutrient fertilizers, quality control of fertilizers, production of slow release fertilizers, super granules fertilizers, fertilizer control order etc.

**Syllabus:**

**Theory**

Fertilizers- production, consumption and future projects with regard to nutrient use in the country and respective states: fertilizer control order. Manufacturing process for different

fertilizers using various raw materials, characteristics and nutrient contents. Recent developments in secondary and micronutrient fertilizers and their quality control as per fertilizer control order. New and emerging issues in fertilizer technology- production and use of slow and controlled release fertilizers, super granules fertilizers and fertilizers for specific crops/situations.

**Practical**

Identification of fertilizers. Nutrient contents in nitrogenous, phosphatic and potassic fertilizers. Determination of biureate content in urea.

**Learning Outcome:**

Students will acquire knowledge on manufacture, nutrient content and use of various fertilizers, slow release fertilizers, fertilizer control order etc.

**SSC-513 Land degradation and restoration (1+0)**

**Objectives:**

The students are expected to gain knowledge on different type, factors and processes of land degradation, its impact on soil productivity and restoration of land degradation.

**Syllabus:**

**Theory**

Type, factors and processes of soil/land degradation and its impact on soil productivity, including soil fauna; biodegradation and environment. Land restoration and conservation techniques- erosion control, reclamation of salt-affected soils, mine land reclamation, afforestation, organic products. Extent, diagnosis and mapping of conventional and modern RS-GIS tools, monitoring land degradation by fast assessment, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

**Learning Outcome:**

Students will acquire knowledge on land degradation processes, factors, its impact and its restoration.

**SYLLABUS: DEPARTMENT OF AGRICULTURAL EXTENSION**

Courses offered by the Department of Agricultural Extension in the M. Sc.(Ag.) programme

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| EXT 501* | Genesis and evolution of extension concept | 1+0 | I |
| EXT 502 | Development perspectives of extension education | 1+1 | I |
| EXT 503* | Development communication and information management | 2+0 | I |
| EXT 504 | Educational technology in extension | 1+1 | I |
| EXT 505 | Concept of sociology,s social and educational psychology relevant in extension | 2+1 | I |
| EXT 506* | Diffusion and adoption of innovations | 1+1 | II |
| EXT 507* | Research methods in behavioural sciences | 2+1 | II |
| EXT 508 | Gender studies in agricultural development | 2+1 | II |
| EXT 509 | Distance education as extension intervention | 1+1 | II |
| EXT 510 | Training and networking | 1+1 | II |
| EXT 511* | E-extension | 1+1 | III |
| EXT 512 | Entrepreneurship development and management | 1+1 | III |
| EXT 513* | Concept of organizational, human resource and marketing management relevant to extension | 2+1 | III |
| EXT 514 | Project management- principles and techniques | 1+1 | III |

| | | | |
|---|---|---|---|
| EXT 515 | Participatory methods for technology Development and transfer | 1+1 | III |
| EXT516 | Visual communication | 2+1 | I |
| EXT 517 | Market led extension | 1+1 | III |
| EXT 518 | Group dynamic and leadership | 2+1 | II |
| EXT 591 | Credit seminar | 0+1 | IV |
| EXT 599 | Master's Research (Thesis) | 0+20 | I to IV |

*Compulsory Core courses for Master's Programme

**EXT 501 Genesis and evolution of extension concept 1+0**

**Objectives:**

The course is intended to orient students on the genesis and evolution of extension system, various extension approaches tried worldwide. It also aims to expose them to extension systems of various countries worldwide. The students learn about problems, future needs and strategies of agricultural extension.

**Syllabus:**

**Theory**

UNIT I

A world wide history of development of agricultural extension; Agricultural extension system of the following countries with brief history, approaches, organisational structure, linkage with research and extension methods used: Kenya, Zambia, Ethiopia, Tanzania, China, India, Indonesia, Japan, Republic Korea, Philippines and Sri Lanka, Nether Lands, Denmark and United Kingdom, Brazil and Mexico, USA, Egypt and Israel, Extension system in SAARC Countries.

UNIT II

FAO small farmers development projects, Masagana 99 programme of Philippines, BIMAS programme of Indonesia, Social laboratory experience and building self help group for extension of Philippines. Farming System Research and Extension, Expert system of Extension and Participatory methods of sustainable extension. Experience of UK, Italy and USA in privatised extension services, Problems of Agricultural Extension and future needs, Major worldwide and region wise problems of agricultural extension, Future needs and strategies of extension to meet the goals of agricultural extension.

**Learning Outcome:**

The students will be able to know the evolution of extension system in different countries with their organisational structure, salient features and functioning. The y will gain knowledge about the important programmes that influenced the agricultural scenario and draw the lessons from those experiences.

**EXT 502 Development perspectives of extension education 1+1**

**Objectives:**

To impart knowledge to the students on concept, Objectivess, philosophy and principles of extension education as well as pioneering extension efforts and analysis of extension system of ICAR and SAU. Course also gives exposure to the student on current approaches in extension as well as various development programmes.

**Syllabus:**

**Theory**

UNIT I

Extension Education – Meaning, Objectivess, concepts, principles and philosophy,critical analysis of definitions – Extension Education as a Profession – AdultEducation and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP,CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralised Decision Making, Bottom-up Planning, Farming System Approach, Farming Situation Based Extension, Market– Led – Extension, Farm Field School, ATIC, *Kisan* Call Centres, NAIP.

**Practical**

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

**Learning Outcome:**

A student community with well-balanced cognitive, affective and psychomotor aspects.

**EXT 503 Development communication and information management 2+0**

**Objectives:**

To make the students aware and knowledgeable about the different aspects of communication with particular reference to development. Besides, to build up capacity of the students to plan and execute development communication materials.

**Syllabus:**

**Theory**

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT II

Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.

UNIT III

Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media– Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV

Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

**Learning Outcome:**

After having this course students are expected to gain knowledge about the role of communication in development and at the same time students will be capable to prepare communication materials for different types of development.

**EXT 504 Educational technology in extension 1+1**

**Objectives:**

To orient the students regarding various concepts and issues of educational technology in extension

**Syllabus:**

**Theory**

UNIT I

Principles and psychological bases in selecting and using extension methods and audio visual aids. Development in instructional technologies - traditional and modern methods.

UNIT II

Writing for farm families (including Radio and Television). Preparation and production of Mass Media materials - electronic, print and visual media.

UNIT III

Photographic techniques - Computer Aided Instructional Technology - Information access through Internet, Interactive Video Disc (IVD) - Recent instructional technology - Teleconferencing.

**Practical**

Practicing video technique - (including Radio, Television,) pre-production and post - production phases. Practicing projection techniques - Overhead projector, slide projector and video projector. Practice in photography and slide making. Preparation of synchronized slide stories - Acquaintance with printing techniques - traditional and modern methods (including Radio, Television). Visiting media institutions.

**Learning outcome:**
The learners are expected to develop expertise on different concepts and issues of educational technology in extension

**EXT 505 Concept of sociology, social and educational psychology relevant in extension 2+1**

**Objectives:**

To orient the students regarding different concepts and issues of rural sociology and educational psychology.

**Syllabus**

**Theory**

UNIT I

Individual and Society, Rural Sociology, concept, scope, Importance of Rural Sociology in Development Extension Work, Rural Sociology and other social sciences, Basic concepts in sociology- society, social structure, community, social organisation, social institution

UNIT II

Social Stratification- concept, status, role, rank, class structure, change in class system in rural India, class and caste system, origin, characteristics, differences between class and caste system, class and caste factor affecting rural development.

UNIT III

Groups- definition, types of groups, group dynamics. Leadership- concept, types and techniques of identifying leaders.

UNIT IV

Social change- concept, types and theories. Social control and social process.

UNIT V

Psychology as science, its scope and importance in extension education,-educational and social psychology-perception, attitude, motivation, personality, intelligence

**Practical**

Problems related to the topics mentioned in the theory syllabus.

**Learning Outcome:**

The learners are expected to develop expertise on different concepts and issues of rural sociology and educational psychology.

**EXT 506 Diffusion and adoption of innovations 1+1**

**Objectives:**

To make the students aware and knowledgeable about the science behind the process of diffusion and innovation decision as well as different factors that influences the process of diffusion and innovation of innovation. Besides, to build up capacity of students to plan for diffusion and adoption of different farm innovation.

**Syllabus:**

**Theory**

UNIT I

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

UNIT II

The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

UNIT III

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV

Diffusion effect and concept of over adoption, opinion leadership- measurement and characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions –Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

**Practical**

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

**Learning Outcome:**

Students are expected to be knowledgeable about different aspects of diffusion and adoption of innovation as well as they will be capable to trace the adoption process in the community and plan for the same.

**EXT 507 Research methods in behavioural science 2+1**

**Objectives:**

To impart knowledge to the students on various extension research methodologies, tools and techniques of behavioural research and to develop skills in preparing research reports.

**Syllabus:**

**Theory**

UNIT I

Research – Meaning, importance, characteristics. Behavioural sciences research –Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem and development of theoretical orientation of the research problem.

UNIT II

Objectivess – Meaning, types and criteria for judging the Objectivess. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis. Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels ofmeasurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling- Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximincon Principle, Sampling – Types of sampling and sampling procedures.

UNIT III

Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of

the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in

conducting, advantages and limitations in its use. Social survey – Meaning, Objectives, types and steps in conducting, advantages and limitations.

UNIT IV

Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

**Practical**

Selection and formulation of research problem - Formulation of Objectives and hypothesis- Selection of variables based on Objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.- Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on Objectives of research. Writing report, Writing of thesis and research articles-Presentation of reports.

**Learning Outcome:**

A student community that think positively on cause-effect relationship and whose mental attitude is based on how to think instead of what to think.

**EXT 508 Gender studies in agricultural development 1+1**

**Objectives:**

To orient the students regarding various concepts, issues, dimensions and polices of Gender Studies in Agricultural Development

**Syllabus:**

**Theory**

UNIT I

Gender concepts, issues and challenges in development; Gender roles, gender balance, status, need and scope; Gender analysis tools and techniques.

UNIT II

National policy for empowerment of women since independence; Developmental programmes for women; Gender mainstreaming in agriculture and allied sectors – need and relevance; Gender budgeting – A tool for empowering women.

UNIT III

Women empowerment –Dimensions; Women empowerment through SHG approach; Women entrepreneurship and its role in economic development; Public Private Partnership for the economic empowerment of women; Building rural institution for women empowerment; Women human rights ; Action plans for gender mainstreaming.

**Practical**

Visits to rural institutions of women for studying in the rural institutions engaged in Women empowerment; Application of gender analysis tools in field- gender disaggrgated planning for agricultural extension. Visits to entrepreneurial unit of women for studying the ways and

means of establishing entrepreneurship units for Women and their development and also SWOT analysis of the Unit; Visit to Center for women development - NIRD to study the different activities related to projects and research on gender; Visit to gender cell, Office of the Commissioner and Director of Agriculture, Hyderabad, to study the mainstreaming of gender concerns and gender budget of the department.

**Learning Outcome:**
The learners are expected to develop expertise knowledge and skills on Gender Studies in Agricultural Development

**EXT 509 Distance education as extension intervention 1+1**

**Objectives:**
To orient the students regarding various concepts, forms, systems and issues of Distance Education as Extension Intervention.

**Syllabus:**

**Theory**

UNIT I
Distance Education – Introduction Meaning, Concept, Philosophy and its work ethics, characteristics of Distance Education – Evolution and Historical view of Distance Education – Theory Methodology, and Epistemology. Dimensions of Distance Education, Scope and difficulties. Open Education – Non-formal Education, Continuing Education, Education by correspondence. Conceptual and philosophical similarities and dissimilarities among extension education, adult education and continuing 'distance education
UNIT II
Forms and systems of Distance and Open Education, Modes of Teaching and Learning in Distance Education, Methods of Distance Education, Significance of Distance Education in Teacher Education.
UNIT III
Planning Distance Education – A Systems Approach Student Learning – Course Planning, The target groups – Barriers to learning in Distance Education – Planning and Management of Networked Learning.
UNIT IV
Educational Technology is Distance Education Application of information and Educational Technologies in Distance Education, Development of Course and Course material, Management of resources, processes, Forms of Instructional material in Distance Education and Media Development and Production in Distance Education - Video Classroom Strategy in Distance Education – Strategies for maximizing the reach – services to students, programme Evaluation - performance indicators and Quality Assessment.
**Practical**
Visit to the University which is implementing the Distance Education Programmes. Detailed Study of their programme in relation to Educational Technology, Methodology, Curriculum Development, Evaluation and Assessment. Exercise on development of curriculum for Distance Education exclusively for farming community.

**Learning Outcome:**

The learners are expected to develop expertise knowledge and skills on different aspects of Distance Education as Extension Intervention.

**EXT 510 Training and networking 1+1**

**Objectives:**

To impart learning on concepts and issues of extension training and networking.

**Syllabus:**

**Theory**

UNIT I

Training – Meaning, training and human resource development- Adult learning principles-experiential learning-training process-phases of training-determining training need and development of training modules – training requirements; Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees' participation; some modern training methods

UNIT II

Networking concept and typology- social networks- process of networking in extension-cases of extension network-network as capacity building intervention

**Practical**

Visit to different training organizations to review ongoing activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes;

Study of development networks- plan for development of an extension network of farmers groups.

**Learning Outcome:**

To develop expertise skills on various aspects of extension training and networking

**EXT 511 E- Extension 1+1**

**Objectives:**

To orient the students regarding various concepts, tools, applications, approaches projects and issues of ICT in extension

**Syllabus:**

**Theory**

UNIT I

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.

UNIT II

ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.

UNIT IV

ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.

**Practical**

Agril. content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

**Learning Outcome:**

The learners are expected to develop expertise knowledge and skills on ICT tools, applications, approaches projects and issues in extension.

**EXT 512 Entrepreneurship development and management in extension 1+1**

**Objectives:**

The first part of this course is intended to provide an overall picture of planning and development of entrepreneurship to promote sustainable livelihoods for rural people. The second part is structured to help students gain knowledge and skills in different concepts and techniques of management in extension organizations**.**

**Syllabus:**

**Theory**

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing.

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

**Practical**

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions- Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

**Learning Outcome:**

Students will gain understanding of the entrepreneurship development process, formulation of the entrepreneurship development project and management of enterprise. Students will get orientation on policies, programmes, institutional framework and market for entrepreneurship development in India. The exposure to managerial functions pertaining to extension management would develop the knowledge and skills of the students.

**EXT 513 Concepts of organizational, human resource and marketing management relevant to extension** 2+1

**Objectives:**

To impart knowledge to the student about the concepts, methods and various techniques of HRD, HRM & HRA and also develop knowledge about agribusiness management.

**Syllabus:**

**Theory**

UNIT I

Introduction to organizations: concept and properties of organizations- levels of organizations, organizational goals, formal and informal organizations.

UNIT II

Organizational structure: concepts and functions of organizational structure, process in organizing, departmentation, span of Management, delegation of authority, centralisation and decentralisation- line and staff organization, functional organization, divisonalisation, project organization, matrix organization, free from organization, top management structure.

UNIT III

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth-Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

UNIT IV

Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counselling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Skills required for Extension workers; Decision Making: Decision Making models, Management by Objectivess; Behavioural Dynamics

UNIT V

Concept of market- marketing and selling, - social marketing- types of markets- agri-input marketing, components of market-market segments- marketing mix- product development-product positioning- packaging- market research

**Practical**

Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information, Presentation of reports

Study Agri-input markets- visit Agri-input companies-develop a market research report of a agricultural product.

**Learning Outcome:**

The Couse will help the students to become a good HRD practitioners.

**EXT 514 Project management – principles and techniques 1+1**

**Objectives:**

To make the students knowledgeable about S & T inputs of project management as well as to build up their capacity for managing developmental project.

**Syllabus:**

**Theory**

UNIT I

Introduction- definitions – classifications – project risk – scope. Project management – definitions – overview – project plan – management principles applied to project management–project management life cycles

UNIT II

Project planning – scope – problem statement – project goals – Objectivess –success criteria – assumptions – risks – obstacles – approval process –projects and strategic planning. Project implementation – project resource requirements – types of resources– men – materials. Project - GOPP/Log Frame analysis

UNIT III

Project monitoring – evaluation – control – project network technique –planning for monitoring and evaluation – project audits – project management information system – project scheduling – PERT & CPM – performance Appraisal- project communication – post project reviews

UNIT IV

Closing the project – types of project termination – strategic implications – project in trouble – termination strategies – evaluation of termination possibilities – termination procedures

**Practical**

Study of an ongoing extension project. Development of an plan through GOPP/Log frame Work- Application of PERT & CPM in a hypothetical situation- Application of performace appraisal technique on an ongoing extension project.

**Learning Outcome:**

Through this course students are expected to have comprehensive knowledge about different aspects of developmental project management as well as will be capable to manage developmental project independently.

**EXT 515 Participatory methods for technology development and transfer 1+1**

**Objectives:**

To orient the students regarding various concepts and issues of participatory methods for technology development and transfer.

**Syllabus:**

**Theory**

UNIT I

Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models.

UNIT II

Participatory tools and techniques. Space Related Methods : village map (social &resource), mobility services and opportunities map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.

UNIT III

Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

**Practical**

Exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

**Learning Outcome:**

To develop expertise skills in various concepts and issues of participatory methods for technology development and transfer.

**EXT 516 Visual communication 1+1**

**Objectives:**

To orient the students regarding various concept, role and issues of visuals and graphics in Communication.

**Syllabus:**

**Theory**

UNIT I

Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals.

UNIT II

Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and procuction of low cost visuals.

UNIT III

Photographs- reprographic visuals. PC based visuals. Degitized video material in multimedia production. Designing visuals for print and TV and video.

UNIT IV

Pre-testing and evaluation of visuals. Scanning of visuals.

**Practical**

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

**Learning Outcome:**

The learners are expected to develop expertise knowledge and skills on various aspects of visuals and graphics in Communication

**EXT 517 Market led extension management 1+1**

**Objectives:**

To orient the students regarding various concepts, scenario, perspectives and issues of Market Led Extension

**Syllabus:**

**Theory**

UNIT I

Agricultural extension at cross roads; Changing scenario of agricultural extension at the national level; Market led extension – emerging perspectives; Market led extension – issues and challenges; Dimensions of market led extension.

UNIT II

Agricultural marketing an overview; Development of a marketing plan, pricing concepts and pricing strategy; Consumer behaviour; Marketing communication and promotional strategies; The marketing research process; Agricultural trade liberalization and its impact; International marketing opportunities; Implications of AOA, TRIPS and IPRs agreements on agriculture; Agreement on SPS and TBT - an over view; Commodity features marketing.

UNIT III

Public private linkages in market led extension; Role of SHG in market led extension; Contact farming – a viable approach to meet market challenges; IT enabled approaches for market led extension and communication; Weather service and crop modeling – An effective tool in market led extension.

**Practical**

Identification and analysis of different marketing sources for agricultural commodities. Development of strategy for an effective market intelligence system; Development of suitable marketing plan to suite rural situation; Visit to APEDA, Rythu Bazaars to study the processes and procedures related to market-led extension.

**Learning Outcome:**

The learners are expected to develop expertise knowledge and skills on various concepts, scenario, perspectives and issues of Market Led Extension

**EXT 518 Group Dynamics and Leadership 2+1**

**Objectives:**

This course emphasises the various aspects of group dynamics, functioning of micro-finance and self-help group (SHG). It also provides the students an understanding of leadership including roles, types and characteristics of leaders with an exposure to different leadership theories. It inculcates the skills in applying small group techniques and identifying the leaders.

**Syllabus:**

**Theory**

UNIT I

Group - Concepts, Importance, classification and description. Dynamics of the group - role, function and performance, group characteristics and their effects. Group techniques. Group-based Extension- concept and cases. Self-Help Group – concept-organization- mobilization, Microfinance-functions for empowerment.

UNIT II

Leaders - types of leaders, roles and functions Leadership - importance in groups and theories.. Identification, selection, training and development of local leaders. Leadership index to identify effective leaders. Review of significant research findings.

**Practical**

Practising group techniques like forum, panel, symposium dialogue, interview, brain storming and role playing. Use of different methods of identifying village leaders – observation, sociometry, key informant technique. Indexing leaders by leadership index.

**Learning Outcome:**

Students will get exposure on different aspects of group dynamics, SHG, micro finance and leadership. They will learn various small group techniques and methods to identifying village leaders.

**SYLLABUS: DEPARTMENT OF AGRICULTURAL ENTOMOLOGY**

Courses by the Department of Agricultural Entomology in the M. Sc.(Ag.) programme

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| AEN- 501* | Insect morphology | (1+1) | I |

| | | | |
|---|---|---|---|
| AEN- 502* | Insect anatomy, Physiology & Nutrition | (2+1) | I |
| AEN- 509 | General Acarology | (1+1) | I |
| AEN- 515* | Principles of Integrated Pest Management | (2+1) | I |
| AEN- 503* | Insect taxonomy | (1+1) | II |
| AEN- 504* | Insect Ecology | (1+1) | II |
| AEN- 505* | Pest of Field crops and their management | (2+1) | II |
| AEN- 510 | Insect embryology & post-embryonic development | (1+1) | II |
| AEN- 511 | Storage entomology & vertebrate pest | (1+1) | II |
| AEN- 506* | Pest of Horticultural crops and their management | (2+1) | III |
| AEN- 507* | Biological control of crop pests and Weeds | (1+1) | III |
| AEN-508* | Toxicology of insecticides | (2+1) | III |
| AEN- 512 | Commercial Entomology | (1+1) | III |
| AEN-513 | Chemical pest control methods | (1+1) | IV |
| AEN-514 | Insect-vectors of plant pathogens & their relationships | (1+1) | IV |
| AEN- 516 | Host plant resistance to Insects | (1+1) | IV |
| AEN- 591* | Credit Seminar | (0+1) | IV |
| AEN- 599* | Master's Research (Thesis ) | 0+20 | I to IV |

*Compulsory Core courses for Master's Programme

**AEN 501*** **Insect morphology** **(1+1)**

**Objectives:**

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

**Syllabus:**

**Theory**

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications. Abdomen- Segmentation and appendages; Genitalia and their modifications; Insect sense organs (mechano-, photo- and chemoreceptors).

**Practical**

Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

**Learning Outcome:**

After completion of the course students will be proficient enough to construct population model and economic use of pesticide model. Also able to take decision based on ETL estimation as well as to make the venture cost effective one.

**AEN 502* Insect anatomy, physiology & nutrition (2+1)**

**Objectives:**

To impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology, nutritional physiology and their application in entomology.

**Syllabus:**

**Theory**

Scope and importance of insect anatomy and physiology, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

**Practical:**

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; examination of insect haemocytes; preparation of various diets and estimation of consumption, and utilization of food by insect.

**Learning Outcome:**

After completion of the course students will acquire the knowledge on various physiological systems of insect. Also they will develop expertise in preparation of permanent slides.

**AEN-503* Insect taxonomy (1+1)**

**Objectives:**

To sensitize the students on theory and practice of classifying organisms. Also acquainted with the rules of governing the same.

