PONDICHERRY UNIVERSITY
PUDUCHERRY – 605 014

6th PG BOARD OF STUDIES IN AGRICULTURAL SCIENCES

M.Sc. (Agri.) Entomology

REGULATIONS AND CURRICULUM

(Effective from 2022-23 batch onwards)

PANDITJAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE (PAJANCOA&RI)
(*A Government of Puducherry Institution*) KARAIKAL – 609 603

PONDICHERRY UNIVERSITY
PUDUCHERRY – 605 014

REGULATIONS AND
CURRICULAM
for
M.Sc. (Agriculture/Horticulture)

(Effective from 2022-23)

REGULATIONS

PONDICHERRY UNIVERSITY

POSTGRADUATE DEGREE PROGRAMME

(Agriculture/Horticulture)

SEMESTER SYSTEM – REGULATIONS

1. SYSTEM OF EDUCATION

1.1 The rules and regulations provided herein shall govern Masters degree programmes **[M.Sc. (Agri.) or M.Sc. (Hort.)]** offered by Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA&RI), Karaikal under Pondicherry University.

1.2 The duration of Master's programme is two academic years (4 semesters). The first year of study shall be the first and second semesters after admission. The second year of study shall be the third and fourth semesters.

2. COMMENCEMENT

These regulations shall come into force from the academic year **2022-23**

3. DEFINITIONS

3.1 **'PG Coordinator'** means a teacher of a department who has been nominated by the Head of the Department to coordinate the postgraduate programmes in the department. The coordinator looks after registration, time table preparation, regulation of credit load, maintenance of individual student's files, *etc*.,

3.2 **'Semester'** means a period consisting of 110 working days inclusive of the mid-semester and practical examinations but excluding the study holidays and final theory examinations.

3.3 **'Academic year'** means a period consisting of two consecutive semesters including the inter-semester break as announced by the Dean.

3.4 **'Curriculum'** is a group of courses and other specified requirements for the fulfillment of the postgraduate degree programme.

3.5 **'Curricula and syllabi'** refer to list of approved courses for postgraduate degree programmes wherein each course is identified with a three-letter code, a course number, outline of the syllabus, credit assigned and schedule of classes.

3.6 **'Course'** is a teaching unit of a discipline to be covered within a semester having a specific number and credits as detailed in the curricula and syllabi issued by the University.

3.7 **'Major Course'** means the subject of Department or discipline in which the student takes admission. Among the listed courses, the core courses compulsorily to be registered shall be given '*' mark.

3.8 **'Minor Course'** means the course closely related to a student's major subject.

3.9 **'Supporting Course'** means the course not related to the major course. It could be any course considered relevant for student's research work or necessary for building his/her overall competence.

3.10 '**Common course'** means a course which is compulsorily registered by the postgraduate student for the completion of postgraduate degree programme. The marks obtained by the student in a common course will also be taken into account for calculating OGPA.

Some of the common courses are in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If the student has already completed any of the common courses during UG, he/she may be permitted to register for other related courses with the prior approval of the Head of the Department/Board of Studies.

3.11 **'A credit'** in theory means one hour of class room lecture and a credit in practical means two and half hours of laboratory or workshop or field work per week.

Explanation : A 1+1 course (2 credits) means 1 hour theory and 2.5 hours practical per week.
A 0+1 course (1 credit) means 2.5 hours practical per week
A 1+0 course (1 credit) means 1 hour theory per week

3.12 **'Credit Load'** of a student during a semester is the total number of credits of all the courses including common courses, that a student register during that particular semester.

3.13 **'Grade Point'** means the total marks in percentage obtained in a course divided by 10 and rounded to two decimals.

3.14 **'Credit Point' means** the grade point multiplied by the credit load of the course.

3.15 **'Overall Grade Point Average (OGPA)'** means the total credit point of the courses completed by the student divided by total credits of the courses studied. The OGPA is to be worked out by rounding to nearest two decimals.

3.16 **'Arrear examination'** is an examination written for the failed course by a student without undergoing regular classes in that course.

3.17 **'Transcript Card'** is the consolidated report of academic performance of a student issued by the University on completion of the curriculum fulfillment. The format of Transcript Card is furnished in *Annexure-1.*

4. POSTGRADUATE PROGRAMMES

The list of various postgraduate programmes offered in various dicipline of the College is as follows:

M.Sc. (Agri.) Agricultural Economics
M.Sc. (Agri.) Entomology
M.Sc. (Agri.) Agronomy
M.Sc. (Agri.) Genetics and Plant Breeding
M.Sc. (Agri.) Soil Science
M.Sc. (Hort.) Vegetable Science

5. ADMISSION

5.1 Eligibility for admission:

i. Candidates seeking admission to master degree programme should have a four year bachelor's degree from State Agricultural Universities (SAU) or from other universities recognized by UGC/ICAR.

ii. Candidate who has undergone the course credit system with an OGPA of 3.00 out of 4.00 or 7.00 out of 10.00 or 70 percent aggregate alone is eligible to apply for various Master's degree programmes in this Institute. **Whereas, for SC/ST/PWD candidates the said requirement is an OGPA of 2.50 out of 4.00 or 6.00 out of 10.00 or 60 per cent aggregate.** However, this will not apply to State Department nominees. Just a pass in the concerned degree is sufficient for them.

iii. Prescribed minimum qualification from a recognized University for admission to Master's degree programme:

Sl.No.	Discipline	Requirement for Master's Degree
1.	Agricultural Economics	B.Sc.(Ag./Hort./Agrl. Marketing and Cooperation/Forestry) or B.Sc.(Hons) Agriculture/Horticulture/ Agrl. Marketing and Cooperation/Forestry
2.	Agronomy	B.Sc. (Ag.) or B.Sc.(Hons) Agriculture
3.	Entomology	B.Sc.(Ag./Hort./Forestry/Sericulture) or B.Sc. (Hons) Agriculture/Horticulture/ Forestry / Sericulture
4.	Genetics and Plant Breeding	B.Sc.(Ag./Hort./Forestry) or B.Sc. (Hons) Agriculture/Horticulture/ Forestry or B.Tech. (Biotechnology)
5.	Soil Science	B.Sc.(Ag./Hort) or B.Sc. (Hons) Agriculture/Horticulture
6.	Horticulture (Vegetable Science)	

5.2 Method of selection:

i. Candidates shall be required to be present on the specified date for a written test at their own expenses. If selected, they should come prepared to pay fees and get admitted immediately.

ii. The students will be ranked based on total marks scored by them in the categories mentioned below

Category	Weightage of marks (%)
OGPA in Bachelor's degree programme	50
Entrance	50
Total	**100**

iii. Written test with objective type (multiple choices) questions in the specific subject will be of one and half hour duration. A minimum of 50% (25 marks) is must for considering the candidate for admission. However, in case of SC/ST candidates, a minimum of 40% (20 marks) is must for considering the candidate for admission into that category.

Note: If a SC/ST candidate seeks admission under other categories a minimum of 50% **(25 marks)** in entrance test is must

iv. Candidates applied for two subjects should write the examination for both subjects continuously for two hours.

v. Seats are reserved for candidates belonging to scheduled Castes/Scheduled Tribes/Other Backward Classes as per the norms of Government of Puducherry.

vi. Two seats of the total sanctioned strength, irrespective of