**Syllabus:**

**Theory:**

Brief evolutionary history of Insects- introduction to phylogeny of insects, Importance of taxonomy. Hierarchic classification, major Classification of class Insecta. Species concept and types species. Variation in taxonomic characters- problems in identification of species; International Code of Zoological Nomenclature. Classification of insects with characters upto family level, Phylogenetic relationships among the insect's order. Salient taxonomic characters, special morphological features, number of species known, geographical distribution of agricultural important order- Isoptera, Orthoptera, Hemiptera, Thysanoptera, Neuroptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera, Strepsiptera, Thysanura, Dictyoptera. Taxonomic characters of the following families; Termitidae, Thripidae, Gryllidae, Tettigonidae, Acrididae, Cicadellidae, Membracidae, Delphacidae, Fulgoridae, Coccidae, Pseudococcidae, Aphididae, Psyllidae, Miridae, Reduvidae, Coreidae, Noctuidae, Pyralidae, Bombycidae, Arctiidae, Papilionidae, Tephritidae Cecidomyidae, Tachinidae,

Braconidae, Tricogrammatidae, Ichneumonidae, Chalcididae, Apidae, Formicidae, Tenthredinidae, Chrysomelidae, Cuculionidae, Bostrychidae, Coccinellidae, Cerambycidae and Scarabidae.

**Practical:**

Study of orders of insects and their identification using taxonomic keys. Keys upto family level for some agricultural insect orders- Orthoptera, Isoptera, Hemiptera, Thysanoptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visit to collect insects of different orders.

**Learning Outcome:**

At the end of the course students will acquire the knowledge of correct identification of an unknown insect up to family level.

**AEN 504*** **Insect ecology** **(1+1)**

**Objectives:**

To teach the students about the concepts of ecology, basic principles, distribution and abundance of organisms and their causes. To impart an idea of life tables, organization of communities and diversity indicies. Also to train the students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

**Syllabus:**

**Theory:**

Principles of ecology and its divisions, concept of ecosystem and its different components:- abiotic components- climatic factors, edaphic factors, , biotic components- plants, animals and microorganisms, their role in the ecosystem, trophic level, food chain. Population ecology:- definition of population, density, characters of population growth, different growth forms. Natality and mortality. Law of population growth, biotic potential and environmental resistance. Life table and age structure, population dynamics-density dependant and density independent phenomenon. Intra and inter-specific phenomenon, population equilibrium. Community ecology and ecological engineering.

**Practical:**

Methods of sampling insects, estimation of densities of insect and understanding the distribution parameters- measures of central tendencies, poison distribution, negative binomial distribution. Determination of optimum sample size. Calculation of some diversity indices- Shannon's , Simpson's index and understanding their association and the parameters that affect their values. Computation of life tables. Field visit to understand different ecosystems and study the insect occurrence in these systems. Day Degree calculation.

**Learning Outcome:**

After completion of the course students will be acquainted with the basic principles of ecology. Also they will learn the various types of interactions in the environment, population

dynamics of insect. Lastly they develop expertise in construction of age specific Life Table of an insect.

**AEN 505* Pest of field crops and their management (2+1)**

**Objectives:**

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

**Syllabus:**

**Theory:**

Pests of field crops and their distribution and relative importance in India, incidence pattern , succession in different growth stages of crops in different crop seasons, Off season behaviour- perpetuation , biology and annual generations, population fluctuation, out break-factors influencing, changing pattern of pests composition and management. Cereals (Rice, wheat, maize millet) and Sugarcane pests:- pest composition as influenced by locality, key pests, sporadic pests, rational management of them, Epidemiology of pests. Cotton and Jute pests:- region based dominancy, pest complex, climatic and plant factors influencing, morphological adaptations. Pest composition of pulses and oil seed crops. Specific pattern on different crop species, alternate host acquisition in different season, biological statistics, level of damage to crop and sustainable management.

**Practical:**

Field visit, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study the life history of important insect pests.

**Learning Outcome:**

After completion of the course students will be acquainted with various insect-pests of field crops their damage symptoms and learn the techniques of AESA based pest management.

**AEN-506* Pest of horticultural crops and their management (2+1)**

**Objectives:**

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history and their integrated management.

**Syllabus:**

**Theory:**

Pests composition of brinjal, okra, potato, tomato, chilli, cole crops, cucurbits in different agroclimatic zones of India, variation of dominance of different species w.r.t season. Seasonal history of occurrence, distribution and population growth peculiarities of key pests of important vegetables crops. A brief introduction of the characteristics of perennial crop pests, reason for multiplication and their perpetuation. Natural damage and symptoms at early (seedling) stages and fruit bearing stages, extent of damage and its reflection to ultimate yield. Pest infesting root, trunk and reproductive parts of the plants. Pest of Citrus, mango, banana,

litchi, coconut, cashew nut and tea. Methods of controlling pests of orchard and plantation crops. Pests of Zinger, turmeric, cardamom, betelvine and ornamentals.

**Practical:**

Field visit, collection and identification of important insect-pests and their natural enemies of horticultural crops in the laboratory and field. Detection and estimation of infestation and losses in different vegetables crops; Distribution pattern of population build up. study the life history of important insect pests.

**Learning Outcome:**

After completion of the course students will be acquainted with various insect-pests of horticultural crops their damage symptoms and learn the techniques of AESA based pest management.

**AEN-507* Biological control of crop pests and weeds (1+1)**

**Objectives:**

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic & microorganisms.

**Syllabus:**

**Theory:**

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation. Importation of natural enemies-Quarantine regulations, biotechnology in biological control. Insect Growth regulators and Botanicals in pest management

**Practical:**

Identification of common natural enemies of crop pests (parasitoids, predators, icrobes) and. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators.

**Learning Outcome:**

Upon completion of the course students will able to identify the common natural enemies of crop pests. They acquire the knowledge of mass production of egg, common predators, microbes and their laboratory hosts.

**AEN 508* Toxicology of insecticides (2+1)**

**Objectives:**

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

**Syllabus:**

**Theory:**

Scope and definition of insecticide toxicology. Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, and some fumigants. Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, co-toxicity ; relative toxicity; potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility,. Selectivity of insecticides—vertebrate selective ratio (V/S). Toxico-dynamics of insecticides (detoxification, reaction with the enzymes and metabolism) Biochemical basis of resistance development and its management.

**Practical:**

Insecticide formulations and mixtures; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Working out doses and concentrations of pesticides; Safety evaluation of insecticides—MRL, ADI, FF, TL etc. visit to toxicology laboratories.

**Learning Outcome:**

After completion of the course students will be acquainted with toxico-dynamics of newer molecules. Also they will develop skills on the bioassay techniques also able to work out joint toxicity.

**AEN 509 General acarology (1+1)**

**Objectives:**

To aquaint the students with external morphology of different groups of mites, train in identification of commonly occurring families of plant associated mites, provide information about important mite pests of crops and their management.

**Syllabus:**

**Theory:**

Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics. Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees. Management of mites using acaricides, phytoseiid predators, fungal pathogens etc. Culturing of phytophagous, parasitic and predatory mites.

**Practical:**

Collection and extraction of mites from plants, soil and store products.; Preparation of mounting media and slide mounts; external morphology of mites; identification of mites up to family level using keys; studying different rearing techniques for mites.

**Learning Outcome:**

After completion of the course the students will be acquainted with different groups of mite and their phytophagous nature to different crops. They will also develop skills on the identification of different groups of mite, their host range, management and mass culturing of phytophagous and predatory mites.

**AEN-510 Insect embryology and post-embryonic development (1+1)**

**Objectives:**
To aquaint the students with the embryonic & post-embryonic development of insects, types of metamorphosis. Focus will also be given to the different modes of reproduction, hatching, development of different organs and types of larva and pupa.

**Syllabus:**

**Theory:**

Embryonic and post-embryonic development; Types of metamorphosis. Development of Imago :- fertilization, development of oocyte, cleavage and blastoderm formation, germ band formation, blastokinesis. Organogenesis. Variation in development:- viviparity, polyembryony, parthenogenesis paedogenesis. Post embryonic development:- hatching and shedding of embryonic cuticle, number and duration of instars, types of larva, pupa and its significance, development of organs.

**Practical:**

Identification of different types of larvae and pupae. Morphometry of insect eggs, Morphological changes of egg cell during incubation period after hatching; observation of instars, body coloration before and after moulting, Larva- pupal intermediate, Pupal colourations with respect to tanning and hardening. Developmental comparison between nymph and adult. Sex related variation in adult insect. Healthy and deformed insect.

**Learning Outcome**:

After completion of the course the students will be acquainted with the different types of metamorphosis, larva and pupa found in insects. They will also learn about fertilization, development of oocyte, blastoderm formation blastokinesis and organogenesis. They will also have a knowledge about the different types of reproduction in insects, hatcing and shedding of embryonic cuticle.

**AEN 511 Storage entomology & vertebrate pest (1+1)**

**Objectives:**

To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage. As well as to impart knowledge on vertebrate pests like birds, rodents, mammals etc.,

**Syllabus:**

**Theory:**

Ecology of occurrence of different storage pests and reasons for variation in different storage conditions and localities. Biological activities of different pest species, relationship of abundance in pest complex, nature and extent of damage by them, source of infestation. Different storage structures and method of storage. Role of different physical factors in storage hygiene and measure to counteract them. Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures-Non-chemical control- ecological, mechanical, ecological, biological and engineering. Chemical control- prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

**Practical:**

Field visit, collection, identification and familiarization with the stored grains, seeds insect pests and nature of damage caused by them. Detection of insect infestation in stored food grains; estimation of losses in stored grains; determination of moisture content in stored food grains, Visit to common storage structures. Calculations of required quantity of fumigants and insecticidal spray for different storage house.

**Learning Outcome**:

After completion of the course the students will be acquainted with the different storage pests of agricultural produce, their identification, nature of damage, measurement of loss caused by them and their management by non-chemical and chemical means. The students will also learn about the rodent pests of stored products and their management.

**AEN-512 Commercial entomology (1+1)**

**Objectives:**

To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products, as well as insect pests of public health and veterinary importance and their management of different crops, their biology, damage they cause and management strategies.

**Syllabus:**

**Theory:**

Apiculture:- Honey bee species occurring in India, morphology for identification of different bee species, society and social organization, caste differentiation, nest formation and behaviour, Methods of artificial /commercial rearing (apiary), care and protection of apiary.

Sericulture:- silkworm species of commercial values, morphological character, systemic position, and distribution. Wild and semidomesticated and domesticated species- their host plant and types of silk produced by them. Mulberry silk production- moricuture including different species, variety, their propagation, cultivation methods and picking of leaves. Silk worm rearing:- requisites for local and scientific rearing, Grainage:- procedure for production of Dfls and commercial cocoon production. Protection from hazards. Lac culture:- Morphological peculiarities of different stages of development. Strains of lac insect, host plants and types of lac. Biological characteristics and life cycle of lac insect. Cultivation of lac host plant- pruning, coup system, preparation of schemes, inoculation and harvesting. Processing and marketing, Natural enemies of lac and their remedies.

**Practical:**

Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery and commercial apiaries. Silkworm rearing and management. Lac host and crop management technology and processing of lac. Products and bye-products of lac.

**Learning Outcome**:

After completion of the course the students will be acquainted with apiculture - honey bees species, their identification, behavior and artificial rearing and care. The students will also be aquainted with Sericulture – different species of silkworm, their identification behavior and artificial rearing and care. The students will learn about moriculture also. Apart from these the students will learn about Lacculture, their different strains, life cycle inoculation and harvesting.

**AEN 513 Chemical pest control (1+1)**

**Objectives:**

To familiarize the students with management of insect-pests with respect to behavioural control (attractants, pheromones and repellants); antifeedants; chemosterilants and insecticidal control (different groups of insecticides their field properties) and their application techniques.

**Syllabus:**

**Theory:**

Behavioural control:- behaviour controlling agents, attractants- food lure, sex lure ; pheromones. Potential uses of them. Repellants- early chemical repellants, synthetic chemical repellents, major area of use and prospects. Antefeedants- chemical types, mode of action. Chemosterilants:- chemical types, structure activity relationship, mechanism of action, practical uses, sterile male release techniques and limitation. Insecticidal control:- kinds of insecticides in common use, characteristics of the major kind of insecticides. General field properties, formulations, principles involved and uses. Application of insecticides, selection of insecticides formulation and dose,and volume of field use formulation. Behaviour of droplet/particles after release from the equipment and deposition on target.

**Practical:**

Evaluation of different types of traps against fruit flies with respect to signals; behavioural study of Bees and flies under laboratory condition. Field evaluation of bioefficacy of insecticides; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Working out doses and concentrations of pesticides.

**Learning Outcome:**

After the completion of the course the students will be aquainted with the different means of insect-pest management in agricultural crops. They will also learn about the different application techniques of insecticides, their dosages, different types of chemical imposition appliances etc. under field condition.

**AEN 514 Insect-vectors of plant pathogens & their relationships (1+1)**

**Objectives:**

To teach the students about the different groups of insects that are vectors of plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases

**Syllabus:**

**Theory:**

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission. Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors. Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips. Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers. Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

**Practical:**

Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies

**Learning Outcome**:

After the completion of the course the students will be acquainted with the different vectors of plant pathogens, their characteristics and process of transmission of plant viruses and fungal pathogens. The students will also learn about the management techniques of different vectors.

**AEN 515 Principles of integrated pest management (2+1)**

**Objectives:**

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes

**Syllabus:**

**Theory:**

History of Plant Protection, Plant Protection Organisation in India and International level. IPM Concept and philosophy, ecological principles, economic threshold concept. Concept and classification of pests, information required to tackle the pest problem-plant aspects, pest's aspect and environment aspects. Economic consideration, Simulation and modelling in plant protection. Merits and demerits of Integrated Pest Management. Tools of pest management and their integration- legislation, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of survey including remote sensing methods, factors affecting surveys; political, social and legal implication of IPM. Case studies of successful IPM programmes. Semiochemicals and Biotechnology in crop protection. Resistance and its integrated management (IRM). Pesticides- Development, Formulations and Designing of pesticide application equipments, HV, ULV, LV spraying, dusting, seed treatment, soil application, heat treatment, fumigation fire & flame applicators, aerosol, aerial and granular application, encapsulation. Use of nanotechnology in insect pest management. Toxic hazards of pesticides in the ecosystem- soil, water, food, forest. Effect on non-target organism, phyto-toxicity. Safety measures in handling pesticides, precaution and antidotes.

**Practical:**

Crop loss assessment- direct losses, indirect losses, potential losses, avoidable losses and unavoidable losses. Assessment of pest population- direct & indirect assessment, Sampling requirements and methods, survey & surveillance, remote sensing. Acquaintances with registered pesticides in India and their formulations, Compatibility. Application of pesticides by various equipments, agricultural aviation. Decision making for pest control, Computation of EIL and ETL; Crop pest modelling, prediction model of crop pest. Calculation of benefit: cost ratio.

**Learning Outcome:**

After completion of the course students will be proficient enough to construct population model and economic use of pesticide model. Also able to take decision based on ETL estimation as well as to make the venture cost effective one.

**AEN 516 Host plant resistance to insects (1+1)**

**Objectives:**

To familiarize the students with types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management of agricultural crops.

**Syllabus:**

**Theory:**

History and importance of resistance, principles, classification, components, types and mechanisms of resistance. Insect-host plant relationship, factors for insect feeding on plants –

visual and gustatory stimuli, physical and mechanical characteristics of plants, chemical factors in plants, nutrients and secondary metabolites. Trophic plasticity in insect--- monophagism, oligophagism and polyphasigm, variation in development of polyphagous insects feeding on different host plants. Factors affecting plant resistance including biotypes and measure to combat them. Role of biotechnology in plant resistance to insects.

**Practical:**

Screening techniques for measuring resistance, measurement of plant characters and working their correlation with plant resistance. Bioassay of plant extracts of susceptible / resistance varieties; Demonstration of antibiosis, tolerance and antixenosis.

**Learning Outcome**:

After the completion of the course the students will be acquainted with insect-host plant relationship, bases of host plant resistance to insects, and different factors influencing feeding of plants by insects. The students will also learn about the role of biotechnology in insect-pest management.

## SYLLABUS: DEPARTMENT OF PLANT PATHOLOGY

### Course offered by Department of Plant Pathology

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| PPC- 501* | Principles of Plant Pathology | 2+0 | I |
| PPC- 502* | Mycology | 2+1 | I |
| PPC- 515* | Principles of Plant Disease management | 2+1 | I |
| PPC-512 | Mushroom Science | 2+1 | I |
| PPC-509 | Seed Pathology | 2+1 | I |
| PPC- 503* | Plant Bacteriology | 2+1 | II |
| PPC- 505* | Diseases of Field crops and their management | 2+1 | II |
| PPC-508 | Epidemiology of Plant diseases | 2+1 | II |
| PPC-511 | Post Harvest Pathology | 2+1 | II |
| PPC-517 | Phytopathological Techniques | 0+2 | II |
| PPC-518 | Biological control of plant diseases | 1+1 | II |
| PPC-510 | Root pathology | 2+1 | II |
| PPC- 504* | Plant Virology | 2+1 | III |
| PPC- 506* | Diseases of Horticultural crops and their management | 2+1 | III |
| PPC-507 | Molecular Plant Pathology | 2+1 | III |
| PPC-516 | Plant Nematology | 1+1 | III |
| PPC-513 | Ecology of Plant Pathogens | 1+1 | III |
| PPC-514 | Virus –vector Relationship | 1+1 | III |
| PPC- 591 | Credit seminar | 0+1 | IV |
| PPC- 599 | Master's Research (Thesis) | 0+20 | I to IV |

*CORE COURSE

**PPC- 501 Principles of plant pathology 2+0**

**Objectives:**

To provide basic knowledge about the pathogens their ecology and host pathogen interactions.

**Syllabus:**

**Theory**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases; Survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development, Co-evolution of plant pathogens. Host parasite interaction, recognition of host by pathogens, concept of infection, entry of pathogen into host, mode of host penetration, appressorium, infection peg, symptomatology, inoculums; Pathogen offence- role of enzymes, toxins, growth regulators and polysaccharides

(classification, mode of action, disease development); Defense strategies- Physical and biochemical (preformed and post inflectional). ISR and SAR; Physiological changes in host after infection- photosynthesis, respiration, transpiration, translocation, absorption, transcription and translation, plant growth etc; Genetics for disease resistance – R genes, vertical and horizontal resistance , tissue culture and genetic engineering for disease resistance**.**

**Learning Outcome:**

Help the learners for proper understating of pathogen behaviour, their interaction with host which in turn allow them for developed resistant cultivars.

**PPC- 502*** **Mycology** **2+1**

**Objectives:**

To provide basic knowledge about the fungi, their taxonomy, growth, reproduction and role in nature.

**Syllabus:**

**Theory**

Introduction, definition of different terms, basic concepts; Importance of mycology in agriculture, fungal biodiversity, Origin and evolution of fungi and fungal like organisms, fungi in human affairs, history of mycology; Concepts of nomenclature and classification, different types of calassification, Modern methods and limitations, Molecular taxonomy , Phylogenetic relationship; The comparative morphology, reproduction in fungi, ultrastructure, characters of different phylum of fungi up to generic level: i) Chytridiomycota ii) Neocallimastigomycota iii) Blastocladiomycota iv) Glomeromycota v) Ascomycota, vi) Basidiomycota, vii) Deuteromycota. viii) Oomycota, Plasmadiophoromycetes, Lichens types and importance, Mycorrhiza, types and importance; Mycosis and Mycotoxicoses, Aerobiology; Fungal growth- Hyphal elongation of fungi, physiology of growth and factors, production of secondary metabolites.

**Practical**

Isolation and identification of plant pathogenic fungi from different sources; Preservation and maintenance of fungal cultures; Study of different reproductive structures obtained under *in vivo* ans *in vitro* by camera Lucida drawing and microphotography; Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Identification of plant pathogenic fungi. i.e. *Pythium , Phytophthora, Sclerospora,Peronospora, Plasmopara and Albugo , Rhizopus and Mucor , Erysiphe, Glomerella , Puccinia, Uromyces, Melampsora , Ustilag Neovossia, Fusarium, ,Cercospora, Helminthosporium, Cercospora.* Fungal morphology- Determination of size by micrometric method. Use of haemocytometer for standardization of spore suspension. Isolation of soil fungi by serial dilution technique by using different media

**Learning Outcome:**

Detailed knowledge about fungi and their biology would help the learners for research in the field of host pathogen interaction and management.

**PPC – 503 Plant bacteriology 2+1**

**Objectives:**

To provide detailed knowledge about bacteria and mollicutes, their taxonomy, growth, reproduction and role in nature.

**Syllabus:**

**Theory**

History of Bacteriology with emphasis on Plant Bacteriology. Morphology of Bacterial cell and bacterial colony. Ultrastructure of Bacterial cell. Growth – concept, measurement, dynamics and factors of growth. Variability and Recombination in bacteria. Bacteria metabolism. Taxonomy – historical retrospective including concepts of subspecies and pathovar, Different kinds of taxonomy, Modern classification system of bacteria, Advanced techniques and tools in classification. Serology – importance, antigen and antibody, preliminary concept of monoclonal and polyclonal antibody; concept and classification of Immunity. Ecology and epidemiology of bacterial plant pathogens. Mollicutes – concept, nature, culturing, detection, classification. Bdellovibrio and other fastidious prokaryotes – nature and present position. Vectors of Bacteria and mollicutes.

**Practical**

Preparation of different media for isolation of bacteria from infected plant hosts and isolation of plant pathogenic bacteria. Koch' postulates for a bacterial disease. Determination of bacterial growth by turbidometric method and study the variation of growth due to different factors like temperature, salt concentration, Ph. Staining of bacterial cell – gram staining, relief staining, flagella staining etc. Selective biochemical tests as per existing laboratory facilities. Ecological investigation of rice bacterial diseases and wilt of solanaceous vegetables. Inoculation technique in plants and determination of hypersensitive reaction. Detection of phytoplasmal diseases by Oxytetracycline sensitivity assay and Dien's test. Study of natural vectors of bacterial plant pathogens in the locality. Assay for bacteriostatic substances.

**Learning Outcome:**

Detailed knowledge about bacteria and mollicutes would help the learners for research in the field of host pathogen interaction and management.

**PPC-504 Plant virology 2+1**

**Objectives:**

To provide detailed knowledge about virus and sub-viral particles, their taxonomy, growth, reproduction and role in nature.

**Syllabus:**

**Theory**

History of plant virology Isolation, Characterization and identification of plant virus. Symptomatology and movement of plant viruses within plants. Components and physicochemical nature of plant viruses. Origin, evolution, nomenclature and classification of plant viruses. Architecture of plant viruses. Replication of plant viruses. Transmission of plant viruses. Virus vector relationship-concepts in brief. Mycoviruses, Satellite viruses, viroids, prions and satellite RNA's, Bacteriophages. Management of virus diseases with emphasis on special techniques.

**Practical**

Study of different types of symptoms (macroscopic, histopathological) produced by plant viruses. Use of local lesion host for identification. Isolation of plant viruses – certain basic steps. Sap, graft and vector transmission; transmission of plant viruses by dodder. Detection of plant viruses in plants and planting materials. Pathometry of virus diseases known in the locality. A field trial for management of virus disease(s). Visit to advanced laboratories for Electron microscopy.

**Learning Outcome:**

Detailed knowledge about virus and sub-viral particles would help the learners for research in the field of host pathogen interaction and management.

**PPC-505 Diseases of field crops and their management 2+1**

**Objectives:**

To generate overall knowledge about the cereals diseases and their management.

**Syllabus:**

**Theory**

Classification of plant diseases according to causal agents. All Indian major diseases and diseases of academic interest [International] will be covered for : Fungal Diseases; Major cereals – Rice (Blast, sheath blight, brown spot, sheath rot, stem rot, false smut); Wheat (Rust, bunt, Karnal bunt, loose smut, Helminthosporium Leaf Spots and A*lternaria* leaf blight ); Barley ( Covered smut ); Maize (Stalk Rots of Maize , Downy Mildews of Maize , Helminthosporium Leaf Spots ); Sorghum (Smut, downy mildew); Bajra; (green ear, ergot ). Fibre crops – Jute and Mesta (wilt, stem rot); Cotton (Anthracnose of Cotton, Vascular wilt). Pulses – Pigeon pea (wilt); Bengal gram (Ascochyta Blight, wilt); Cowpea (anthracnose); pea (rust, Ascochyta Blight, powdery mildew); Lentil (wilt). Oilseed crops- Mustard and rapeseed (Club root , *Alternaria* leaf spot ,downy mildew , white rust); groundnut( tikka, rust); linseed ( rust), Soybean ( rust). Cash crops – Sugarcane (red rot, Whip smut, wilt); Tobacco (Black Shank). Fodder legumes – Oat (smut, rust); Lucerne (rust, smut). Bacterial diseases Major cereals – Rice (BLB, BLS); Wheat (Yellow ear rot); Maize (Bacterial stalk and ear rot). Fibre crops –Cotton (Angular leaf spot of cotton). Pulses – Soybean (Bacterial pustule). Oilseed crops - Mustard and rapeseed (Black rot of mustard). Cash crop – Sugarcane (Ratoon stunting). Virus diseases: Major cereals – Rice (Tungro); Wheat (Yellow ear rot); Maize

(Maize dwarf virus, Maize mosaic). Pulses – Pigeon pea (Sterility mosaic); Bengal gram and green gram (Yellow mosaic). Oilseed crops – Ground nut (Groundnut rosette and bud blight). Cash crop – Sugarcane (Sugarcane mosaic); Tobacco (mosaic and leaf curl). Phytoplasmal Diseases: Major cereals – Rice (rice yellow dwarf); Fibre crops –Cotton (Stenosis of cotton); Cash crop – Sugarcane (Grassy shoot of sugarcane); Acquaintance with other phytoplasmal diseases; Nematode diseases:Major cereals – Rice (Ufra, Root knot, White tip); Wheat (Ear-cockle), Barley (Molaya); Cash crop – Sugarcane (root knot); Brief knowledge of uniflagellate protozoa, insect, and mites as causal agents of plant diseases; Diseases caused by Angiospermic plant parasites; Diseases due to abiotic causes – Khaira disease of rice, Boron deficiency of wheat; Disease complex and unknown aetiology – Cotton parawilt;
Note: (** Important diseases to be covered including new immerging diseases)

**Practical**
Isolation of plant pathogens following standard techniques. Study of symptoms, C.O. etc for different plant diseases as outlined in theory courses. Calculations of fungicides or other substances for management of different diseases for seed treatment, soil treatment, spraying/dusting at different stages of plant growth. Histopathological studies. *In vitro* and *in vivo* evaluation of botanicals and fungicides. Camara lucida drawing and micrometric measurement of plant pathogen. At least five semipermanent slides are to be deposited during practical examination. Visits of field, market and storage. Submission of catalogued plant disease herbarium.

**Learning Outcome**:
Help the learners for identify the diseases through symptoms in field, their proper management as well as identification of causal agents by microscopic study.

**PPC-506 Diseases of horticultural crops and their managements** 2+1**

**Objectives:**
To generate overall knowledge about the diseases of horticultural crops and their management.

**Syllabus:**

**Theory**

Diseases of major fruit crops grown in India: Tropical and sub- tropical fruits- Mango, banana, citrus spp., grape, guava, jackfruit, papaya, pineapple, pomegranate, sapota, ber datepalm. Temperate fruits -Apple, pear, peach, plum, Apricot and strawberry. Diseases of vegetables- Cole crops (cabbage, cauliflower, knoll khol, radish, broccoli); cucurbitaceous vegetables (cucumber, pumpkin, pointed gourd, bitter gourd, bottle gourd, ridge gourd); leguminous vegetables ( pea, cowpea, beans) Solanaceous vegitables (potato, Brinjal , tomato, chilli); others important vegetables ( okra, carrot, beet, sweet potato, onion and garlic). Diseases of spices and condiments - Turmeric, black pepper, coriander, cumin, fennel, ginger. Diseases of flowering and ornamental plants - Rose, dahlia, chrysanthemum, gladiolus, marigold, tube rose, carnation, cactus & orchids. Diseases of medicinal and aromatic plants - Plantago, rosagrass, sacred basil,

mentha, *Aloe vera, Ashwagandha.* Diseases of plantation crops - Tea, coffee, cocco, rubber, coconut , arecanut, betelvine sandal and mulberry. Selected market and storage diseases of fruits and vegetables.

**Practical**

Isolation of plant pathogens following standard techniques. Study of symptoms, c.o. etc. for different plant diseases as outlined in theory course. Calculation of fungicide or other substances for management of different diseases for seed treatment, soil treatment, spraying /dusting at different stages of plant growth. Histopathology- use of stains. *In vitro and in* vivo evaluation of botanicals and fungicides by spore germination inhibition techniques. Camera lucida drawing and Micrometric measurement of plant pathogens. At least five semi-permanent slides are to be deposited during practical exanimation. Visits of field, market and storage. Submission of a catalogued plant disease herbarium.

**Learning Outcome**:
Help the learners for identify the diseases through symptoms in field, their proper management as well as identification of causal agents by microscopic study.

**PPC-507 Molecular plant pathology* 2+1**

**Objectives:**
To generate knowledge about the Host pathogen interactions at molecular level, developed idea about the recent molecular technologies related to plant pathology

**Syllabus:**

**Theory**

Genesis, importance and scope of molecular plant pathology. Study of basic techniques like Electrophoresis, Immunoassay, Nucleic acid sequencing & hybridization, PCR, RAPD, RFLP, HPLC, MS. Study of basic and advanced serological techniques; production of monoclonal and polyclonal antibodies. Instrumentation and maintenance of molecular plant pathology laboratory. Detection and diagnosis of plant pathogens by various immuno- and molecular techniques. Molecular techniques in understanding of pathogenesis. Molecular techniques to trace origin and evolution of different groups of pathogens, and understanding of phylogenetic relationship, co-evolution. Tissue culture and biotechnological advancements relevant to molecular plant pathology; Gnotobiotic culture. Molecular techniques in epidemiology, food safety etc. Bioinformatics and advanced computations in molecular techniques. Nanotechnology in Plant Pathology.

**Practical**
Instrumentation of Molecular Plant Pathology Lab. Use of different equipment. Tissue culture. Detection of Plant pathogens in Plants and Plant Parts.
**Learning Outcome**:

Acquired knowledge helps in the research of genomics, proteomics and genetic engineering. It also helps them in resistance breeding.

**PPC-508 Epidemiology of plant diseases 2+1**

**Objectives:**
To provide basic knowledge about the epdemilogy,crop loss and modulation of epidemics

**Syllabus:**
**Theory**

Epidemiology- history, concept, components and factors affecting disease, relationship in epidemics as a process. Pathometry -Assessrnent of incidence, intensity, disease index, Disease Progress Curve and Area under disease progress curve; crop loss due to disease, Principal Component Analysis in epidemiology. Environmental factors affecting disease development; Macro -and Microclimatic factors in relation to disease, climatological tools, Microclimate - tools, Relationship with disease. Analysis of epidemic as a system, Predisposition of hosts and dispersal of plant pathogens. Geophytopathology. Pathosystem Management - Strategy of Control, Monitoring of Disease; detection of new races through molecular techniques, Forecasting - Principles and Methods, Factors affecting forecasting, some early forecasting procedures based on inoculums density and weather; Modern Predictive systems; scope in India. Objectivess and effects of genetic control with special reference to epidemiology.

**Practical**

Preparation of disease severity scale and determination of Disease Index Percent in different Pathosystems. Preparation of disease progress curve and Calculation of AUDPC, Annual Infection Rate. Principal Component Analysis using computer. Preparation of Geophytopathological maps by using data. *ln situ monitoring* of a disease by different methods. Simple correlation and MR of climatological factors in disease development. Aquaitance with meteorological instruments and their function, data recording.
**Learning Outcome**:
Help the learners for proper understating of crop losses, environmental factor and disease relationship which may help in disease forecasting and formation of forecasting models.

**PPC – 509 Seed Pathology 2+1**

**Objectives:**

To provide knowledge about various seed borne pathogens, ecology, spread, survival etc. and related seed born diseases

**Syllabus:**

**Theory**

Concept, Economic significance; History of seed pathology. Regulations on Seed production and marketing in Developed and Developing Countries with emphasis on South East Asian Countries; The Indian Seed Act. Seed Diseases – Concept, Types. Seed Borne Pathogens – Variety, Nature, Kinds of relationship, Criteria of transmission, mechanisms, proofs of transmission. Biochemical changes in seed. Ecology of seed borne pathogens. Epidemiology – Forecasting losses, and assessment of disease tolerance for seed health testing. Seed health testing – Objectivess, requirements, and Common and Advanced techniques of seed health. Mycotoxins and seed infections. Strategy of control, Management of seed storage, modern grain storage techniques.

**Practical**

Seed health testing by physical examination and seed washing method. Seed health testing by different incubation methods moist blotter test, 2-4 D, agar plate test for different kind of seeds. Detection of seed borne microflora in paddy, wheat, vegetables etc. *In vivo* and grow on test of seed infection. Forecasting of losses with infected seeds. Biochemical changes in maintenance of seed quality particularly carbohydrate etc. Detection of mycotoxins.

**Learning Outcome**:
Detailed knowledge seed borne pathogens, ecology etc. help the learners for proper management of seed borne diseases

**PPC-510 Root pathology 2+1**

**Objectives:**
To provide knowledge about various root pathogens, ecology, spread , survival etc. and various soil born diseases they cause.

**Syllabus:**
**Theory**
General – Root System, root growth and root growth modeling, soil-root interaction and interface, root-shoot interrelationship, host root exudates. Soil-microorganism in relation to plant root diseases and brief account of soilborne plant pathogens. Mycorrhiza – Types and role in agriculture. Classification of root diseases – systems, chronic and acute, organism involved. Pathogenic root infecting fungi – types and their ecology; factors and measurements of tropism in fungi and other pathogens in host recognition. Ecological concepts – inoculums potential, CSA, EGH, rhizosphere and soil mycostasis. Structure and physiology of resting structure. Molecular detection of soil borne plant pathogens. Polyetic epidemiology and modeling in soil microorganism with special reference to pathogens. Conducive and suppressive soils. Control of root diseases – strategy, methods, side effects of pesticides, biological control.

**Practical**

Isolation of soil microbes and determination of rhizosphere effect. Determination of mychorrhizal status in different healthy and diseased host roots. Growth and survival of soil microbes. Bioassay of soil fungicides. Laboratory evaluation and field studies with biocontrol agents. Experiments with soil amendments and soil mycostasis. Comparison of soil characteristics between conducive and suppressive soils in selected host pathogen system. Survey for root diseases in the locality.

**Learning Outcome**:

Detailed knowledge about root pathogens, ecology etc. help the learners for proper management of root and other soil borne diseases

**PPC-511 Post-harvest pathology 2+1**

**Objectives:**

To provide knowledge about the post harvest pathogens, ecology, spread , survival etc. and various diseases they incite.

**Syllabus:**

**Theory**

History, concept, definition, significance with reference to environment and health. Losses in durables and perishables. Postharvest diseases of durables – types and control. Postharvest diseases of perishables – important pathogens and important diseases in India. Host-pathogen relationships aflatoxigenic and other mycotoxigenic fungi and monitoring for any health hazard. Ecology and Epidemiology of postharvest diseases of perishables. Descriptions of selected diseases of mango, banana, citrus, apple, tomato, potato, cucurbits, okra subterranean crops. Management – Principles, strategy, methods, botanicals, chemicals and biocontrol agents, induced resistance.

**Practical**

Isolation of grain deteriorating fungi using agar plate technique and grain washing. Survey for occurrence and loss of perishables and interpretation of data. Diagnostics by comparative symptomatology. Isolation and identification of postharvest pathogens. Koch's postulates. Exercises on host parasite relationship. Selected exercises on ecology and epidemiology (Association, infectivity titration, effect of temperature and pH. Bioassay and management with chemicals, botanicals, volatile oils etc. Mycotoxin assay. Submission of catalogued specimens and permanent slides.

**Learning Outcome:**

Detailed knowledge about post harvest pathogens, ecology etc. help the learners for proper post harvest disease management.

**PPC-512 Mushroom cultivation 1+2**

**Objectives:**
To generate knowledge about edible and cultivated mushroom, their cultivation and entrepreneurship development.

**Syllabus:**
**Theory**
Historical developments of mushroom cultivation and present status, taxonomy, classification. Food, medicinal value, uses of mushroom, edible and poisonous mushrooms. Life cycle of cultivated mushroom, preparation and strain improvement, maintenance of pure culture preparation of spawn and facilitated required for establishing commercial spawn lab. Cultivation technology of *Agaricus bisporus* (different *Agaricus* species, composting and its formulation, casing, preparation of casing mixture, sterilization; *Pleurotus* sp.( different *Pleurotus* species , substrate selection and cultivation technique: *Volvariella* sp.( different *Volvariella* species and their cultivation);other cultivated mushroom i.e. *Calolacia indica*, *Lentinus edodes* and *Ganoderma lucidum*. Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, C02, ventilation in cropping rooms. Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition. Economics of mushroom cultivation, biotechnology and mushroom cultivation.

**Practical**
Survey of locally available mushrooms and their identification. Preparation of spawn, compost, spawning, casing, harvesting and postharvest handling of edible mushroom. Identification of various pathogens, competitors of various mushrooms. Development of mushroom isolates through somatic anatomises. Spore print and single spore culture.
**Learning Outcome:**
Student can start their own entrepreneurship by acquiring the knowledge and **s**kills about mushroom cultivation

**PPC- 513 Ecology of plant pathogens 1 +1**

**Objective:** To provide basic knowledge about the pathogen ecology , spread , survival etc.

**Syllabus:**

**Theory**
Microbial ecology and its relation to plant pathogens; contribution of Odum, Patten, Garett, Gregory, Neergard and others. Survival, Distribution and population dynamics of plant pathogens. Ecosystem analysis of microbial community and Mathematical tools and statistical designs in ecosystem. Microchemistry of Plant/ microbe interactions. Autoecology and Evaluation of plant pathogens in complex ecosystems. Study of ecology of soil borne plant

pathogens, airborne pathogens, seed borne pathogens and postharvest pathogens, phaenerogamic plant parasites.

**Practical**

Use of mathematical and statistical tools for ecosystem analysis. Ecosystem analysis in soil borne and airborne diseases in cereals, oilseeds, vegetables. Biodiversity of postharvest pathogens. Techniques in microchemistry analysis to investigate plant /microbe interactions.

**Learning Outcome**: Detailed knowledge about pathogen ecology help the learners for proper understanding survival of the pathogens which help for developing forecasting modules and disease management.

**PPC 514 Virus –vector relationship 1+1**

**Objectives:**
To provide detailed knowledge about viruses their vectors and their interrelationship in different ecosystem.

**Theory**

History of virus vector relationship and critical gaps. Designing glass house, insectory and maintenance; Modern instrumentations of virus vector relationship studies. Transmission characteristics in different types of virus-vector relationship. Evidence of propagation of viruses in vectors. Identification of different groups of vectors up to species level. Techniques of handling of different vectors and maintenance of viruliferous insect colony. Concepts of terminologies in virus-vector relationship. Detailed studies of virus-vector relationship of arthropods, nematodes and fungi.

**Practical**

Identification common vectors up to species (major stress on insect vectors). Study of characteristics of nematode and fungal vectors with permanent slides and isolation. Transmission of plant virus by plant vectors. Handling of aphids, leaf and plant hopper, white fly beetle and weevil etc. practical on designing glass house.

**Learning Outcome**:
Detailed knowledge about viruses, vectors and their interrelationship help the learners for proper understanding of virus spread and their multiplication which help for developing forecasting modules and disease management.

**PPC- 515 Principles of plant disease management 2+1**

**Objectives:** To generate knowledge about crop loss, risk management, IDM

**Syllabus:**

**Theory**

Principles of plant disease management, various methods of plant disease management- cultural, physical, biological, chemical, organic amendments of soil ,use of botanicals, traditional /indigenous techniques for plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. Crop losses and their assessment, risk management and options, decision making factors. History of fungicides and bactericides. Nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals. Foliage, seed, soil and other methods of application of chemicals, role of stickers, spreaders and other adjuvants. Health *vis-a-vis* environmental hazards, residual effects and safety measures.

**Practical**

*In vitro* and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values. Study of structural details of sprayers and dusters. Assessment of crop loss. Acquaintance with different formulations and preparation of certain homemade fungicide and botanicals etc.

**Learning Outcome**:

Acquired knowledge may help the students for predicting crop loss and disease management through various approaches.

**PPC-516 Plant nematology 1+1**

**Objectives:**

To provide basic knowledge about the nematodes, their taxonomy, biology growth, importance and various symptoms they produced and their managements.

**Syllabus:**

**Theory**

History, Importance and scope of Plant Nematology with special reference to India. Morphology of nematodes especially taxonomically diagnostic parts. Study of digestive, reproductive, excretory, and nervous system in nematodes; Life cycle pattern and phases in *Meloidogyne*. Parthenogenesis, senescence, quiescence, and anabiosis in nematodes. Taxonomic characteristics of Dorylaimida, Tylenchida, Pratylenchida,Aphelenchida with typical genera. Adaptation of plant pathogenic nematodes - morphological, physiological, ecological. Infection behaviours and plant disease development patterns in different host parasite systems. Ecology- Population ecology and factors affecting population. Management of nematodes - Brief outline with examples of different conventional and non - conventional methods exclusively used by plant nematologists.

**Practical**

Isolation of nematodes from soil and plant by different techniques. Study of taxonomic characters of important plant pathogenic genera of nematodes. Study of reproductive structures in *Meloidogyne* spp. Estimation of population and community analysis. Management of nematodes (*in-vitro* assay and field trial).

**Learning Outcome**:
Detailed knowledge about Plant Parasitic nematode, their biology and other aspects would help the learners for research in the field of Phytonematology.

**PPC-517 Phytopathological techniques 0+2**

**Objectives:**
To generate knowledge about the basic techniques related to plant pathology and microbiological research.

**Syllabus:**
**Practical**
Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, spectrophotometer. *Invitro* evaluation of fungicides, bactericides etc.

**Learning Outcome**:
Acquired knowledge may help the students for isolation, inoculation,culturing, preservation, maintenance of microorganisms and handling of different instruments.

## SYLLABUS: DEPARTMENT OF GENETICS AND PLANT BREEDING

### Courses offered by Genetics and Plant Breeding for M.Sc. (Ag.) Programme

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| GPB 501 | Principles of genetics | 2+1 | I |
| GPB 502 | Principles of cytogenetics | 2+1 | II |
| GPB 503 | Principles of plant breeding | 2+1 | I |
| GPB 504 | Principles of quantitative genetics | 2+1 | II |
| GPB 505 | Mutagenesis and mutation breeding | 2+1 | II |
| GPB 506 | Population genetics | 2+1 | III |
| GPB 507 | Heterosis breeding | 2+1 | II |
| GPB 508 | Cell biology and molecular genetics | 3+0 | I |
| GPB 509 | Biotechnology for crop improvement | 2+1 | III |
| GPB 510 | Breeding for biotic and abiotic stress resistance | 2+1 | I |
| GPB 511 | Breeding cereals, forages and sugarcane | 2+1 | III |
| GPB 512 | Breeding legumes, oilseeds and fibre crops | 2+1 | II |
| GPB 513 | Breeding for quality traits | 1+1 | II |
| GPB 514 | Gene regulation and expression | 2+0 | II |
| GPB 515 | Maintenance breeding, concepts of variety release and seed production | 1+1 | III |
| GPB 516 | Germplasm collection, exchange and quarantine | 2+1 | II |
| GPB 517 | Data base management, evaluation and utilization of PGR | 2+1 | III |
| GPB 591 | Credit seminar | 0+1 | IV |
| GPB 599 | Master's Research (Thesis) | 0+20 | I to IV |

**GPB 501 Principles of genetics 2+1**

**Objectives:**

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem- solving skills from classical to molecular genetics.

**Syllabus:**

**Theory**

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance. Multiple alleles,Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance. Population - Mendelian population - Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis. Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters. Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular

chaperones and gene expression. Gene regulation in eukaryotes, RNA editing. Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR- based cloning, positional cloning; Nucleic acid hybridization and immuno- chemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Genomics and proteomics; Functional and pharmacogenomics; Metagenomics. Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

**Practical**

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis - basic principles and running of amplified DNA - Extraction of proteins and isozymes - use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

**Learning Outcome:**

i.understand the basic concepts of the ultrastructure of cell, cell organelles, chromosomes and nucleic acids
ii. apply the principles of inheritance to plant breeding
iii. acquaint with the fundamentals of chromosomal and cytoplasmic inheritance, sex determination, mutations and chromosomal aberrations
iv. learn molecular genetics.

**GPB 502 Principles of cytogenetics 2+1**

**Objectives:**

To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

**Syllabus:**

**Theory**

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes. Chromosomal theory of inheritance - Cell Cycle and cell division - mitosis and meiosis; Differences, significance and deviations - Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over-recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - *in situ* hybridization and various applications. Structural and Numerical variations of chromosomes and their implications - Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras - endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and

chromosome complexes. Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploidsvs allopolyploids -- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer - Alien addition and substitution lines - creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes. Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) - Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species. Fertilization barriers in crop plants at pre-and postfertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies - Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

**Practical**

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation - Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera* **-** Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops - Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro;*Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture - Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly - Morphological observations on alloployploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. -Fluorescent *in situ* hybridization (FISH)- Genome *in situ* hybridization GISH.

**Learning Outcome:**

i.understand the basic concepts of chromosome and its structures.
ii. To learn chromosome aberrations.
iii. acquaint with the fundamentals of chromosomal and cytoplasmic inheritance
iv. Idea about genome mapping in polyploids , gene transfer, chromosome manipulation.

**GPB 503 Principles of plant breeding 2+1**

**Objectives:**

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

**Syllabus:**

**Theory**

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance. Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of variability, components of variation; Heritability and genetic advance, genotype- environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding. Self-incompatibility and male sterility in crop plants and their commercialexploitation. Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach). Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter- population improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development-testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

**Practical**

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

**Learning Outcome:**

i.. learn breeding procedures in self and cross pollinated crops
ii. understand exploitation of heterosis utilizing male sterility and other methods
iii. know about the various population improvement programmes
iv. learn about hybrid breeding
v. learn about floral biology.
vi. study about the fundamentals of mutation, polyploidy and wide hybridization and their role in crop improvement

**GPB 504 Principles of quantitative genetics 2+1**

Objective

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects.

**Syllabus:**

**Theory**

Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic andenvironmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects. Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

Designs for plant breeding experiments - principles and applications; Genetic diversity analysis - metroglyph, cluster and $D^2$ analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance. Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis-principles and interpretation. QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

**Practical**

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - $D^2$ analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II - Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis: Analytical part and Interpretation - Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) - use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model - Principal Component Analysis model - Additive and multiplicative model – Shiftedmultiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

**Learning Outcome:**

i.. learn about nature of quantitative traits and its inheritance
ii. understand genetic diversity analysis, Selection indices.

iii. know about the various population improvement programmes
iv. learn about different Mating designs

**GPB 505 Mutagenesis and mutation breeding 1+1**

Objective
To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made.

**Syllabus:**

**Theory**

Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms - paramutations. Mutagenic agents: physical -- Radiation types and sources: Ionising and non-ionizing radiations viz., X rays, y rays, a and P particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (, photoelectric absorption, Compton scattering and pair production) and their biological effects -RBE and LET relationships. Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute*vs* chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume. Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens - Combination treatments; Other causes of mutation - direct and indirect action, comparative evaluation of physical and chemical mutagens. Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras *etc,* - Observing mutagen effects in $M_2$ generation - Estimation of mutagenic efficiency and effectiveness - spectrum of chlorophyll and viable mutations -- Mutations in traits with continuous variation. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc.* - Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species - Case studies. Use of mutagens in creating oligogenic and polygenic variations - Case studies - *In vitro* mutagenesis - callus and pollen irradiation; Handling of segregating genrations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops- Procedures for micro-mutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING.

**Practical**

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity - Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring - safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of M1 generation - Parameters to be observed; Study of $M_2$ generation - Parameters to be observed; Mutation breeding in cereals and pulses - Achievements made and an analysis - Mutation breeding in oilseeds and cotton - Achievements and opportunities - Mutation breeding in forage crops and vegetatively propagated crops; Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

**Learning Outcome:**

i.. learn about nature and classification of mutations.
ii. understand effect of mutations on DNA.
iii. know about the *In vitro* mutagenesis
iv. learn about allele mining, TILLING.

**GPB 506 Population genetics 2+1**

Objective

To impart knowledge on structure, properties and their breeding values of different population.

**Syllabus:**

**Theory**

Population - Properties of population - Mendelian population - Genetic constitution of a population through time, space, age structure etc. Mating systems - Random mating population - Frequencies of genes and genotypes-Causes of change: population size, differences in fertility and viability, migration and mutation. Hardy-Weinberg equilibrium - Hardy-Weinberg law - Proof - Applications of the Hardy-Weinberg law - Test of Hardy-Weinberg equilibrium - Mating frequencies - Non-dominance - Codominance - Snyder's ratio, importance and its effect over random mating in succeeding generations. Multiple alleles - More than one locus - Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency - Migration - Mutation - Recurrent and nonrecurrent - Selection - Balance between selection and mutation - Selection favouring heterozygotes - Overdominance for fitness. Non random mating: selfing -inbreeding coefficient - panmictic index - sibmating - Assortative mating and disassortative mating - Pedigree populations and close inbreeding - Estimation of selection - Estimation of disequilibrium - Estimation of linkage - Correlation between relatives and estimation of F; Effect of inbreeding and sibbing in cross pollinated crops. Gene substitution and average effects; Breeding value- Genetic drift; Genetic slippage, Co-adapted gene complexes; Homoeostasis- Adapative organization of gene pools, Polymorphism-

Balanced and Non-balanced polymorphism, heterozygous advantage- Survival of recessive and deleterious alleles in populations.

**Practical**

Genetic exercise on probability; Estimation of gene frequencies; Exercises on factors affecting gene frequencies; Estimation of average affect of gene substitution and breeding value; Exercises on inbreeding and linkage disequilibrium- Cavalli's joint scaling test; Exercises of different mating designs; Estimation of different population parameters from experimentaldata; Measurement of genotype-environment interaction; Genetic divergence.

**Learning Outcome:**

i.. learn about Mendelian population, Hardy-Weinberg equilibrium.
ii. understand effect of estimation of selection.
iii. know about the Breeding value
iv. learn about Estimation of gene frequencies, Genetic divergence.

**GPB 507 Heterosis breeding 2+1**

Objective

To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

**Syllabus:**

**Theory**

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops crops. Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis - Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis. Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in $F_2$ and segregating populations, importance of inbreeding in exploitation of heterosis - case studies. - Relationship between genetic distance and expression of heterosis - case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis. Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of self- incompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines - functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids. Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagatedcrops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid. Organellarheterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

**Practical**

Selection indices and selection differential - Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed production in field crops - an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

**Learning Outcome:**

i.. learn about mechanisms of heterosis.
ii. understand Divergence and Genetic Distance analyses.
iii. Development of inbreds and parental lines
iv. learn about hybrid seed production.

**GPB 508 Cell biology and molecular genetics 3+0**

Objective
To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

**Syllabus:**

**Theory**

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles - nucleus, plastids- chloro/chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes. Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus-Structure and chemical composition; Cell division and physiology of cell division. Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation - Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes - ribosomes, t-RNAs and translational factors. Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes - DNA content variation, types of DNA sequences - Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

**Learning Outcome:**

i.. learn about Ultrastructure of the cell, Cellular Organelles
ii. understand Structure and properties of nucleic acid.
iii. Proteomics and protein-protein interaction
iv. learn about Cancer and cell aging.

**GPB 509 Biotechnology for crop improvement 2+1**

**Objective:**
To impart knowledge and practical skills to use biotechnological tools in crop improvement.

**Syllabus:**
**Theory**
Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations ($F_2$s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits.Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs. Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecularfarming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

**Practical**
Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ; observations on the contaminants occurring in media - interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

**Learning Outcome:**

i.understand the various techniques of plant tissue culture
ii. know about the fundamentals of genetic engineering
iii. study about molecular markers, Quantitative Trait Loci (QTL) mapping and Marker Assisted Selection

**GPB 510 Breeding for biotic and abiotic stress resistance 2+1**

**Objective:**
To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

**Syllabus:**

**Theory**

Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses - major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria. Types and genetic mechanisms of resistance to biotic stresses -Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies. Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data - Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors -moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies. Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment. Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- Achievements.

**Practical**
Phenotypic screening techniques for sucking pests and chewing pests - Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds - ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest

resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

**Learning outcomes:**

i. understand the genetic mechanisms of biotic and abiotic stresses.

ii. phenotyping screening methods for major pest and diseases.

iii. learn about the source of resistance.

**GPB 511 Breeding cereals, forages and sugarcane 2+1**

**Objective:**

To provide insight into recent advances in improvement of cereals and forage crops and sugarcane using conventional and modern biotechnological approaches.

**Syllabus:**

**Theory**

Rice: Evolution and distribution of species and forms - wild relatives and germplasm; Genetics - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc.* - Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding. Wheat: Evolution and distribution of species and forms - wild relatives and germplasm; cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis etc; Sorghum: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc; Pearl millet: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc. Maize: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc - QPM and Bt maize - strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.

Sugarcane: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Forage grasses: Evolution and distribution of species and forms - Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

Forage legumes: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc,* palatability studies.

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

**Practical**

Floral biology - emasculation - pollination techniques ; Study of range of variation for yield and yield components - Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance- Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

**Learning Outcome:**

i. understand the origin, distribution and different breeding methods to be adopted for the development of varieties / hybrids in various cereals, forages and sugarcane

ii. study about the plant genetic resources, centres of diversity and breeding for resistance to biotic and abiotic stresses

iii. learn about the influence of Genotype x Environment interaction on yield / performance

**GPB 512 Breeding legumes, oilseeds and fibre crops 2+1**

**Objective:**

To provide insight into recent advances in improvement of legumes, oilseeds and fibre crops using conventional and modern biotechnological approaches.

**Syllabus:**

**Theory**

Pigeonpea: Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectives- yield, quality characters, biotic and abiotic stress *etc* - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress etc.

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc; Oil quality - characteristics in different oils; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality - characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress *etc* - Hybrid breeding in castor - opportunities, constraints and achievements.

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterile lines - Hybrid development and seed production - Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc.

Distinguishing features of the released varieties in pulses, oilseeds and cotton; Maintenance of seed purity and seed production.

**Practical**

Use of descriptors for cataloguing - Floral biology - emasculation - pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing - Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing - Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation - conventional and modern approaches; analysing the lint samples of different

species, interspecific and interracial derivatives for fibre quality and interpretation - Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance - Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters - learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills - Learning on cotton yarn production, its quality evaluation and uses.

**Learning Outcome:**

i. understand the origin, distribution and different breeding methods to be adopted for the development of varieties / hybrids in various legumes, oilseeds and fibre crops.

ii. study about the plant genetic resources, centres of diversity and breeding for resistance to biotic and abiotic stresses

iii. learn about the influence of Genotype x Environment interaction on yield / performance

**GPB 513 Breeding for quality traits 2+1**

**Objective:**

To provide insight into recent advances in improvement of quality traits in rice, millets, legumes, oilseeds and forage crops and for physiological efficiency using conventional and modern biotechnological approaches.

**Theory**

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, aminoacids and anti-nutritional factors - Nutritional improvement - A human perspective - Breeding for grain quality parameters in rice and its analysis - Golden rice and aromatic rice - Breeding strategies, achievements and application in Indian context - Molecular basis of quality traits and their manipulation in rice - Post harvest manipulation for quality improvement.

Breeding for baking qualities in wheat; Characters to be considered and breeding strategies - Molecular and cytogenetic manipulation for quality improvement in wheat - Breeding for quality improvement in barley and oats.

Breeding for quality improvement in Sorghum and pearl millet; Quality protein maize - Concept and breeding strategies - Breeding for quality improvement in forage crops - Genetic resource management for sustaining nutritive quality in crops.

Breeding for quality in pulses - Breeding for quality in groundnut, sesame, sunflower and minor oilseeds - Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton.

Genetic engineering protocols for quality improvement - Achievements made - Value addition in crops; Classification and importance - Nutritional genomics and Second generation transgenics.

**Practical**

Grain quality evaluation in rice; Correlating ageing and quality improvement in rice - Quality analysis in millets; Estimation of antinutritional factors like tannins in different

varieties/hybrids; A comparison - Quality parameters evaluation in wheat; Quality parameters evaluation in pulses - Quality parameters evaluation in oilseeds; Value addition in crop plants ; Post harvest processing of major field crops; Quality improvement in crops through tissue culture techniques; Evaluatingthe available populations like RIL, NIL etc. for quality improvement using MAS procedures.

**Learning Outcome:**

i. learn about improvement of quality traits in rice, millets, legumes, oilseeds and forage crops

ii. Molecular and cytogenetic manipulation for quality improvement

iii. Genetic engineering protocols for quality improvement

**GPB 514 Gene regulation and expression 2+0**

**Objective:**

To provide insight into recent advances in the phenomenon of gene regulation and mechanisms by which plants and microbes express different traits and how these are modified during different stages.

**Syllabus:**

**Theory**

Introduction: Gene regulation-purpose; Process and mechanisms in prokaryotes and eukaryotes; Levels of gene controls. Coordinated genetic regulation-examples- Anthocyanin and gene families and maize; Genetic and molecular basis depending on tissue specificity. Gene expression-Transposons in plant gene expression, cloning-transposon tagging; Light regulated gene expression-model systems in *Arabidopsis* and maize; Paramutations and imprinting of genes and genomes. Transgene expression and gene silencing mechanisms; Regulatory genes-horizontal and vertical homology; Transformation-regulatory genes as visible markers; Reporter systems to study gene expression; Combinatorial gene control. Eukaryotic transcriptional control; Translational and post-translational regulation; Signal transduction; Stress-induced gene expression; Gene traps and enhancer traps.

**Learning Outcome:**

i. learn about Gene regulation.
ii. Gene expression, Gene traps
iii. understanding of visible markers

**GPB 515 Maintenance breeding and concepts of variety release and seed production 1+1**

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

**Syllabus:**

**Theory**

Variety Development and Maintenance; Definition- variety, cultivar,extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid,and population; Variety testing, release and notification systems in India and abroad. DUS testing-DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production. Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

**Practical**

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

**Learning Outcome:**

i. learn about Development and Maintenance of variety.

ii. DUS testing

iii. Principles of seed production

iv. Hybrid seed production technology

**GPB 516 Germplasm collection, exchange and quarantine 2+1**

**Objectives:**
To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

**Syllabus:**

**Theory**

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora. Concept of population and

gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection. Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens. Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica,* okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge. History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.). Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

Genetically modified organisms (GMOs) or genetically engineered plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

**Practical**

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations; Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

**Learning Outcome:**

i. learn about information about collection, germplasm exchange, quarantine, maintenance.

ii. use of plant genetic resources including genetically modified plants

iii. Identification of wild relatives of crop plants

iv. seed treatment and other prophylactic treatments

**GPB 517 Data base management, evaluation and Utilization of PGR 2+1**

Objective

To train the students in germplasm data base management using modern tools and softwares.

**Syllabus:**

**Theory**

Statistical techniques in management of germplasm; Core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation; Introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability equations and numograms; Estimation of sample size for storage and viability testing. Germplasm documentation; Basics of computer and operating systems; Database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network. Germplasm management system- global scenario; Genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; Predictive methods for identification of useful germplasm; Characterization of germplasm and evaluation procedures including specific traits; Gene markers and their use in PGR management. Management and utilization of germplasm collections; Concept of core collection, molecular markers and their use in characterization; Evaluation and utilization of genetic resources; Pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; Harmonizing agro- biodiversity and agricultural development crop diversification- participatory plant breeding.

**Practical**

Basics of computer and operating systems; Identification of useful germplasm, evaluation of crop germplasm; Statistical techniques in management of germplasm- estimation of sample size for storage and viability testing; Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm; Molecular markers and their use in characterization.

**Learning Outcome:**

i. learn about germplasm data base management using modern tools and softwares.

ii. Gene markers and their use in PGR management

iii. Evaluation procedure and experimental protocols (designs and their analysis)

## SYLLABUS: DEPARTMENT OF HORTICULTURE

**Courses offered by Department of Horticulture in M. Sc. (Ag.) programme**

| Course No | Course Title | Credit | Semester |
|---|---|---|---|
| HOR 501* | Growth and development of fruit, vegetable and ornamental crops | 2+1 | I |
| HOR 502* | Fundamentals of fruit, vegetable and ornamental crops | 2+1 | I |
| HOR 503* | Basics of plantation, spices, medicinal & aromatic crops | 2+0 | II |
| HOR 504* | Post harvest technology of fruit, vegetable and ornamental crops | 2+1 | III |
| HOR 505* | Technological advancement of fruit, vegetable and ornamental crops | 2+0 | III |
| | **Major in Fruit Science** | | |
| HOR 511$ | Propagation and nursery management in horticultural crops | 1+1 | I |
| HOR 512$ | Tropical and dry land fruit production | 2+1 | I |
| HOR 513$ | Subtropical and temperate fruit production | 2+1 | II |
| HOR 514$ | Breeding of fruit crops | 1+1 | II |
| HOR 515 | Biodiversity and conservation of fruit crops | 1+1 | II |
| HOR 516 | Canopy management in fruit crops | 1+1 | III |
| HOR 517 | Biotechnology of horticultural crops | 2+1 | II |
| HOR 518 | Organic horticulture | 1+1 | III |
| | **Major in Vegetable Science** | | |
| HOR 521# | Production technology of cool season vegetable crops | 2+1 | II |
| HOR 522# | Production technology of warm season vegetable crops | 2+1 | I |
| HOR 523# | Breeding of vegetable crops | 2+1 | II |
| HOR 524# | Seed production technology of vegetable crops | 2+1 | III |
| HOR 525 | Systematics of vegetable crops | 1+1 | I |
| HOR 526 | Production technology of underexploited vegetable crops | 1+1 | II |
| HOR 527 | Organic vegetable production technology | 1+1 | III |
| HOR 528 | Fundamentals of processing of vegetables | 1+1 | IIII |

| | Major in Floriculture and landscape architecture | | |
|---|---|---|---|
| HOR 531¶ | Fundamentals of floriculture and landscape architecture | 2+1 | I |
| HOR 532¶ | Production technology of cut flowers | 2+1 | III |
| HOR 533¶ | Production technology of loose flowers | 2+1 | II |
| HOR 534¶ | Breeding of flower crops and ornamental plants | 2+1 | II |
| HOR 535 | Landscaping and ornamental gardening | 2+1 | II |
| HOR 536 | Protected floriculture | 2+1 | II |
| HOR 537 | Value addition in flowers | 2+1 | III |
| HOR 538 | Turfing and turf management | 2+1 | II |
| HOR 539 | Cad for outdoor and indoorscaping | 2+1 | II |
| HOR 591* | Credit seminar | 0+1 | IV |
| HOR 599* | Master's Research (Thesis) | 0+20 | 20I to IV |

* Compulsory for M. Sc. (Agriculture) in Horticulture

$ Compulsory for majoring in Fruit Science

# Compulsory for majoring in Vegetable Science

¶ Compulsory for majoring in Floriculture and landscape architecture

**HOR 501 Growth and development of fruit, vegetable and ornamental crops 2+1**

**Objectives:**

The students are expected to gain knowledge on brief outline of the physiology of horticultural crops, concept of different plant growth regulators and their uses, seed dormancy and germination and biotic and abiotic stresses on crop plants.

**Syllabus:**

**Theory**

UNIT I

Growth and development- definition, parameters of growth and development, growth dynamics/analysis and its importance.

UNIT II & III

Assimilate partitioning during growth and development; environmental impact on growth and development; Morphogenesis; Role of light, temperature and photoperiod on growth,

development of underground parts, flowering and sex expression in horticultural crops; influence of water and mineral nutrition during growth and development; apical dominance.

UNIT IV & V

Auxins, gibberellilns, cyktokinins and abscissic acid; biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene; role and mode of action of brasssinosteroids, growth inhibitors, morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in horticultural crops.

UNIT VI & VII

Physiology and bio-chemistry of seed germination. Dormancy: physiology, causes, method of breaking etc.; bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, flower and fruit drop, fruit growth, ripening and seed development; parthenocarpy.

UNIT VIII

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

**Practical**

Techniques of growth analysis; evaluation of photosynthetic efficiency; study of growth regulator, Preparation of solutions of plant growth substances and their application; understanding ripening phenomenon in fruits and vegetables; understanding stress impact on growth and development.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on physiology of horticultural crops, PGR and their functions uses and biotic and abiotic stresses.

**HOR 502 Fundamentals of fruit, vegetable and ornamental crops 2+1**

**Objectives:**

The students are expected to gain the fundamental knowledge on importance, branches and area specific different types of horticultural crops and their classification, techniques of orchard and garden establishment.

**Syllabus:**

**Theory**

UNIT I

Importance of horticulture in nutritional security and national economy; Horticultural geography (regions and zones); Present status and prospects of important horticultural crops.

UNIT II

Classification of fruit crops; Propagation technique; nursery management; training and pruning; rootstock and scion; causes of unfruitfulness and control; Orchard establishment and orchard floor management.

UNIT III

Classification of vegetable crops; types of vegetable farming; factors affecting vegetable productivity; economics, marketing and export potential of vegetable crops etc.

UNIT IV

Importance of flower crops and ornamental plants. Global Scenario of flower production and trade; classification of ornamental plants; Landscape designs, Bioaesthetic planning; types and styles of gardens; landscaping; Garden plant components; brief ideas about lawn, indoor gardening, pot culture, bonsai, hanging baskets, avenue trees, water garden, rockgardens, herbaceous and shrubbery borders, hedges and edging plants etc.

**Practical**

Identification of various horticultural crops, garden plants, garden implements etc.; preparation of layout and schemes for gardens; preparation of rooting media; potting and repotting; propagation techniques of horticultural crops; preparation of seed bed/nursery bed for vegetables and annuals; economic analysis; visit to commercial flower growing areas, nurseries etc.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on horticultural crops and their classification, establishment of orchard, vegetables cultivation and landscaping

**HOR 503 Basics of plantation, spices, medicinal & aromatic crops 2+0**

**Objectives:**

The students are expected to gain the basic knowledge on importance and propagation techniques, varieties and cultivation practices and processing techniques of different types of plantation, spices, medicinal and aromatic crops.

**Syllabus:**

**Theory**

UNIT I

Importance of plantation crops grown in India. Role of plantation crops in national economy and export potential.

UNIT II & III

Plant multiplication, systems of cultivation, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, nutritional and water requirements, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting and processing of produce of: Coffee, Tea, Cashew and Coconut.

UNIT IV

Introduction; importance of spice crops; historical accent, present status (national and international), future prospects and export potential of spice crops; organic spices.

UNIT V & VI

Climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed / planting material, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, harvesting, post harvest management, plant protection measures of: Black pepper, cardamom, turmeric, ginger and garlic, Coriander and fenugreek.

UNIT VII

Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, Classification of medicinal crops.

UNIT VIII & IX

Production technology, post harvest handling (drying, processing, grading, packing and storage), processing and value addition and quality standards in herbal products for Senna, Periwinkle, Aswagandha, Sarpagandha, *Dioscorea* sp., *Aloe vera*, medicinal solanum, Isabgol, Poppy and *Ocimum sp.*

UNIT X

Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry.

UNIT XI

Production technology, post-harvest handling, distillation methods, value addition, aroma chemicals, quality standards and regulations for palmarosa, lemongrass, citronella, vettiver, geranium, mentha, ocimum, eucalyptus, patchouli and lavender.

**Learning Outcome:**

Students will acquire theoretical and practical knowledge on of different types of plantation, spices, medicinal and aromatic crops, their processing and use.

**HOR 504 Post harvest technologies of fruit, vegetable and ornamental crops 2+1**

**Objectives:**

The students will gain the knowledge on pre and post-harvest physiology and management technologies of fruits and vegetables. Students are also expected to gain knowledge on conventional and modern packaging and preservation technology of fruits, vegetables and ornamental crops.

**Syllabus:**

**Theory**

UNIT I & II,

History and importance of post harvest technology; Composition and nutritive value of horticultural crops. Factors leading to post-harvest loss. Maturity indices of horticultural crops. Harvesting practices for specific market requirements, Pre-harvest crop management practices and their influence on quality during storage and marketing. Respiration, transpiration. Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management.

UNIT III

Post harvest handling (harvesting, sorting, grading and packing and transportation) of fruits, vegetables and flowers. Post harvest treatments (pre cooling, hot water, hot air and vapour heat, fungicide & biologically safe chemicals, irradiation, curing, pulsing etc.) for quality retention of horticultural crops.

UNIT IV

Storage systems – on farm storage (evaporative cooled stores, ventilated storage, pit storage etc.), refrigerated storage, controlled / modified atmosphere storage, hypobaric, hyperbaric storage. Physical injuries and disorders.

UNIT V

Contamination and spoilage of fresh fruits, vegetables and process products. Importance of microorganisms in fermentation processes.

UNIT VI, VII, VIII

Present status and future prospects of preservation industry in India. Principles and methods of preservation; Raw materials for processing. Processing of fruits and vegetables (canning; drying and dehydration; fruit beverages and juice concentrates; sugar based products; tomato products; fermented products, value added products etc.), food additives, minimal processing. Packaging technique and storage system for processed products. Labels. Utilization of byproducts and waste management of processing industry. Preparation of various products from flowers, and dehydrated technique.

UNIT IX & X

Importance of quality, quality management standards, ISO/BIS, PFA, AGMARK, etc.; HACCP, Codex alimentarius, Total quality management (TQM) etc.; Food standards (FPO, PFA etc.). Food laws and regulations.

**Practical**

Analyzing maturity stages of commercially important horticultural crops, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release and study of vase life extension in cut flower using chemicals; Study of machinery and equipments used in processing of horticultural produce; Preparation of fruit jam, squashes, sauce, pickle; drying of fruits and vegetable etc. Chemical analysis of nutritive value of fresh and processed fruits and vegetables. Visit to cold storage and CA storage units; visit to fruit and vegetable processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

**Learning Outcome:**

Students will acquire knowledge on maturity and physiology of ripening, pre and post harvest management techniques, storage and modern packaging and preservation techniques and value addition of fruits, vegetables and ornamental crops.

**HOR 505 Technological advancement of fruit, vegetable and ornamental crops 2+0**

**Objectives:**

Students are expected to know about the recent advancement in horticulture and advanced technology like organic horticulture, protected cultivation, biotechnological tools,

micropropagation techniques and their application in the field of fruits, vegetables and ornamental crops.

**Syllabus:**

**Theory**

UNIT I, II and III

Organic horticulture – definition, principles, methods, merits and demerits. IFOAM and global scenario of organic movement. Organic farming systems. Components of organic horticultural systems. Different organic inputs, their role in organic horticulture. Sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement. Post-harvest management of organic produce. Certification. Organic horticulture and export.

UNIT IV, V and VI

Objectives, importance and scope of protected cultivation of vegetable, fruits, flowers and ornamental plants. World scenario, Indian situation: present and future. Principles and structures used in protected cultivation including hotbed, cold frame, glasshouse polyhouse, shade net, low tunnels, rain shelters etc. Interaction of light, temperature, humidity, CO2, water on crop regulation. Greenhouse heating, cooling, ventilation and shading. Containers and substrates, soil decontamination. Water and nutrient management. Automated greenhouses. Management of pest and diseases. Selection of crops and varieties. Recent advancement.

UNIT VII & VIII

Basic principle of plant tissue culture. Commercial application of plant tissue culture with major emphasis on ornamental, fruits and vegetable crops. Basic concept and application of biotechnology in horticultural crops.

UNIT IX & X

Recent advancement in various horticultural technologies.

**Learning Outcome:**

Students will gather details knowledge on modern advanced technology like micro propagation, precision farming, biotechnological tools, establishment and management of high density orchard etc and their application in horticulture.

**HOR 511 Propagation and nursery management in horticultural crops 1+1**

**Objectives:**

Students are expected to gain the knowledge on different aspects of seed propagation and vegetative propagation like cutting, budding, grafting, layering, micro-propagation as well as nursery management.

**Syllabus:**

**Theory**

UNIT I

Introduction, life cycles in plants, cellular basis for propagation, sexual propagation, apomixis, polyembryony, chimeras. Principles factors influencing seed germination of horticultural crops, dormancy, hormonal regulation of germination and seedling growth.

UNIT II

Seed quality, packing, storage, certification, testing. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering – principle and methods.

UNIT III

Budding and grafting – selection of elite mother plants. Root stock. Establishment of bud wood bank, stock, scion and inter stock, relationship – Incompatibility. Rejuvenation through top working – Progeny orchard and scion bank.

UNIT IV

Micro-propagation – principles, concepts and techniques; commercial exploitation in horticultural crops. Hardening, packing and transport of micro-propagules.

UNIT V

Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

**Practical**

Anatomical studies in rooting of cutting and graft union, study and preparation of media and PGR. Hardening – case studies; various methods of asexual propagation (cutting, budding, grafting etc.); visit to commercial nurseries.

**Learning Outcome:**

Students will gather theoretical and practical knowledge of different types of sexual and asexual methods of propagation, aspects of micro-propagation and nursery management.

**HOR 512 Tropical and dry land fruit production 2+1**

**Objectives:**

Students are expected to know the details of national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, advanced

production system, maturity indices, harvesting, physiological disorders of major tropical and dry land fruits.

**Syllabus:**

**Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

**Crops**

UNIT I: Mango and Banana

UNIT II: Citrus and Papaya

UNIT III: Guava, Sapota and Jackfruit

UNIT IV: Pineapple, Annonas and Avocado

UNIT V**:** Aonla, Pomegranate and Ber, minor fruits of tropics

**Practical**

Identification of tropical and dry land fruit crops and their important cultivars; observations on growth and development; practices in growth regulation, malady diagnosis, analyses of quality attributes; preparation of layout for orchards; visit to tropical and arid zone orchards.

**Learning Outcome:**

Students will gather theoretical and practical knowledge of advanced production technology of different tropical fruits like mango, banana, citrus, papaya, guva, sapota etc. and dry land fruits like aonla, pomegranate, ber, pineapple, annona etc.

**HOR 513 Subtropical and temperate fruit production 2+1**

**Objectives:**

Students are expected to gather the details knowledge of national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, advanced production system, maturity indices, harvesting, physiological disorders of major subtropical and temperate fruits.

**Syllabus:**

**Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders-causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones(AEZ) and industrial support.

**Crops**

UNIT I: Apple, pear, grapes

UNIT II: Plums, peach, cherries

UNIT III: Litchi, loquat, kiwifruit, strawberry

UNIT IV: Nuts- walnut, almond, pistachio

UNIT V: Minor fruits- carambola, bael, wood apple, rambutan, pomegranate

**Practical**

Identification of sub-tropical and temperate fruit crops and their important cultivars; observations on growth and development; practices in growth regulation, malady diagnosis, analyses of quality attributes; preparation of layout for orchards; visit to tropical, subtropical, humid tropical and temperate orchards,

**Learning Outcome:**

Students will gather theoretical and practical knowledge of advanced production technology of different subtropical fruits like grapes, litchi, loquat, carambola, bael, rambutan etc. and temperate fruits like apple, pear, peach, cherry, strawberry etc.

**HOR 514 Breeding of fruit crops 1+1**

**Objectives:**

Students are expected to know the detail of different basic aspects of fruit breeding like introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding etc. as well as breeding techniques , breeding achievements of different major fruit crops.

**Syllabus:**

**Theory**

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding Objectivess, ideotypes, approaches for

crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

**Crops**

UNIT I: Mango, banana and pineapple

UNIT II: Citrus, grapes, guava and sapota

UNIT III: Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT IV: Mangosteen, litchi, phalsa, mulberry and nuts

UNIT V**:** Apple, pear, plums, peach and strawberry

**Practical**

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement.

**Learning Outcome:**

Students will gather basic knowledge on different aspects of fruit breeding and breeding of different fruits like mango, banana, citrus, grapes, guava, apple, pear, plums etc

**HOR 515 Biodiversity and conservation of fruit crops 2+1**

**Objectives:**

Students are expected to gain the knowledge on evolution, centre of origin, centre of diversity, genetic diversity, utilization and conservation strategies of different germplasm of fruit crops.

**Syllabus:**

**Theory**

UNIT I

Biodiversity and conservation; issues and goals, centres of origin of cultivated fruits; primary and secondary centres of genetic diversity.

UNIT II

Present status of gene centres; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ*.

UNIT III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

**Crops**

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, *Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

**Practical**

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, may visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

**Learning Outcome:**

Students will gather the advanced knowledge on evolution, centre of origin, centre of diversity, genetic diversity, and utilization and conservation strategies of different fruit crops.

**HOR 516 Canopy management in fruit crops 1+1**

**Objectives:**

Students are expected to gather the details knowledge of importance, advantages, factors affecting canopy management, canopy structures, light interception in canopy and different methods of canopy management.

**Syllabus:**

**Theory**

UNIT I

Canopy management - importance and advantages; factors affecting canopy development.

UNIT II

Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies.

UNIT III

Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion.

UNIT IV

Canopy management through plant growth inhibitors, training and pruning and management practices.

UNIT V

Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

**Practical**

Study of different types of canopies, training of plants for different canopy types, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

**Learning Outcome:**

Students will gather theoretical and practical knowledge of factors affecting canopy management, canopy structures, light interception in canopy and different methods of canopy management and specific canopy management techniques of major fruit crops.

**HOR 517 Biotechnology of horticultural crops 2+1**

**Objectives:**

Students are expected to know the details about tissue culture, bioreactor and secondary metabolite production, somatic hybridization, somaclonal variation, invitro mutgenesis, uses of molecular markers etc.

**Syllabus:**

**Theory**

UNIT I

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.
UNIT II

Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III

Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT IV

Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V

Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

**Practical**

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, *in vitro* mutant selection against abiotic stress, protoplast culture, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory.

**Learning Outcome:**

Students will gather theoretical and practical knowledge of tissue culture, bioreactor and secondary metabolite production, somatic hybridization, selection against biotic stress, invitro mutgenesis, uses of molecular markers etc.

**HOR 518 Organic horticulture 1+1**

**Objectives:**

Students are expected to gain the knowledge on components of organic horticulture system, organic inputs, sustainable natural resource management, organic disease and pest management, standard management and organic certification etc.

**Syllabus:**

**Theory**

UNIT I

Organic horticulture – definition, synonyms and misnomers, principles, methods, merits and demerits.

UNIT II

Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and the recent developments.

UNIT III

EM technology and its impact in organic horticulture, indigenous practices of organic farming, sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement.

UNIT IV

GAP - Principles and management, HACCP exercise, certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies.

UNIT V

Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic produce.

**Practical**

Features of organic orchards, working out conversion plan, Input analysis manures, nutrient status assessment of manures, biocomposting, biofertilizers and their application, panchagavya preparation and other organic nutrients application, methods of preparation of compost, vermicompost, green manuring, preparation of neem products and application, BD preparations and their role, EM technology and products, biological/natural control of pests and diseases, soil solarization, visit to fields cultivated under organic practices.

**Learning Outcome:**

Students will gather the advanced knowledge on components of organic horticulture system, organic inputs, sustainable natural resource management, organic disease and pest management, standard management and organic certification etc.

**HOR 521 Production technology of cool season vegetable crops 2+1**

**Objectives:**

To educate production technology of cool season vegetables.

**Syllabus:**

**Theory**

Introduction, origin, distribution and botanical relationship; general morphology and taxonomy; commercial varieties/hybrids, their evaluation and characteristics; basic principles of production

(climatic and soil requirements, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production); specific problem associated in crop production and their solution; nutritive value and uses of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

UNIT VI

Minor cool season vegetables

**Practical**

Morphological study and identification of economic part and seed; Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Demonstrate the role of mineral elements, plant growth substances and herbicides etc.; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial vegetable growing areas, farm etc.

**Learning Outcome:**

Students will acquire theoretical knowledge and practical skill on production of cool season vegetable crops.

**HOR 522 Production technology of warm season vegetable crops 2+1**

**Objectives:**

To educate production technology of warm season vegetables.

**Syllabus:**

**Theory**

Introduction, origin, distribution and botanical relationship; general morphology and taxonomy; commercial varieties/hybrids, their evaluation and characteristics; basic principles of production (climatic and soil requirements, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production); specific problem associated in crop production and their solution; nutritive value and uses of:

UNIT I

Tomato, eggplant, hot and sweet peppers

UNIT II

Okra, beans and cowpea

UNIT III

Cucurbitaceous crops

UNIT IV

Tapioca and sweet potato

UNIT V

Green leafy warm season vegetables

UNIT VI

Minor worm season vegetables

**Practical**

Morphological study and identification of economic part and seed; Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Demonstrate the role of mineral elements, plant growth substances and herbicides etc.; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial vegetable growing areas, farm etc.

**Learning Outcome:**

Students will acquire theoretical knowledge and practical skill on production of warm season vegetable crops.

HOR 523 Breeding of vegetable crops 2+1

**Objectives:**

To educate principles and practices adopted for breeding of vegetable crops.

**Syllabus:**

**Theory**

UNIT I

Importance, history and evolutionary aspects of vegetable breeding; breeding systems and methods; brief account on breeding through selection, hybridization, heterosis breeding, male sterility, self-incompatibility etc.

Origin, botany, taxonomy, cytogenetics, genetics, breeding Objectivess, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops

UNIT II

Potato

UNIT III

Tomato, eggplant

UNIT IV

Hot pepper, sweet pepper and okra

UNIT V

Peas and beans, amaranth, chenopods and lettuce

UNIT VI

Gourds, melons, pumpkins and squashes

UNIT VI

Cabbage, cauliflower,

UNIT VII

Carrot, beetroot, radish,

UNIT IX

Sweet potato and tapioca

UNIT X

Plant variety protection (PVP), International Union for Protection of New Varieties of Plants (UPOV), Issue of patenting, PPVFR act etc.

**Practical**

Observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; flowering and palanological studies; selfing and crossing techniques in vegetable crops; hybrid seed production of vegetable crops; screening techniques for insect-pests, disease and environmental stress resistance; demonstration of sib-mating and mixed population; analysis of biometrical problems; Visit to breeding blocks, research stations.

**Learning Outcome:**

Students will acquire theoretical knowledge on breeding principles, understand vegetable breeding methods and developed the required practical skills on vegetable germplasm handling and breeding work.

**HOR 524 Seed production technology of vegetable crops 2+1**

**Objectives:**

To impart a comprehensive knowledge of seed and planting material production in vegetable crops with adequate practical training.

**Syllabus:**

**Theory**

UNIT I

Definition of seed and its quality; floral biology, pollination, breeding behaviour, seed development and maturation. Scope of vegetable seed industry in India.

UNIT II

Genetical and agronomical principles of seed production; methods of seed production; methods of hybrid seed production. Use of growth regulators and chemicals in vegetable seed production;

UNIT III

Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT IV, V, VI

Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

UNIT VII

Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards. Testing, releasing and notification procedures of varieties.

UNIT VIII

Seed act and law enforcement, plant quarantine and quality control; new seed policies; DUS test; impact of PVP on growth of seed industry.

**Practical**

Seed sampling, seed testing (physical purity, genetic purity, seed viability, seed germination seedling vigour and seed health); floral biology; rouging of off-type; methods of hybrid seed production in important vegetable crops; seed extraction techniques; handling of seed processing and seed testing equipments; visit to seed processing units, seed testing laboratory and seed production farms.

**Learning Outcome:**

Students will acquire adequate theoretical knowledge and practical skills on vegetable seed and planting material production.

**HOR 525 Systematics of vegetable crops 1+1**

**Objectives:**

To teach morphological, cytological and molecular taxonomy of vegetable crops.

**Syllabus:**

**Theory**

UNIT I

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops.

UNIT II

Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables.

UNIT III

Cytological level of various vegetable crops; descriptive keys for important vegetables.

UNIT IV

Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

**Practical**

Identification and description of vegetable species and varieties; collection of allied species and genera locally available; preparation of keys to the species and varieties; methods of preparation of herbarium and specimens.

**Learning Outcome:**

Students will acquire theoretical knowledge and practical skills on taxonomy of vegetable crops.

**HOR 526 Production technology of underexploited vegetable crops 2+1**

**Objectives:**

To educate production technology of underutilized vegetable crops.

**Syllabus:**

**Theory**

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of:

UNIT I

Asparagus, artichoke and leek

UNIT II

Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III

Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathua (chenopods) and chekurmanis.

UNIT IV

Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V

Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

**Practical**

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

**Learning Outcome:**

Students will acquire theoretical knowledge and practical skill on production of underexploited vegetable crops.

**HOR 527 Organic vegetable production technology 1+1**

**Objectives:**

To educate principles, concepts and production of organic farming in vegetable crops.

**Syllabus:**

**Theory**

UNIT I

Importance, principles, perspective, concept and component of organic production of vegetable crops.

UNIT II

Organic production of vegetables crops, *viz.,* solanaceous crops, cucurbits, cole crops, root and tuber crops.

UNIT III

Managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods.

UNIT IV

Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Biodynamics, preparation etc Pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents.

UNIT V

GAP and GMP- Certification of organic products; organic production and export - opportunity and challenges.

**Practical**

Method of preparation of compost, vermicomposting, biofertilizers, soil solarization, bio pesticides in horticulture, green manuring, mycorrhizae and organic crop production, waster management, organic soil amendment for root disease, weed management in organic horticulture. Visit to organic fields and marketing centers.

**Learning Outcome:**

Students will acquire theoretical knowledge on organic farming concepts and principles. They will also develop the practical skills for organic vegetable production.

**HOR 528 Fundamentals of processing of vegetables 2+1**

**Objectives:**

To educate principles and practices of processing of vegetable crops.

**Syllabus:**

**Theory**

UNIT I

History of food preservation. Present status and future prospects of vegetable preservation industry in India.

UNIT II

Spoilage of fresh and processed horticultural produce; biochemical changes and enzymes associated with spoilage of horticultural produce; principal spoilage organisms, food poisoning and their control measures. Role of microorganisms in food preservation.

UNIT III

Raw materials for processing. Primary and minimal processing; processing equipments; Layout and establishment of processing industry, FPO licence. Importance of hygiene; Plant sanitation.

UNIT IV

Quality assurance and quality control, TQM, GMP. Food standards – FPO, PFA, etc. Food laws and regulations.

UNIT V

Food safety – Hazard analysis and critical control points (HACCP). Labeling and labeling act, nutrition labeling.

UNIT VI

Major value added products from vegetables. Utilization of byproducts of vegetable processing industry; Management of waste from processing factory.

UNIT VII

Investment analysis. Principles and methods of sensory evaluation of fresh and processed vegetables.

**Practical**

Study of machinery and equipments used in processing of horticultural produce; Chemical analysis for nutritive value of fresh and processed vegetables; Sensory evaluation of fresh and processed vegetables; Visit to processing units to study the layout, equipments, hygiene, sanitation and residual / waste management.

**Learning Outcome:**

Students will acquire theoretical knowledge on principles and methods of processing. They will also develop the practical skills for vegetable processing.

**HOR 531 Fundamentals of floriculture and landscape architecture 2+1**

**Objectives:**

Students will get acquainted with fundamentals of floriculture, flower production and its trade. A brief outline of production technology of selected ornamental plants and value addition of flowers. Landscaping and fundamental knowledge about the types and styles of garden and its components along with use of various plants.

**Syllabus:**

**Theory**

UNIT I

Global and national scenario of flower production and trade; Propagation, sexual and asexual propagation methods, propagation in mist chambers; nursery management, pro-tray nursery under shadenets; transplanting techniques.

UNIT II

Types of gardens (English, Mughal, Japanese etc.); styles of garden (formal, informal and free style gardens); Special types of gardens (roof garden, bog garden, rock garden etc.)

UNIT III & IV

Landscape designs; Urban landscaping, landscaping for specific situations; Garden plant components, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds.

UNIT V

Turfing and turf management.

UNIT VI

Production technology for selected ornamental plants.

UNIT VII

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening etc.

UNIT VIII

Value addition in flowers: Types of value added products; Value addition in loose flowers and cut flowers; flower arrangement; Dry flowers; Concrete and essential oils; Types of pigments, significance of natural pigments, extraction methods and Applications.

**Practical**

Identification of flowers, garden plants, garden implements etc.; preparation of layout and schemes for gardens; preparation of rooting media; potting and repotting; propagation techniques of flower and garden plants; economic analysis; visit to commercial flower growing areas, nurseries etc. Techniques in flower arrangement and floral decoration; Practices in preparation of bouquets, flower baskets, corsages, garlands etc. with fresh flowers; Practices in dry flower making; Preparation of dry flower baskets, bouquets etc.

**Learning Outcome:**

The students are expected to learn about identification of plants and garden tools, propagation of plants and value added flower products. Visit to commercial flower growing areas, nurseries and preparation of layout and schemes for gardens are necessary for understanding of landscaping at field level.

**HOR 532 Production technology of cut flowers 2+1**

**Objectives:**

Acquaintance with scope of global trade of cut flower under available varietal wealth and diversity is necessary for undertaking open and protected cultivation of different cut flowers and its related problems. Understanding of various grades of cut flower and post-harvest handling, packing, storage and transportation are necessary to get idea about its marketing and export.

**Syllabus:**

**Theory**

UNIT I

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India.

UNIT II

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

**Crops:** Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, cut foliages and fillers.

**Practical**

Identification and botanical description of species and varieties; propagation techniques, mist chamber operation; training and pruning techniques; practices in manuring, irrigation, foliar nutrition, growth regulator application, pinching, disbudding, staking; harvesting techniques; post-harvest handling, project preparation for regionally important cut flowers, visit to commercial cut flower units and case study.

**Learning Outcome:**

Above mentioned theoretical part should be supported with learning of identification of species and varieties, propagation and cultural techniques for growing and post-harvest handling of cut flowers reinforced with visit to commercial cut flower units.

**HOR 533 Production technology of loose flowers 2+1**

**Objectives**

To impart theoretical information about scope, significance and production of loose flowers and its trade in domestic market and for export with available varietal wealth and diversity. This is supplemented with flower forcing, post-harvest handling, packing storage, value addition, transportation and marketting.

**Syllabus:**

**Theory**

UNIT I

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation,

UNIT II

Soil and climate requirements, field preparation, systems of planting, precision farming techniques.

UNIT III

Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM.

UNIT IV

Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling and grading, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones.

**Crops:** Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

**Practical**

Identification and botanical description of species and varieties; propagation techniques, mist chamber operation; training and pruning techniques; practices in manuring, irrigation, foliar nutrition, growth regulator application, pinching, disbudding, staking; harvesting techniques; post-harvest handling; project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

**Learning Outcome:**

The students should get practical experience about identification of species and varieties, propagation and cultural techniques for growing and post-harvest handling of loose flowers reinforced with field visit and markets.

**HOR 534 Breeding of flower crops and ornamental plants 2+1**

**Objectives:**

To impart theoretical knowledge about origin, distribution, genetic resources, genetic divergence of various flower crops, genetic inheritance of various characters, breeding methods, their constraints and achievements made in different ornamental plants.

**Syllabus:**

**Theory**

UNIT I

Origin, distribution, genetic resources, genetic divergence of various flower crops and ornamental plants; Evolution of varieties.

UNIT II

Genetic inheritance of flower colour, doubleness, flower size, fragrance, post harvest life etc.

UNIT III

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants: introduction, selection, domestication, polyploid and mutation breeding for varietal development; Role of heterosis, Production of hybrids; Male sterility, incompatibility problems; seed production of flower crops.

UNIT IV

Breeding constraints and achievements made in commercial flowers: rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium etc.

UNIT V

Breeding constraints and achievements made in ornamental plants: petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages; Introduction and selection of plants for waterscaping and xeriscaping.

**Practical**

Identification and description of botanical features of cultivars, varieties and species in flowers; floral biology; selfing and crossing technique; seed production; Induction of mutants through physical and chemical mutagens, induction of polyploidy, screening of plants for biotic, abiotic stresses and environmental pollution, *in vitro* breeding in flower crops and ornamental plants.

**Learning Outcome:**

To impart practical experience on identification and description of botanical features of cultivars, varieties and species in flowers, floral biology; selfing and crossing technique, induction of

mutants through physical and chemical mutagens, screening of plants for biotic, abiotic stresses etc.

**HOR 535 Landscaping and ornamental gardening 2+1**

**Objectives:**

Students are expected to know the types of garden, types of landscaping, garden components, special gardens etc.

**Syllabus:**

**Theory**

UNIT I

Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II

Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III

Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants.

UNIT IV

Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

UNIT V

Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

**Practical**

Selection of ornamental plants, practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders,

project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

**Learning Outcome:**

Students will gather the detail knowledge of different types of garden, classification and features of landscaping, components of garden as well as landscaping etc.

**HOR 536 Protected floriculture 2+1**

**Objectives:**

Students are expected to gain the knowledge on types and features of different protective structures suitable for flower crop cultivation, environmental manipulation inside protective structures, growing media, crop regulation etc.

**Syllabus:**

**Theory**

UNIT I

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control – management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

**Practical**

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in

environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, postharvest handling, packing methods, project preparation, visit to commercial greenhouses.

**Learning Outcome:**

Students will gather theoretical and practical knowledge on types, layout, features of different protective structures suitable for flower crop cultivation, environmental manipulation inside protective structures, growing media, crop regulation, harvesting and postharvest handling etc.

**HOR 537 Value addition in flowers 2+1**

**Objective:**

Students are expected to gain the knowledge on types of value added floral products, aspects of dry flowers, floral arrangement, extraction of essential oil and pigments.

**Syllabus:**

**Theory**

UNIT I

Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management.

UNIT II

Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.

UNIT III

Dry flowers– Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage.

UNIT IV

Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

**Practical**

Practices in preparation of bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh flowers; Techniques in flower arrangement; Techniques in floral decoration; Identification of plants for dry flower making; Practices in dry flower making; Preparation of dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths, etc.; Visit to dry flower units, concrete and essential oil extraction units.

**Learning Outcome:**

Students will gather the advanced knowledge on various types of value added floral products, aspects and methods of dry flowers preparation, floral arrangement and its types, extraction of essential oil and types of pigments and their extraction.

**HOR 538 Turfing and turf management 2+1**

**Objectives:**

Students are expected to know the properties of soil for turfing, types of turf grasses, turf establishment methods, management of turf, establishment and management of turf for play grounds etc.

**Syllabus:**

**Theory**

UNIT I

Prospects of landscape industry; History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment.

UNIT II

Turf grasses - Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic requirement- Adaptation; Turfing for roof gardens.

UNIT III

Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing.

UNIT IV

Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing: mowing equipments,

techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs.

UNIT V

Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

**Practical**

Identification of turf grasses, Preparatory operations in turf making, Practices in turf establishment, Layout of macro and micro irrigation systems, Water and nutrient management; Special practices: mowing, raking, rolling, soil top dressing, weed management; Biotic and abiotic stress management; Project preparation for turf establishment, visit to IT parks, model cricket and golf grounds, airports, corporates, Govt. organizations; Renovation of lawns; Turf economics.

**Learning Outcome:** Students will gather the detail knowledge on physical and biological properties of soil for turfing, different types and characters of turf grasses, turf establishment methods, management of turf, establishment and management of turf for play grounds etc.

**HOR 539 CAD for outdoor and indoor scaping 2+1**

**Objectives:**

Students are expected to know the detail about application of CAD in 2D and 3D garden plant and non plant gardening component design using AUTOCAD, ARCHICAD, operation of AUTOCAD for 2D, basics and operation of ARCHICAD for 3D design etc.

**Syllabus:**

**Theory**

UNIT I

Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing.

UNIT II

2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects.

UNIT III

Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout.

UNIT IV

3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD.

UNIT V

ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components, Visualization tools for landscape preview, Data management, plotting and accessories for designing, Inserting picture using photoshop, Making sample drawing for outdoor and indoor gardens.

**Practical**

Practices in point picking methods, Using tool bars and icons, Using modifying tools and modifying comments, Isometric drawings, Using productivity tools, Drawing designs by AUTOCAD for home garden, institutional garden and special types of garden, Using tools and info-box for 3D drawing, Creation of garden components with ARCHICAD, Organization, dimensioning, detailing and visualization tools with ARCHICAD, Using Photoshop package for 3D picture insertion, Drawing designs with ARCHICAD for home garden, interior garden designing, IT parks, Corporates, Theme parks and Ecotourism spots.

**Learning Outcome:**

Students will gather theoretical and practical knowledge of application of CAD in 2D and 3D garden plant and non plant gardening component design using AUTOCAD, ARCHICAD, operation of AUTOCAD for 2D, basics and operation of ARCHICAD for 3D design etc.

HOR 591: Credit seminar

HOR 599: Master's research (Thesis)

## SYLLABUS: DEPARTMENT OF AGRICULTURAL ECONOMICS

### Courses Offered by Department of Agricultural Economics in M.Sc (Ag.) programme

| Course No. | Name of the Course | Credit Hours | Semester |
|---|---|---|---|
| AEC 501 | Agricultural Production Economics | 2+1 | I |
| AEC 502 | Agricultural Marketing & Price Analysis | 2+1 | II |
| AEC 503 | Agricultural Finance & Project Management | 2+1 | III |
| AEC 504 | Globalization and Agricultural Policy | 2+1 | III |
| AEC 505 | Benefit-Cost Analysis | 2+1 | I |

**AEC 501 Agricultural production economics 2+1**

**Objectives:**
To develop the understanding of production process and the guiding economic principle for agricultural production; to apply the appropriate economic principle under different production scenario to optimize the production process

**Syllabus:**

**Theory**

**UNIT I**
Nature, scope and significance of agricultural production economics- concept of production in economic sense. Factors of production-classification, interdependence and factor substitution.

**UNIT II**
Production functions - assumptions of production functions, commonly used forms and their properties, limitations, specification, estimation and interpretation. Determination of optimal levels of production and factor application-Law of diminishing returns. Optimal factor combination and least cost combination of production' application of Law of technical substitution. Production possibility curve-theory of product choice, and selection of optimal product combination.

**UNIT III**
Cost functions and cost curves, components, and cost minimization. Cost function and its applications. Derivation of firm's input demand and output supply functions. Shut Down and Break-Even Analysis. Returns to scale- economies and diseconomies of scale.

**UNIT IV**
Technology in agricultural production, nature and effects and measurement- Measuring efficiency in agricultural production; technical, allocative and economic efficiencies. Yield gap

analysis-concepts-types and measurement. Nature and sources of risk, modeling and coping strategies.

**Practical**
Different forms of production functions - specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination- optimal product choice- cost function estimation, interpretation-estimation of yield gap - incorporation of technology in production functions-measuring returns to scale-risk analysis through linear programming.

**Learning Outcome:**
Students will be able to acquire necessary theoretical and analytical skills to optimise the agricultural production and analyse the financial health of any farm for possible progress towards maximisation of profit.

**AEC 502 Agricultural marketing and price analysis 2+1**

**Objectives:**
Agricultural marketing in a broader sense is concerned with the marketing of farm products produced by farmers and of farm inputs and services required by them in the production of these farm products. Thus, the learning Objectives of agricultural marketing is to study both product marketing as well as input marketing.

**Syllabus:**

**Theory**

UNIT I

Concepts and definition of Agricultural Marketing- its new role. Market and market structure. Problems in Agricultural Marketing. Characteristic of agricultural product and production-factors affecting demand for and supply of farm products. Market intermediaries and their role - Need for regulation in the present context. Marketing Integration- efficiency, costs, margins and price spread.

UNIT II

Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming, contract marketing and retailing - Supply Chain Management. State trading, Warehousing and other Government agencies -Performance and Strategies - Market infrastructure needs, performance and Government role – Value Chain Finance. Market information.

UNIT III

Spatial and temporal price relationship – price forecasting – time series analysis – time series models – spectral analysis. Market segmentation, measurement and forecasting.

UNIT IV

Introduction to commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis. Trade policy for agriculture-International trade agreements. Marketing research.

**Practical**

Price spread and marketing efficiency analysis. Marketable & Marketed surplus estimation. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming/marketing and supply chain management of different agricultural commodities, milk and poultry products. Online searches for market information sources and interpretation of market intelligence reports – commodity outlook - Technical Analysis for important agricultural commodities - Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

**Learning Outcome:**

After studying this course, students will have an understanding on structure of Agriculture marketing in India, agriculture cooperatives, future trading, critical appraisal of agriculture marketing, major Objectivess and instruments of agriculture price policy, buffer stock, appraisal of agriculture pricing policy.

**AEC 503 Agricultural finance and project management 2+1**

**Objectives:**

To understand the role of agriculture in the economic development of India, to assess the impact of agriculture on the macroeconomic indicators, Nature and scope of financial management in agri-business, to understand the functions of agricultural lending products, to assess investment analysis and projections, to understand the level and type of risk nalysis a bank must perform while evaluating agri-business financing, to understand agri-value chain finance, to understand the factors a bank must keep in mind when marketing agricultural banking products, to understand the role of the regulator in agricultural financing

**Syllabus:**

**Theory**

UNIT I

Role and Importance of Agricultural Finance. Basic economic principles involved in finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending – Financing through Co-operatives, NABARD and Commercial Banks and RRBs. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II

The concept of 3 C's, 7 P's and 3 R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Credit inclusions – credit widening and credit deepening.

UNIT III

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis.

UNIT IV

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects.

UNIT V

Risks in financing agriculture. Crop Insurance programmes – review of different crop insurance schemes - yield loss and weather based insurance and their applications.

**Practical**

Estimation of Demand and supply of agricultural credit and over dues. Assessment of Rural Lending Programmes of Commercial Banks. Preparation of District Credit Plan. Preparation of financial statements using farm/firm level data. Performance of Micro Financing Institutions - NGO's and Self-Help Groups. Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Case Study Analysis of an Agricultural project, Financial Risk and risk management strategies – crop insurance schemes.

**Learning Outcome:**

On the completion of the course, students will be able to learn sources of agricultural micro-macro financing and credit systems, understand the history of financing agriculture in India, significance and limitations of crop insurance, significance of farming cooperatives, acquire knowledge of successful cooperative systems in India and newly launched crop insurance schemes, estimation of credit requirement of farm business, preparation and analysis of project reports and balance sheet, analysis and performance of commercial banks, cooperative banks to acquire first-hand knowledge of their management, schemes and procedures.

**AEC 504 Globalization and agricultural policy 2+1**

**Objectives:**

To understand the concept of globalization and agricultural policy and their implication on the society as a whole.

**Syllabus:**

**Theory**

UNIT I

Concept of globalization and the relevance of agricultural policies in India. Role of agriculture in economic development. Development Issues – Population, Food Security, Rural Poverty, Inequality and Environmental Concerns.

UNIT II

International Trade- The role of trade. Free trade versus Protectionism, Tariff, Producer Subsidy, Export Subsidy, Import Quota, Exchange Rate, Terms of Trade and Trade Blocks. Trade Models- Ricardian Model of Trade- Comparative Advantage and Absolute Advantage.

UNIT III

International Trade agreements – Uruguay Round – GATT – WTO – Agreement on Agriculture and Lessons for developing countries. International co-operation in agriculture-IMF, World Bank, IDA, IFC, ADB, CGIAR.

UNIT IV

Agricultural Policies- National Agriculture Policy, National Water Policy, National Seed Policy, National Fertilizer Policy, Credit Policy, Price Policy, Crop Insurance Policy, etc.

**Practical**

Estimation of Trade Gains- Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC. Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota

and Export Voluntary Restraints on National Welfare. Estimation of Ricardian Model, Terms of Trade and Exchange rate. Gini-coefficient and Lorenz Curve.

**Learning Outcome:**

Students will understand the concept of globalisation and agricultural policy and will be enabled with necessary skills to analyse the impacts of changing agricultural policies and international trade.

**AEC 505 Benefit-cost analysis 2+1**

**Objectives:**

The learning Objectives of Benefit-Cost Analysis is to provide decision-makers with information about the social value of government-sponsored programs, projects and policies, so that they can allocate resources in a way that improves the well-being of society as a whole. The course covers the key concepts and tools that are essential for the evaluation of government activity by applying cost-benefit techniques, including under conditions of uncertainty. Case studies are employed to give students the confidence and insights required to undertake their individual assignment. Alternative decision-making approaches will also be presented to provide a perspective on the advantages and disadvantages of cost-benefit analysis.

**Syllabus:**

**Theory**

UNIT I

Concept and background of Benefit-Cost Analysis. Fundamental Principles of Benefit-Cost Analysis.

UNIT II

Agricultural Development Projects and their Characteristics- Formulation of Agricultural Development Projects.

UNIT III

Identification and selection of Agricultural Development Projects. Efficiency criterion- Benefit-Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Return (IRR) and Pay Back Period (PBP). Benefit-Cost Analysis from private and social point of view-Types and measurement of Benefits and Costs at farm level and at aggregate level. Approaches of Benefit-Cost Analysis- with (treatment) and without (control) approach; and Before and after approach. Equity criterion-Subsistence criterion and Contributing criterion. Employment criterion. Physical environment criterion.

UNIT IV

Application of Benefit-Cost Analysis in selection of development schemes- irrigation projects and systems; purchase of farm assets like tractors and farm buildings; establishment of crop, dairy, fishery and poultry farms; selection of agronomic practices; establishment of horticultural projects and schemes like plantation, orchards, etc; selection of plant protection practices and schemes like IPM; extension programmes; etc

**Practical**

Identification and formulation of investment projects, Project appraisal techniques – Discounted and undiscounted measures of project evaluation and their limitations. Estimation of BCR, IRR, NPV and PBP.

**Learning Outcome:**

Upon successful completion, students will have the knowledge and skills to a solid understanding of the basic rationale and techniques for applying cost-benefit analysis to government-sponsored programs, policies and projects, the ability to plan and implement a cost-benefit study and the ability to understand and critique a cost-benefit study prepared by someone else.

## SYLLABUS: DEPARTMENT OF AGRICULTURAL STATISTICS

### Courses Offered by Department Of Agricultural Statistics in M.Sc (Ag.) programme

| Course No. | Name of the Course | Credit Hours | Semester |
|---|---|---|---|
| STAT 550 | Statistical methods for applied sciences | 3+1 | I |
| STAT 551 | Experimental designs | 3+1 | II |
| STAT 552 | Bio-assay | 3+0 | II |
| STAT 553 | Nonparametric techniques | 2+1 | II |
| STAT 554 | Data analysis | 1+2 | III |

**STAT 550 Statistical methods for applied sciences 3+1**

**Objectives:**

This course is meant for students who have some knowledge on basic statistical tools and techniques. The students would be exposed to those concepts of statistics that deal with modelling observed data using different probability models, how to draw a good sample from a population in order to make some valid conclusion about the population a population parameter etc.

**Syllabus:**

**Theory**

UNIT I

Random variables, Probability mass function, Probability density function, mathematical expectation, continuous probability distribution, Normal distribution and its applications.

UNIT II

Correlation and Linear regression, Fitting of quadratic curve, Method of least square, Multiple linear regression, Multiple and partial correlation upto two independent variables.

UNIT III

Concept of sampling, Concept of population, sample, parameter, statistic etc., Sampling unit, Sample size,

Sampling frame, Sampling versus complete enumeration, Sampling and non-sampling errors,Probability and non-probabilitysampling, Sampling from a finite and infinite population, Sampling techniques: Simple random sampling with and without replacement, Stratified random sampling, Allocation problem in stratified random sampling, Concept of cluster sampling.

**Practical**

Problems related to the topics mentioned in the theory syllabus.

**Learning Outcome:**

Students will be well equipped to handle field level data for analysis and modelling purposes. They will learn how to draw a good sample from a population in order to draw valid inference

about the population a population parameter and how to build multiple linear regression models and study correlation among them under a multivariable set-up.

**STAT 551 Experimental designs 3+1**

**Objectives:**

This course is designed to give a comprehensive knowledge on how to design a study or experiment so that the results of the experiments are free from errors or biases, and then how to draw a valid conclusion using the results so obtained. In this context, laying out of different agricultural field experiments will also be covered. Designing an experiment is an integrated component of research in almost all sciences.

**Syllabus:**

**Theory**

UNIT I

Basic principles of design of experiments: randomization, replication and local control. Uniformity trials, Analysis of variance,Basic experimental designs:Completely randomized design (CRD), Randomized complete block design (RBD) and Latin square design (LSD), Missing plot technique.

UNIT II

Factorial experiments: symmetrical and asymmetrical, Split plot design, Strip-plot design, Analysis of co-variance in CRD and RBD.

UNIT III

Response curves and input optimization.

**Practical**

Problems related to the topics mentioned in the theory syllabus.

**Learning Outcome:**

The students would be exposed to various concepts of designing an experiments so as to enable them understand the science involved in planning, designing their research experiments and how to make analysis of different experimental data.

**STAT 552 Bio-assay 3+0**

**Objectives:**

To develop expertise in modelling different biological phenomena, where the observations are of special characters. Different types of growth models will be studied to model such data sets. More frequently applied statistical tools may not be applicable directly to such data sets. Some transformations may needed before making the data fit for application of different statistical

tools. Skills of selecting appropriate transformation to make the data set amenable for application of statistical tools for a particular situation will be developed at the end.

**Syllabus:**

**Theory**

UNIT I

Principle of biological assays, Direct assay, Quantitative dose-response relationship, Analytical assay, Parallel line assay, Slope-ratio assay.

UNIT II

Dose response curve, Quantal response, Probit transformation, Estimation of median effective dose, Relative potency.

UNIT III

Concept of Mathematical model, Classification of Mathematical models, Growth model, Nonlinear growth models: Malthus model, monomolecular model, logistic model and Gompertz model.

**Learning Outcome:**

Expertise in handling data related to different biological variables in relation to their modelling will be developed. The course, as expected, will help the student modelling of biological data in a better way and making proper inference for data sets where data have to be transformed to make them amenable for usual statistical treatments.

**STAT 553 Nonparametric techniques 2+1**

**Objectives:**

The course will introduce different inferential procedures used to analyze data when there is no knowledge about the functional form of the population distribution from which the sample has been drawn. The students will learn how to test different hypotheses related to location and scale parameters for one or more populations.

**Syllabus:**

**Theory**

UNIT I

Classification of data, Variables and attributes, Concept and scales of measurement, Basic ideas of nonparametric procedures, Need for nonparametric tests.

UNIT II

Run test for the randomness, Tests for location parameter: One sample and paired sample Sign test and Wilcoxon signed-rank test, Mann-Whitney U-test for two independent samples.

UNIT III

Kruskal-Wallis test (Nonparametric one-way ANOVA), Friedman,stest (Nonparametric two-way ANOVA), Chi-square test for goodness of fit and independence of attributes.

**Practical**

Problems related to the topics mentioned in the theory syllabus.

**Learning Outcome:**

It is expected that the students will develop skills to draw inference from data sets which are non-normal and are not of quantitative nature.

**STAT 554 Data analysis 1+2**

**Objectives:**

This course is meant for the students to let them know about the usage of various statistical packages for analyzing data. It would provide the students a hands on for analysing their research data along with some basic ideas on the statistical tools used in the research analysis with their applications.

**Syllabus:**

**Theory**

UNIT I

Introduction of Software packages for data analysis, Classification of data, Summarization and tabulation of data, Graphical representation of data, Descriptive statistics

.UNIT II

Fitting of probability distributions; Binomial, Poisson and Normal, Testing of hypothesis: Z-test, t-test,Chi-square test and F-test.

UNIT III

Analysis of variance and covariance, Experimental designs, Correlation and regression, Logistic regression, Concept of time series.

UNIT IV

Multivariate Statistical Analysis: Principal component analysis, Mahalanobis distance, Factor analysis, Cluster Analysis.

**Practical**

Uses of software packages like excel, SPSS, R and INDOSTAT etc. to solve the problems related to the topics mentioned in the theory syllabus.

**Learning Outcome:**

Some expertise on analysing data using software packages will be developed. Special skills will be developed for reading of the output tables and picking up of the right numbers from the output

tables for inferential purposes. At the end, Skills will be developed in writing computer programmes when it is not available in the menu driven software packages.

## SYLLABUS: DEPARTMENT OF CROP PHYSIOLOGY

**Courses offered by Department of Crop Physiology in M.Sc. (Ag.) programme**

| Course No. | Name of the Course | Credit Hours | Semester |
|---|---|---|---|
| CPH 501 | Stress physiology | 2+1 | I |
| CPH 502 | Mineral nutrition of plants | 2+1 | II |

**CPH 501 : Stress physiology 2+1**

**Objectives:**
To study various types of stresses in crop production and strategies to overcome them.

**Syllabus:**
**Theory**
UNIT I
Response of plants to abiotic stress: Abiotic stresses affecting plant productivity, interactions between biotic and abiotic stresses.

UNIT II
Drought characteristic features, water potential in the soil-plant-air continuum. Development of water deficits, energy balance concept.

UNIT III
Transpiration and its regulation – stomatal functions.

UNIT IV
Physiological processes affected by drought. Drought resistance mechanism: Escape, dehydration postponement (drought avoidance), dehydration tolerance and characteristics of resurrection plants, osmotic adjustment, osmoprotectants, stress proteins, water use efficiency as a drought resistant trait. Water logging and flooding injury. Molecular responses to water deficit: expression of regulatory and functional genes and its significance.

UNIT V
Stress and determined hormones – ABA as a signaling molecule – Cytokinin as a negative signal. Oxidative stress: Relative Oxygen Species (ROS), role of scavenging systems (SOD catalase etc.).

UNIT VI
Stress due to high temperature: heat wave tolerance mechanisms – role of membrane lipids in high temperature tolerance, functions of HSP's.

UNIT VII

Low temperature stress: Chilling and freezing stress, frost and cold injury effects on physiological process, crucial role of membrane lipids.

UNIT VIII

Salinity: Species variation in salt tolerance, salinity effects at – Cellular and whole plant level, tolerance mechanisms, salt tolerance in – Glycophytes and halophytes.

UNIT IX

Heavy metal stress: Aluminum and cadmium toxicity in acid soils, role of phytochelatins (heavy metal binding proteins).

**Practical**

Determination of proline content of plant parts; determination of Relative Leaf water content of plants; Quantification of anti oxidative enzymes like Super oxide desmutase (SOD); Determination of membrane injury index (MII); Determination of chlorophyll stability index (CSI) ; Studying the effect of ABA / Cytokinin on stomatal behavior.

**Learning Outcome:**

The students will understand various aspects of stress physiology such as physiological and molecular basis of abiotic stress tolerance in plants; the knowledge in stress physiology will be useful for developing climate resilient genotypes for sustainable crop production.

**CPH 502 : Mineral nutrition of plants 2+1**

**Objectives:**

To impart knowledge about physiological and molecular aspects of carbon reduction cycle and nitrogen assimilation

**Syllabus:**

**Theory**

UNIT I

Overview of essential mineral elements, forms of plant nutrients, Role of mineral nutrients in plants, Deficiency Symptoms, Mechanism of nutrient uptake by plants, Factors influencing mineral absorption in plants.

UNIT II

Nutrient uptake by root cells and foliar absorption of nutrients, long distance transport in plants and movement into developing grains, Nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

UNIT III

Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for Nitrate, Phosphate, Potassium and other nutrients.

UNIT IV

Molecular physiology of micronutrient acquisition, Genes encoding mineral ion transporters. Strategies plants adopt to acquire and transport minerals under deficient levels.

UNIT V

Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, Phosphorous, Iron and Zinc efficient crop varieties.

UNIT VI

Plant responses to mineral toxicity.

**Practical**

Physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels. Quantification of pigment levels, enzyme activities.

**Learning Outcome:**

The students will understand various aspects of mineral nutrition of plants such as physiological and molecular basis of mineral ion uptake and utilization in plants; the knowledge in mineral nutrition will be useful for improving nutrient use efficiency of crops for achieving higher productivity.

## ORDINANCE: DEPARTMENT OF ANIMAL SCIENCE

**Master Degree Programme, Dept. of Animal Science, PSB, Visva-Bharati**

**Preamble:** As per suggestions from the UGC, ICAR and the Academic Council, Visva-Bharati (vide Ref. No. Aca. S-19.2/174/2009-10 dt. 08.05.09 on introduction of Semester System including the Choice Based Credit System wherever possible) at the Post-graduate Level the New Ordinance has been set forth.

**Contents**



**Notes:** Adhyaksha- Principal/ Dean; Bhavana- Institute of Agriculture; HOD- Head of the Department; BOS- Board of Studies; PPW- Plan of Post-graduate Work; ORW- Outline of Research Work; GP- Grade Point; OGPA- Overall Grade Point Average.

**1. General:**

**a.** There shall be subjects of studies for the Master of Science in Agriculture *i.e.* a) M. Sc. (Ag.) in Agronomy, b) M. Sc. (Ag.) in Soil Science and Agril. Chemistry, c) M. Sc. (Ag.) in Agril. Extension, d) M. Sc. (Ag.) in Plant Protection e) M. Sc. (Ag.) in Horticulture and M. Sc. in Animal Science (Poultry) at Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan. Introduction of any new subject(s) of studies in PG Level at the Institute will be made in due course without modification of the ordinance Part- I: (Rules and regulations).

**b.** The Post-graduate Degree courses of two-year duration comprising four semesters will run under "Course and Credit System".

**c.** A candidate seeking admission to M. Sc. (Ag.) Programme is required to produce a certificate that he / she has passed the four-year B. Sc. (Ag.) Honours degree examination of Visva-Bharati

or equivalent examination recognized by the ICAR and/or the UGC. For M. Sc. in Animal Science (Poultry) course; requisite qualifications are B.V. Sc. & A.H./ B.Sc. (Ag.) Hons. / B.Sc. (Zoology) Hons. degree. The other eligibility criteria like percent of marks, OGPA etc. will be decided as per University guidelines, which may vary from time to time. However, for the ICAR nominated candidates, the eligibility criteria adopted by the ICAR will be followed as such.

**d.** The candidate admitted for admission to the M.Sc. (Ag.) (M.Sc. in Animal Science Poultry) Programme in various disciplines shall abide by the regulations regarding the course curricula and the academic standards as prescribed by the University from time to time.

**e.** The medium of instruction and examination shall be in English.

**Department and major field of specialization**: Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati offers Master's degree in the following programmes with major studies in:

| **M. Sc. (Ag.) in** | **Major subject(s)** |
|---|---|
| Agronomy | Agronomy |
| Soil Science & Agril. Chemistry | Soil Science and Agril. Chemistry |
| Plant Protection | Agril. Entomology / Plant Pathology |
| Agricultural Extension | Agricultural Extension |
| Horticulture | Fruit Science / Vegetable Science |
| M. Sc. in Animal Science | Poultry |

2. **Standing Committee (PG Programme):**

a. A Standing Committee (PG Programme) shall be formed for examining the issues related to M. Sc. (Ag.) / M. Sc. in Animal Science (Poultry) Programme of the Institute.

b. The composition of the Standing Committee (PG Programme) shall be

j. Chairman: A Senior Professor appointed by the Principal of the Institute.

ii. Head(s) of the Department(s).

i. Vice-Principal: may act as liaison to the Principal and other members.

ii. PG Coordinator of each M. Sc. (Ag.) Programme (*i.e.* Agronomy, Soil Science & Agricultural Chemistry, Plant protection, Agricultural Extension and Horticulture and M. Sc. in Animal Science (Poultry).

c. Function of Standing Committee (PG Programme) may include:

iv. Looking after the general work of M. Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) Programmes of the Bhavana.

v. Reviewing academic standards including syllabus, examinations etc.

vi. Looking after matters related to examinations, evaluation etc.

3. **PG Coordinator**:

a. BOS / Departmental Committee of the concerned Department offering M. Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) Programme(s), may select a faculty member as a PG Coordinator for each course.
b. The PG Coordinator(s) will look after smooth running of M. Sc. (Ag.) /M. Sc. in Animal Science (Poultry) Programmes of the concerned Department (s).

4. **Academic Session and Semester Calendar**:

a. The duration of M. Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) Programme(s) shall be of two academic years consisting of four semesters. The maximum allowable semesters for completion of any M. Sc. (Ag.) / M. Sc. in Animal Science (Poultry) Programme is eight (8).
b. The academic year of M. Sc. (Ag.) / M. Sc. in Animal Science (Poultry) Programme shall be in terms of two semesters in a year.
The odd semesters (*i.e.* First and Third) shall run in the first half of an academic year and even semesters (*i.e.* Second and Fourth) shall run in the second half of the same academic year. The broad schedule of two semesters is

Odd semesters (I & III) : July to December

Even semesters (II & IV) : January to June

c. The commencement of each semester in a particular academic year shall be decided by the Standing Committee (PG Programme) from time to time.

d. There shall be no semester break but summer and autumn recesses and enlisted holidays will be followed as prescribed by the University.

e. Degree to be awarded after completion of 2 years PG programme in Poultry Science
i. M.Sc. in Animal Science (Poultry): students completed B.Sc. (Ag.) Hons / B.Sc. (Zoology) Hons. in UG (both cases extra credits to be covered requires as remedial)
ii. M.V.Sc. in Poultry Science: students completed B.V.Sc & A.H in their UG course

5. **Courses:**
a. Code: Each course shall bear a distinguishing code (three letters and three digits) that identifies the discipline from which it is being offered.
b. Code numbers:
iv. All Master's level courses shall ordinarily belong to 500-series.
v. Credit seminar shall be designated by Code No. 591
vi. Master's research (Thesis) shall be designated by Code No. 599.
c. There shall be two types of courses, "**credit courses**" and "**non-credit courses**". Grade points obtained only in 'credit courses' will be considered for the classification of results.

Performance in non-credit courses including Thesis will be as "Satisfactory / Non-satisfactory"

d. There shall be four types of credit courses, "**only theory courses**", "**only practical courses**", "**composite courses**" and "**credit seminar**". The composite courses will consist of both theory and practical components.

e. The distribution of marks in various courses of M. Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) shall be:

| | | | |
|---|---|---|---|
| i. | **For 'Only theory courses'** | | |
| | Semester Terminal Examination | : | 80 |
| | Internal Assessment | : | 20 |
| | **Total** | **:** | **100** |
| ii. | **For 'Only practical courses'** | | |
| | Semester Terminal Practical Examination | : | 80 |
| | Internal Assessment | : | 20 |
| | **Total** | **:** | **100** |
| iii. | **For 'Composite courses' i.e. Theory & Practical (70:30)** | | |
| | Semester Terminal Theory Examination | : | 50 |
| | Internal Assessment (Theory) | : | 20 |
| | Semester Terminal Practical Examination | : | 30 |
| | **Total** | **:** | **100** |
| iv. | **For 'Credit seminar'** | **:** | **100** |

f**. Internal assessment**:

Internal assessment will be done in the form of **Continuous Evaluation** having at least two tests of different forms (tutorial, class test as Objectives, essay, viva-voce, quiz type, assignment / term paper, class seminar, group discussion, interaction, small projects etc.) per course. The tests should be spread throughout the Semester but 15 days before the commencement of Terminal Examination. At least 50 % weightage should be on written form of tests. In case of the student who fails to appear in the Terminal examination of a given semester but appears in Internal Assessment (continuous evaluation) of the courses, marks of internal assessment of the student will remain valid during his/her next chances

but if a student remains absent or scores low or nil marks even in internal assessment, he/she will not be permitted to reappear for internal assessment after the semester is over.

Within 15 days of conducting the Tests, the Course Leaders will submit marks in the prescribed form in duplicate to the HOD who will sign on both the copies, keep one copy for office use and forward the other copy to the Deputy Registrar (Examinations). The marks of the Internal Assessment should be displayed in the concerned Department for at least seven days before forwarding the same to the Deputy Registrar (Examination). Once the marks of the Internal Assessment are submitted to the Deputy Registrar (Examination) by the Department, the marks cannot be corrected or changed.

g. Marks scored in Internal Assessment are to be mentioned separately in the Mark sheet.

h. Courses:

i) **Major courses**: The discipline in which the student shall pursue major study in his/her Master's Programme.

ii) **Minor courses**: The discipline closely related to a student's major discipline. Split minors will be permissible.

iii) **Supporting courses**: It could be any discipline excluding major considered relevant for student's research work or necessary for building his/her overall competence.

iv) **Non-credit compulsory courses**: Courses are of general nature and are compulsory for M. Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) Programme. Students' require to complete six courses as stated below:

| CODE | COURSE TITLE | CREDITS |
|---|---|---|
| PGS 501 | Library and Information Services | 0+1 |
| PGS 502 | Technical Writing and Communication Skills | 0+1 |
| PGS 503 (e-Course) | Intellectual Property and its management in Agriculture | 1+0 |
| PGS 504 | Basic Concepts in Laboratory Techniques | 0+1 |
| PGS 505 (e-Course) | Agricultural Research, Research Ethics and Rural Development Programmes | 1+0 |
| PGS 506 (e-Course) | Disaster Management | 1+0 |

j. One credit hour indicates one hour lecture or two hours practical work per week for the entire semester.

6. **Credit Requirements**:

d. A student is required to complete a minimum of 60 credits of which 40 credits shall be of course work and 20 credits shall be allocated for the research (Thesis) work. In addition six (6) non-credit compulsory courses as mentioned in 5 h iv are required to be completed.

e. A student's programme of studies shall not be more than 25 credits in any semester.

f. The total course and credit requirements for obtaining Master's Degree shall be:

| Particulars | Minimum Credits |
|---|---|
| **ii) Course Work** | |
| Major courses* | 25 |
| Minor courses | 09 |
| Supporting courses | 05 |
| Non-credit Compulsory courses | 06 |
| Seminar | 01 |
| **Total** | **46** |
| **ii) Comprehensive Examination** | Non-credit |
| **iii) Thesis** | 20 |

*For students, other than B.V.Sc. & AH Degree holders, course no PSC- 511, PSC- 512 and PSC-514 are compulsory core courses.

d. In addition to above a candidate may be permitted to opt for required number of credits from optional major courses and minor or supporting courses as suggested the Chairman of Advisory Committee.

7. **Course Regulation**:

a. The courses to be offered in a particular academic year or semester shall be decided by the BOS /HOD based on available facilities and faculty strength.
b. Allotment of courses, designating faculties as Course Leader and Course Associates shall be decided by the BOS /HOD well in advance of the commencement of a semester. The Course Leader will be in rotation considering the workload of each teacher associated with a particular course.
c. Towards introduction of a new course or revision of course, University rules will be followed.
d. There shall be no rigid rule or guideline regarding the minimum number of students required for offering a course. The course will be offered even for a single student.
e. There shall be the provision of inviting the Guest Lecturers to deliver lecture on some highly specialized topics if required.

8. **Course Registration**: The students will have to submit their choices for course(s) for a particular Semester in writing (in prescribed format) to the HOD through the Major Advisor and PG Coordinator of concerned Department at least one week before the commencement of classes of the said Semester. Students intending to change the Course opted for once will be allowed to do so in the same process within 15 days after the initial Registration.

9. **Advisory Committee:**

a. The Advisory Committee consisting of at least three members from both major and minor subjects shall be constituted for each student.
b. Every student shall have a Major Advisor who shall be from the Major Field to which the student has been admitted. The Major Advisor shall function as the Chairman of the Advisory Committee.
c. The nomination for Chairman of the Advisory Committees of all newly admitted students shall be completed within four weeks of the first Semester by the HOD.
d. The Advisory Committee of the student should meet frequently to monitor the progress of the student.
e. A proposal for the formation of the students' Advisory Committee along with the Plan of Post-graduate Work (PPW) shall be forwarded in the prescribed proforma to the HOD for approval within six weeks from the date of admission of the student.
f. The Major Advisor will select other members of the student's Advisory Committee (with the knowledge and consent of the members concerned). Co-advisor shall be from the major field of study / specialization of the concerned Department; Member(s) one each from the Department(s) offering Minor Courses; and Member(s), from any discipline, if Major Advisor feels it necessary for the student's Thesis work.
g. Co-advisor will act as the Major Advisor of the concerned student if the original Chairman is not available due to one or more reasons (death, leaving the university, prolonged absence, ill health etc.)
h. Replacement of members of the Advisory Committee: The Chairman of the concerned student after consultation with the HOD can replace any member of the Advisory Committee due to one or more reasons as stated in Para 9. g above.
i. In case of newly admitted students, the HOD will discharge the functions of the Chairman of the Advisory Committee till the Chairman is selected as per procedure prescribed above.
j. A faculty member having a minimum of one year teaching/ research experience or Doctoral degree can be the Chairman of the Advisory Committee.

10. **Plan of Post-graduate Work (PPW):**

a. The programme of studies indicating the PPW of each student in prescribed format shall be finalized by his / her Advisory Committee to provide considerable latitude in the choice of courses, taking into account the requirement for research in that particular field.
b. The broad research topic of every student will be mentioned at the time of preparation of PPW. The Advisory Committee should finalize PPW within six weeks of the first Semester.

11. **The Outline of Research Work (ORW)**:

a. The ORW in prescribed format will have to be approved by the Advisory Committee and forwarded by the Chairman of the Committee to the HOD through the PG Coordinator.
b. The ORW will be presented in the Departmental Seminar for discussion and suggestions.

12. **Attendance:**

a. Candidates should have an average attendance of 75% in every Semester to be eligible to appear for the Terminal Examination of a given Semester. Candidates having 60% and more but less than 75% attendance may be allowed to appear in the Semester Examination after paying the requisite fine as decided by the University from time to time.

13. **Paper setting and Evaluation**:

a. In the Semester Terminal examination question papers for fifty percent of the major courses in each semester shall be set externally but evaluated internally. But for only practical courses evaluation will jointly be made by the external and internal(s) examiners. For minor course(s) concerned BOS will make appropriate arrangement.
b. In case any external examiner fails to arrive in the practical examination, the concerned HOD may exercise the option to appoint himself or any other teacher of the University or an expert available in the vicinity other than internal examiner(s).
c. For all the non-credit compulsory courses the paper setting as well as evaluation will be made internally.

14. **Examination and Regulation**:

a. Semester Terminal examinations for odd Semesters shall ordinarily be held in December while for even Semesters be held in the month of June in every academic year. Standing Committee (PG Programme) will fix the period of every Semester Terminal examination preferably at the beginning of the semester. It is also expected that the Semesters of all M. Sc. (Ag.) Programme in the Institute will commence at the same time.
b. The candidates shall be required to pass all the courses mentioned in his/her PPW. He/she also needs to complete required Thesis credit hours within the stipulated period i.e. not more than eight (8) Semesters.
c. Before appearing in the end semester theory and/or practical examinations (both theory and practical examinations for composite courses) the student must pass all the backlog paper(s).
d. There shall be the provision for **Review System** and the evaluation will be done internally. The BOS will recommend the names of three members (HOD and other two members excluding the first examiner) for Review Examination. In case the HOD has evaluated the course, Adhyaksha will act as a member in the Board replacing the HOD.
e. The duration for semester Terminal examination of different courses shall be as follows:

| | | |
|---|---|---|
| i. For theory courses | : | 3 hours |
| ii. For practical courses | : | 3 hours or more |

f. The candidates appearing in each Semester Terminal examination of M.Sc. (Ag.)/ M. Sc. in Animal Science (Poultry) Programme shall: (i) produce a certificate from the HOD that he/she has attended at least 75 % of the in-campus classes. Relaxation, if any, will be guided by the University Ordinance; (ii) produce a certificate from HOD that his/her conduct has been good and that he/she is fit and proper candidate for the examination.
g. A student found adopting unfair means at the examination will be treated heavily and stringent action will be taken as per University rules.
h. No 'make up' examination shall be permitted in lieu of the missed Terminal theory and/or practical examination.
i. If a student fails to appear in any final theory and /or practical examination or does not secure pass marks in any course, he/she requires fresh registration for the course during the next available Semester with that course but the candidate has to complete the degree programme including all the repeat courses within eight (8) Semesters.

j. If a candidate is compelled to drop a Semester on medical ground he/she will be allowed to repeat in the next available Semester. However, he/she has to complete all the courses within eight (8) Semesters.
k. If a student has to drop a course on medical ground but having less than 75 % attendance the student shall be given 'I' grade, i.e. "incomplete", and will be allowed to repeat the course in the next available Semester. The 'I' grade shall be entered in the transcript also. In all other cases dropping of course will be declared 'Fail' in the course.

15**. Fees and other Charges:**

Student admitted to PG Programme shall pay examination fees (as per University guidelines) for each Semester Terminal Examination at the time of filling up of form for the purpose.

16. **Moderation:**

a. A Moderation Committee consists of at least three members may be appointed as per University rule but excluding an external moderator, shall do moderation of question papers for the Terminal Theory Examinations.

b. Separate Moderation Committee shall be formed for each M. Sc. (Ag.) / M. Sc. in Animal Science (Poultry) Programme and that may act under the Chairmanship of HOD.

17. **Scrutiny:**

a. There shall be a Scrutiny Committee consisting of HOD and two other teachers of the Department to scrutinize the results of internal assessment, Terminal as well as Review examinations before finalization. The BOS of the concerned Department will approve the Committee.
b. Each PG Programme will have separate Scrutiny Committee that will act independently.

18. **Credit Seminar:**

a. Each student shall be required to deliver a Seminar during the course of studies on a topic relevant to the concerned discipline.
b. Code No. 591 shall be assigned for Credit Seminar.
c. PG Coordinator shall act as Seminar Leader. Otherwise, HOD of concerned Department himself or may select any faculty member as Seminar Leader.
d. Departmental students' Credit Seminar will be an open Seminar.
e. The Seminar Leader in consultation with the HOD shall fix the schedule for the Seminars.
f. The Seminar topic shall not be within the purview of the student's Thesis instead should cover a subject of topical interest.
g. Each student will prepare and distribute copies of 'Abstract' to the persons attending the Seminar. The Abstract (within 300 words) should precisely state the main theme of the talk.
h. **Seminar write-up:** The student shall prepare a full account (not normally exceeding 3000 words) on the topic covered in the seminar and submit to the Seminar Leader on or before the date of presentation of the Seminar.
i. **Seminar evaluation:** Seminar Leader and the members of the Advisory Committee will evaluate the performance of the students, taking into account all the relevant factors like,

Introduction, Review of Literature, presentation of subject, capacity to draw general conclusion from literature and ability to answer questions raised and will award marks to the student.

**19. Comprehensive:**

a. Every student has to appear at Comprehensive Examination to be conducted by the Advisory Committee.
b. A candidate should be allowed for comprehensive examination after completion of 75% course work separately in major and minor subject(s) but before the submission of Thesis.
c. Written comprehensive examination consists of one paper in major courses and one paper in minor courses each of three hours duration having 100 marks.
d. Paper setting and evaluation will be done internally.
e. Qualifying marks will be 50% and grading will be Satisfactory/Unsatisfactory. If the performance of a student becomes unsatisfactory he/she has to appear again to a maximum of three more attempts within eight (8) Semesters. Repeat comprehensive test(s) shall be conducted at least with a gap of 30 days of the previous test.
f. The results of comprehensive examination shall be forwarded by the HOD to the Examination Section for record. The grade obtained will not be reflected in the Final transcript.

**20. Thesis:**

a. The thesis for the Master's Degree shall indicate student's potentialities for conducting research.
b. The topic of Thesis will be within the Major field of specialization under the Code No. 599.
c. The subject of the Thesis should be approved by the student's Advisory Committee and the HOD at the time of formation of the student's PPW and then ORW.
d. The Thesis shall be based on the results of the student's own work. A certificate to this effect from the Major Advisor shall accompany the Thesis.
**e.** The Thesis shall preferably follow the following: chapters on Introduction, Review of literature, Materials and Methods, Results, Discussion, Conclusion and Summary, Future scope of research and References.
f. **Thesis Seminar**: A student shall deliver a seminar on the research problem before the submission of Thesis and all the faculty members may be invited to participate in the discussion and make constructive suggestions on the Thesis.
g. **Thesis submission:** After fulfilling the prescribed courses, residential requirements and minimum semester requirements (4 Semesters) and successfully completing the research work to the level of full satisfaction, a student shall submit the Thesis.
h. The Chairman of the student's Advisory Committee shall ensure that all members of the Advisory Committee are duly consulted before submission of the manuscript of the Thesis.
i. Each student shall submit three copies of the Thesis within the date notified by concerned HOD, one copy to deposit to the Institute Library, another to the Departmental Library, third to the Major Advisor.
j. The Thesis shall accompany a certificate to the effect that the work has not been submitted in part or full for any other degree or diploma.
k. The candidate shall submit the Thesis to the concerned HOD along with "no dues certificate" and other formalities.

l. **Thesis Viva-Voce:** An External Examiner shall examine the Thesis. An arrangement for *viva voce* shall be made by the concerned Department by an Examination Committee consisted of External Examiner, HOD and the members of the Advisory Committee of the candidate. The student shall be awarded "Satisfactory" (*i.e.* pass) or "non-satisfactory" (*i.e.* fail) in Thesis Viva-Voce.

m. The grade obtained (*i.e.* Satisfactory / Non-satisfactory) shall be shown in the final transcript but shall not be included for the purpose of calculation of OGPA.

n. In case, the External Examiner suggests modification / re-submission, the student may be permitted to defend his/her thesis in final *viva-voce*, and as such of modifications as are finally agreed upon may be carried out after the *viva-voce*.

o. Re-examination: If a student fails (*i.e.* non-satisfactory) in Thesis he/she may be permitted to continue the work and/or rewrite the Thesis as per comments of the Examination Committee and resubmit it to the HOD with the recommendation of the Chairman of the Advisory Committee for permission to appear a second time. Re-examination shall not take place earlier than three months after the final semester examination but within eight (8) Semesters and as far as possible the Committee as previously constituted, will conduct it. No further re-examination is permissible and a student failing to secure 'satisfactory' grade a second time shall not qualify for the degree.

21. **Rights on Thesis:**

a. The Thesis submitted by a student shall become the property of the Institute.

b. Whenever, an extract from the Thesis is published, there should be an acknowledgement in the form of footnote stating that the results are from the Thesis submitted for the degree from the Institute of Agriculture, Visva-Bharati.

c. All patents, designs and inventions derived from the Thesis research work shall belong to the Institute which may, at its discretion, allow or direct any benefit thereon to be retained by or given to the author of the Thesis.

d. Copies of the Thesis submitted to the Institute Library or in the Departmental Library shall not be issued on loan for a period of two years from the date of submission.

e. In case where student does not take care to publish the Thesis work even after three years of completion of the degree, there stands no objection of the student to publish papers/ articles by the Chairman, Advisory Committee of the concerned student.

**22. Grading System:**

a. There will be a ten point grading system of evaluation with grade point (GP) equals to percent marks obtained divided by 10.

b. The conversion formula will be: Percent of marks = 10 x OGPA

c. Minimum requirement: Grade point (GP) of 5.00 for passing a course and an Overall Grade Point Average (OGPA) of 5.00 for completing the M. Sc (Ag.) Programme. A candidate failing to secure minimum OGPA (5.00) will not be considered for the award of degree and shall be declared as 'failed'. If a candidate fails to secure 40 % marks in Practical examination of composite course he /she will be declared as 'fail' in the concerned course.

d. A candidate failing to obtain minimum GP (5.00) in not more than three courses, in a Semester, will be allowed to repeat the failed course(s) afresh not more than two times in next available Semesters. A candidate failing in more than three courses in a Semester has

to repeat the Semester. In any circumstance the student is to complete the degree Programme including all the repeat courses within the maximum of 08 Semesters.

e. Symbols to be used in the Semester Transcript:

I = Incomplete
S = Satisfactory
NS = Non-Satisfactory
R = Repeat

Specialization of the candidate needs to be mentioned in the Semester Marksheet/Transcript.

**23. Residential Norms:**

i. Residential requirement shall mean presence of the student continuously in working days/hours in the Institute/University (class room for classes, laboratories for practical and/or research, farm for field work, library for collecting information or placed somewhere on duties etc.).

ii. The minimum residential requirement shall be of four Semesters from the date of admission to the University. However, with the prior written permission of the HOD / Adhyaksha, PSB through the Chairman a student may be allowed to discontinue after completion of two consecutive Semesters and renew studies even after two Semesters. Completion of semester shall mean clearing of all examinations as scheduled. He /she has to pay annual fees for the University for retention of the studentship.

iii. A student may be allowed for discontinuance only by one break and he/she shall have to complete all courses including submission of Thesis within eight semesters from the date of admission to the University, failing which his/her studentship shall be treated as cancelled.

iv. A student appealing discontinuance for one or two semester(s) has to vacate hostel accommodation.

Revised in the BOS meeting dated26.04.12, reviewed on 11.04.14 in presence of external members and subject matter expert in the department of ASEPAN, PSB, Visva-Bharati and approved in the Academic Council meeting dated 20.02.2016.

**SYLLABUS: DEPARTMENT OF ANIMAL SCIENCE**

Courses offered by Department of Animal Science in the M. Sc.(Ag.) in Animal Science programme

| Course No. | Course Title | Credits | Semester |
|---|---|---|---|
| PSC 501 | Poultry breeding and genetics | 2+1 | I |
| PSC 502 | Poultry nutrition and feeding | 2 + 1 | I |
| PSC 503 | Commercial layer production | 2 + 1 | III |
| PSC 504 | Commercial broiler production | 2 + 1 | III |
| PSC 505 | Breeder stock and hatchery management | 3 + 1 | II |
| PSC 506 | Management of poultry other than chicken | 2 + 1 | II |
| PSC 507 | Poultry products technology and marketing | 2 + 1 | III |
| PSC 508 | Poultry economics, projects and marketing | 2 + 1 | III |
| PSC 509 | Physiology of poultry production | 2 + 1 | I |
| PSC 510 | Diseases of poultry and flock health | 2 + 1 | II |
| PSC 511 | Avian anatomy and physiology of different systems; related to poultry production | 2 + 1 | I |
| PSC 512 | Applied pharmacology and therapeutics in poultry | 1 + 1 | I |
| PSC 513 | Poultry diseases, pathological changes and diagnosis | 2 + 1 | II |
| PSC 514 | Poultry medicine & preventive measures | 1+1 | II |
| PSC 515 | Poultry wastes management, integrated fish farming with poultry production, bio-technological intervention and environment | 2 + 1 | III |
| PSC 591 | Credit seminar | 0+1 | IV |
| PSC 599 | Master's Research (Thesis) | 0+20 | I to IV |

(Course Nos PSC 501-510 and PSC- 591, 599 are at per ICAR)

**PSC 501 Poultry breeding and genetics 2+1**

**Objectives**

To impart knowledge on different systems of breeding, selection methods, design and implementation of breeding programme in developing egg-type and meat type birds. Modern tools in poultry breeding.

**Syllabus:**

**Theory**

UNIT I

Genetic classification of Poultry –Origin and breed characteristics of poultry- Development of Poultry Industry in India - Mendel's laws of inheritance related to poultry -Qualitative and Quantitative traits in Poultry breeding -Additive, Non Additive, Epistatic and complementary gene action – Lethal and mutations in poultry – Sex linked, Sex limited and Sex influenced traits

– Economic traits - Heritability – Quantitative inheritance –– Phenotype, Genotype & environment interactions.

UNIT II

Systems of Breeding – Systems of Mating – Selection methods – Breeding programme for developing egg-type and Broiler type of birds – Developing hybrids - Other species of Poultry breeding and management - Formation and Management of inbred, pure lines, grand parent and parent stock.

UNIT III

Industrual breeding-Artificial insemination in chicken-Autosexing-Random SampleTest. Use of molecular genetics in poultry breeding-Quantitative trait loci and marker-assisted selection-Conservation of poultry genetic resources.

**Practical:**

Breeds of poultry – Factors affecting inheritance of qualitative and quantitative traits in poultry - Constructing index and Osborne index-Estimating heritability – Breeding program for developing commercial hybrid layers, broilers, Japanese quail, duck, turkey, fancy birds, Guinea Fowl and Pigeons – Semen collection, evaluation & insemination in chicken & turkey – Breeding records –Use of computers to maintain breeding records and for selection.

**Learning Outcome:**

Students will get exposure on different systems of breeding, selection methods, design and implementation of breeding programme in developing egg-type and meat type birds. Modern tools in poultry breeding.

**PSC 502 Poultry nutrition and feeding 2+1**

**Objectives**

Teaching about nutrients & their functions, nutrient requirements of poultry and factors influencing the same. Imparting knowledge of different types of feeds and feeding methods.

**Syllabus:**

**Theory**

UNIT I

Digestive system, digestion, metabolism and absorption of feed in poultry – Factors influencing the feed consumption in birds – Macro and micro-nutrients – Nutrient requirements for various species of poultry. Partitioning of energy - Calorie: protein ratio – Nutrient interrelationships – Factors influencing the nutrient requirements.

UNIT II

Feed ingredients composition, feed storage technique-milling and quality control Processing of feed – Types & forms of feeds and feeding methods – Commonly occurring anti nutrients and toxicants in poultry feed ingredients – Mycotoxins and their prevention – Feeding chicks, growers, layers, broilers and breeders – Principles of computing feed- – Balanced feeds -Least

cost feed formulation and programming – Feeding in different seasons and stress conditions – Nutritional and metabolic disorders in poultry.

UNIT III

Systems of feeding – restricted, forced, controlled and phase feeding -Use of Additives and Non additives- enzymes, probiotics, prebiotics antibiotics, herbs, performance enhancers – Utilization of non-conventional feedstuff - Feeding of ducks, turkeys, Japanese quails, Guinea fowls.

UNIT IV

Organic, functional, designer & SPF feed production - Production of drug residue, pesticide residue & toxin free feeds – regulations for Import and Export of feed and feed supplements.

**Practical:**

Physical and sensory evaluation of feed ingredients- sampling techniques for ingredients and compounded feed-Estimation of proximate principles of feed and feed ingredients – Computing various poultry feed formulae based on commonly available feed ingredients – Estimation of Aflatoxin, Calcium, Phosphorus, Sand, Silica and Salt – Mash, pellet & crumble feed preparation – Feeding procedures. Visit to feed mills – Preparation of Project report for a feed mill–Hands on Training in feed analytical lab- Preparation & quality control of organic and designer feeds.

**Learning Outcome:**

Students will learn about nutrients & their functions, nutrient requirements of poultry and factors influencing the same. Imparting knowledge of different types of feeds and feeding methods.

**PSC 503 Commercial layer production 2+1**

**Objectives**

To impart knowledge on different systems of rearing commercial egg laying birds, care and management of commercial layers for optimal egg production.

**Syllabus:**

**Theory**

UNIT I

Layer Industry in India and the World – Systems of layer farming – Location – Lay out of the farm – Systems of housing – Types of roofs, roof materials, pillars, trusses for poultry houses – Design of different Poultry Houses for large & medium size layer farms – Cages & modified cages for egg type birds – Layer farm equipments –Automation in poultry houses and its maintenance – Management of layers in different systems of rearing.

UNIT II

Deep litter & cage system of management – Medication and vaccination schedules & procedure for layers – Lighting programme for egg type birds - Water quality standards, watering of layer and water sanitation – Brooder, grower and layer management – All in All out and Multiple batch system of rearing layers.

UNIT III

Management of layers during peak egg production and maintaining the persistency in production–Factors causing uneven growth and low egg production -Monitoring egg production curve.

UNIT IV

Culling of unproductive birds – Record keeping – Biosecurity & health management – Management during different seasons – Induced moulting.- HACCP application for safe egg, value added egg production – Production of eggs free from harmful microbes, Mycotoxins & drug residues- Integration in layer production.

**Practical:**

Layer farm lay out and blue print– Design of different chick, grower & layer houses, their specifications & blue print of deep litter and cage system– Selection & culling of layers, debeaking, dubbing, deworming, delicing, vaccination & other farm routines and operations – Farm sanitation, disinfection & waste disposal – Maintaining farm records – Visit to commercial layer farms – Record keeping – Calculating Hen day egg production, Hen housed egg production and other economic traits – Case study of production loss, reasons and corrective measures – Preparing project reports for layers under different batch systems – Calculating the cost of production of eggs.

**Learning Outcome:**

Students will exposure on different systems of rearing commercial egg laying birds, care and management of commercial layers for optimal egg production.

**PSC 504 Commercial broiler production 2+1**

**Objectives**

To deal with different systems of rearing commercial broilers, manage mental practices for higher bodyweight with best feed efficiency in commercial broilers. Marketing of broilers efficiently.

**Syllabus:**

**Theory**

UNIT I

Broiler Industry in India and the World – Systems of rearing broilers – Location, layout and design of Broiler houses – Broiler farm equipment.

UNIT II

Brooding and rearing of broilers- All in all out and multiple batch systems – Litter materials and deep litter management – Lighting for broilers – Environmentally controlled broiler houses & their management – Water quality and Watering of broiler and water sanitation- Management during different seasons.

UNIT III

Mash, crumble and pellet feeding of Broilers – weekly growth rate, feed conversion and livability in broilers- sex separate feeding – Feeding broilers for optimum growth rate & feed efficiency- Broiler performance indices – Broiler farm records.

UNIT IV

Broiler farm routine, medication and vaccination schedule – Bio-security and health management and their control – Systems of Integration in broiler production and marketing –transport of broilers– Different ways of marketing of broilers- Regulations and specifications for production of export quality broilers – Organic broiler meat production.

**Practical:**

Location and blue print for a broiler farm – Broiler house design – Preparation of project report for broiler farm – Visit to broiler farms – Judging of live broilers and ready-to-cook broilers– Broiler vaccination, medication, brooding and transportation and farm routines. Record keeping - Calculating the cost of production of broilers – Feeding of broilers at different ages – Working out Feed efficiency – Case study on low body weights, reasons and corrective measures.

**Learning Outcome:**

Students will exposure on different systems of rearing commercial broilers, manage mental practices for higher bodyweight with best feed efficiency in commercial broilers. Marketing of broilers efficiently.

**PSC 505 Breeder stock and hatchery management 3+1**

**Objectives**

To impart knowledge about care and management of breeders, hatchery operation, health management of breeder stock. And to study about common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment. Bio security measures in control of general & hatchery borne diseases.

**Syllabus:**

**Theory**

UNIT I

History of Natural and Artificial incubation- embryo development-different breeder flocks – Planning a hatchery, breeder farm – Special care of breeder flock –Collection, selection and care of hatching eggs – Breeder male and female management – Flock testing & culling - Farm and hatchery equipments –Incubation practices – Ventilation and temperature control – Hatchery; Management, Fumigation and sanitation – Breeder farm and hatchery operations, routine & schedule - Factors affecting fertility and hatchability.

UNIT II

Care of day old chicks and their vaccination - Restricted & controlled feeding of breeders – Sex separate feeding and nutrient supplementation. – Seasonal management of breeders – Location of hatchery – Layout and design of breeder houses, hatchery & other buildings.

UNIT III

Biosecurity, health management and waste disposal – Vaccination & medication schedule for breeders. Control of vertically transmissible & hatchery borne diseases.

UNIT IV

Principles of bio security- Farm sanitation and disinfection procedures-Common bacterial diseases- Salmonella, Pasteurella, E.coli, Fowl typhoid, CRD, Infectious; Coryza, Viral diseases-Newcastle, Infectious bronchitis, Infectious laryngeo; tracheitis, Mareks, Fowl pox, Infectious Bursal disease, Egg drop syndrome-76; Avian Encephalomyelitis, Avian influenza, Duck viral Enteritis, Duck viral hepatitis-Fungal diseases- Aspergillosis, Mycotoxicosis, Metabolic disorders-Fatty liver haemorrhagic syndrome(FLHS), Gout and Ascites, Protozoan diseases-Coccidiosis, Ecto and endo parasitic infestation of poultry. Diagnosis, vaccination, prevention, treatment and control – Locational, structural & operational biosecurity in Poultry farms – Water sanitation & control of water borne diseases – Quarantine of poultry. Packaging and transportation of hatching eggs and chicks.

UNIT V

Hatching egg & SPF egg import and export regulations – Maintaining Salmonella and Mycoplasma free breeding flock –Application of HACCP and Good
Management Practices (GMP) in hatchery management for better chick quality.

**Practical:**

Breeder farms and hatchery records, selection, fumigation, care and storage of hatching eggs. Layout and blue prints for breeder farm and hatchery –Incubation requirements –Incubator management – Hatchery sanitation & fumigation procedures – Pedigree hatching – Hatchery waste disposal and recycling –Calculating cost of production of hatching eggs and day-old-chicks – Attending breeder farm routines & operation – Flock testing & culling of reactors –Analyzing hatchability results and hatchery records-Economics of layer and broiler hatchery.

**Learning Outcome:**

Students will get knowledge about care and management of breeders, hatchery operation, health management of breeder stock; common diseases and disorders of poultry, diagnosis, vaccination, prevention, control and treatment. Bio security measures in control of general & hatchery borne diseases.

**PSC 506 Management of poultry other than chicken 2+1**

**Objectives**

Care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affecting them and their control measure.

**Syllabus:**

**Theory**

UNIT I

Breeds and varieties of Turkey, Duck, Goose, Pigeon, Guinea fowl, Budgerigar, Japanese quail, Emu and Ostrich – Incubation periods & incubation procedure for different species – Housing, cage & equipments for different species – Duck, Turkey, Japanese Quail, Guinea fowl, Emu, Ostrich production and rearing under different systems.

UNIT II

Management and rearing of Turkey, duck, goose, Guinea fowl, Japanese quail, pigeon, emu and ostrich- Feeding standards and feeding, watering and rearing systems and procedure for different species of poultry- Breeding policies of egg and meat production in different species – Preparation of Project reports for different species for commercial exploitation.

UNIT III

Common diseases affecting poultry other than chicken and their control –Regulations for import and export of different species of poultry – prevention of exotic diseases through import of poultry products and live birds.

**Practical:**

Layout and design of housing & cages for other species of poultry. Visit to commercial Japanese quail, turkey and duck farms. Incubation and care of hatching eggs and young ones – Rearing practices followed by duck, quails and turkey farmers under field conditions. Preparing project reports for different species and calculating the cost of production.

**Learning Outcome:**

Students will get knowledge about care and management of different breeds, varieties of poultry other than chicken, methods of rearing and common diseases affecting them and their control measure.

**PSC 507 Poultry products technology and marketing 2+1**

**Objectives**

Composition and nutritive value of eggs and chicken meat, grading and preservation methods of eggs and meat, functional and value added poultry products, marketing of eggs and poultry meat.

**Syllabus:**

**Theory**

UNIT I

Physical and chemical composition and nutritive value of eggs and meat –Grading of eggs & meat by different standards –Preservation of eggs – Egg quality deterioration - Factors affecting egg quality – Handling, processing, packaging materials, packaging, transport and marketing of eggs.

UNIT II

Quality control of poultry meat – Quality preservation – Marketing of egg and poultry meat – Marketing channels – Integration in poultry processing and marketing-Functional and value added eggs and meat – Further processing of eggs and meat – Various egg and meat fast foods.

UNIT III

Sanitary and phyto sanitary measures to ensure food safety – Post oviposition value addition to the eggs & Post processing value addition to the meat for export– Production of low cholesterol eggs – Microbial safety of poultry products –Import and export of poultry products – Further processing of poultry for export –Implementation of GMP and HACCP procedures for food safety – Codex regulations for poultry products safety.

**Practical:**

Measuring internal and external egg qualities – Preservation of table eggs, grading of eggs – Processing of chicken – Further processing of poultry – Preservation of poultry meat – Preparation of various eggs and poultry meat products and fast foods – Preservation, packaging and transport – Quality control of value added poultry products – Estimation of pesticides, antibiotics and mycotoxin residues in eggs and meat – Measures of microbial safety of poultry products for export.

**Learning Outcome:**

Students will get knowledge about composition and nutritive value of eggs and chicken meat, grading and preservation methods of eggs and meat, functional and value added poultry products, marketing of eggs and poultry meat.

**PSC 508 Poultry economics, projects and marketing 2+1**

**Objectives**

To study about measures of performance efficiency in poultry farms and its allied sector, components of project reports and preparation of viable projects related to poultry Industry.

**Syllabus:**

**Theory**

UNIT I

Glossary of terms used in poultry economics & projects – Measures of performance efficiency in broiler, layer, breeder and other poultry species, hatcheries and other poultry related operations – Production standards and goals.

UNIT II

Planning poultry enterprise –Bank norms for poultry projects – Poultry insurance – Methods to improve the production efficiency and reduce the production cost - Components of project reports and preparing projects.

UNIT III

Integration in Poultry production – Marketing channels for eggs and meat –Integration in marketing of eggs and meat - Cost of production of egg, broiler, hatching egg, day-old chick, compounded feed - Effect of new economic policies on poultry industry – Viability of poultry projects.

**Practical:**

Preparing different poultry projects for bank finance – Calculating the cost of production of various products under various systems-case study – Preparation of Balance sheet, break even points, benefit: cost ratio & other farm economic indices - Preparation of feasibility & viability reports.

**Learning Outcome:**

Students will get knowledge about measures of performance efficiency in poultry farms and its allied sector, components of project reports and preparation of viable projects related to poultry Industry.

**PSC 509 Physiology of poultry production 2+1**

**Objectives**

To study the basic principles of physiology of poultry production in relation to egg formation, production, incubation, stress and role of environment.

**Syllabus:**

**Theory**

UNIT I

Skeletal system of poultry – Comb pattern, plumage - Physiology of poultry digestive system-Digestion, metabolism and absorption of feed and water – Role of enzymes – Poultry circulatory system – Respiratory system – Physiology of growth- muscle growth-bone growth and growth of body parts-Types of muscle
fibre and functions.

UNIT II

Poultry nervous system and its function – Excretory system – Male and female reproductive system-Reproductive tract-Semen production-semen characteristics; Artificial insemination-Semen extenders-reproductive tract-egg formation-egg laying pattern-photo periodic responses – Role of endocrine glands and their functions. Thermoregulatory mechanism – Stress due to adverse environmental factors –Acid –base balance – Poultry ethology.

UNIT III

Neuro-endocrine control of egg production-Ovulation and Oviposition – Clutch and Pause.

**Practical:** Demonstration of various systems of birds – structure of feather- Identification of endocrine glands –hormones in poultry production and reproduction-Haematology of poultry species - SGOT, SGPT, free fatty acids - Morphology of Poultry spermatozoa.

**Learning Outcome:**

Students will get knowledge about basic principles of physiology of poultry production in relation to egg formation, production, incubation, stress and role of environment.

**PSC 510 Diseases of poultry and flock health 2+1**

**Objectives**

To study about common diseases and disorders of poultry, their diagnosis, vaccination, prevention & treatment, emphasis on control of emerging poultry diseases of zoonotic importance, disease diagnostic techniques.

**Syllabus:**

**Theory**

UNIT I

The concepts of disease prevention in poultry – Emerging and reemerging avian diseases -Factors influencing immuno suppression and stimulation – Developing immunity in poultry

UNIT II

Water sanitation, hatchery sanitation procedures - Control of vertically transmissible diseases – non-infectious and metabolic diseases in poultry and their control – Bio security – Mycotoxins and their control.

UNIT III

Stress alleviation – prevention and control of bacterial and viral diseases in poultry – Biosecurity measures – Control measures of problematic re-emerging diseases of poultry like Ranikhet, Avian influenza, Marek's disease, Infectious bursal disease, Infectious Bronchitis, Infectious laryngo tracheitis.

UNIT IV

Flock management for Specific pathogen free egg production – Maintaining the HACCP standards in poultry farms – developments in the Exim policies for flock health.

**Practical:**

Studying the Immune status of birds – Egg inoculation techniques in laboratory diagnosis – differential diagnosis of various poultry diseases by postmortem, and laboratory techniques – Antibiotic sensitivity test – Vaccination – Disinfection and ectoparasite control, medication procedures.

**Learning Outcome:**

Students will get knowledge about common diseases and disorders of poultry, their diagnosis, vaccination, prevention & treatment, emphasis on control of emerging poultry diseases of zoonotic importance, disease diagnostic techniques.

**PSC- 511 Avian Anatomy and physiology of different systems; related to Poultry production 2+1**

**Objectives:**

To study about avian anatomy and physiology of different systems

**Syllabus:**

**Theory:**

Introduction to Anatomy and physiology of Cell Biology; embryology, skeletal system, Microanatomy of bone, Muscular system, Blood and circulatory system, Respiratory system, Digestive system, Male and Female reproductive system, Urinary system Nervous system, Sense organs and endocrinology.

**Practical:** Dissection and illustration of different systems related to Poultry production.

**Learning Outcome:**

Students will get knowledge about avian anatomy and physiology of different systems.

**PSC- 512- Applied pharmacology and therapeutics in Poultry 1+1**

**Objectives:**
To study about pharmacology and therapeutics in Poultry

**Syllabus:**

**Theory:**
Antimicrobial agents-General principles of antimicrobial therapy, Sulfonamides, combination of sulphonamide with trimethoprim or ormethoprim, nitrofuran, beta lactam antibiotic, aminoglycoside, tetracyclines polypeptide antibiotic, fluoroquinolone, miscellaneous antibacterial –Ionophores, Monensin etc..., Antifungal agent, Antihelmintic antiprotozol drug-Source ,Chemistry, Mechanism of action, toxicity and drug reaction, clinical application in poultry diseases.

**Practical:**
Relevant courses as stated above, field visit, diagnosis, trial of medicines, preventive and controlling of diseases

**PSC- 513 – Poultry diseases, pathological changes and diagnosis 2+1**

**Objectives:**
To study about poultry diseases, pathological changes and diagnosis

**Syllabus:**

**Theory**
**Bacterial diseases**
Infectious Coryza, Chronic respiratory diseases, Fowl cholera, Fowl typhoid,Fowlparatyphoid,Pullorumdiseases,Staphylococcosis,Streptococcosis,Diseases due to Escherichia coli etc.
**Viral diseases:** Newcastle disease, Avian Influenza, Marek's diseases, Gumboro disease, Avian pox, Avian infectious bronchitis, Infectious laryngotracheitis etc
**Fungal diseases-**Aspergillosis (Brooder pneumonia),Candidiasis, Mucormycosis, etc.
**Mycotoxicosis-**Aflatoxicosis,Ochratoxicosis,Rubratoxicosis,Mouldy corn disease
**Parasitic disease-**Round worm, Cestodes, Trematodes, Ectoparasites, Protozoan disease
**Nutritional disease**-Protein, fat, vitamin,mineral deficiency,etc
**Miscellaneous diseases –**Heat stroke, Digestive system, respiratory system, reproductive system etc.
Common vices of poultry and their prevention-Cannibalism, Egg eating, Pica etc.
Managemental problems and tips for their prevention-Rainy season,Summer season,General managemental tips

**Disinfection**

**Common duck diseases and their control-**Viral diseases, Bacterial diseases, Fungal diseases, Protozoan diseases, Parasites, Vitaamin and mineral deficiency.

**Practical :**

Diagnosis of diseases on the basis of symptom, Material required for post mortem examination, Post mortem examination, Collection of blood sample, Methods for Total leucocytic count, Erythrocytic count, Histopathologial diagnosis for poultry diseases, vaccines for poultry, Vaccination schedule

**PSC- 514 Poultry Medicine & Preventive measures 1+1**

**Objectives:**

To study about poultry medicine & Preventive measures

**Syllabus:**

**Theory:**

Application of chemotherapy, antibiotics and other medicine with mode of actions and results in Poultry production. Ethical uses of hormones & probiotics in poultry production. Residual effect of different medicines. Detail of preventive medicine & vaccines in poultry.

**Practical:**

Uses of different drugs and its effect. Application of preventive medicines and vaccines. Observation of the study. Farm visits & extension.

**PSC- 515 Poultry wastes management, integrated fish farming with poultry production, Bio-technological intervention and Environment 2+1**

**Objectives:**

To study about poultry wastes management, integrated fish farming with poultry production, Bio-technological intervention and Environment

**Syllabus:**

**Theory:**

Utility of poultry droppings in Agricultural crop husbandry including Fish production. Uses of poultry farm yard manure. Uses of poultry slaughter house refusals/ offal's in fish production. Applications of Bio-technology in Poultry production. Poultry farming and its effect in environment with remedial measures.

**Practical:**

Studies of different types of poultry wastes and their uses through manure in Agricultural crops, fish production etc. Visits of modern Farm and poul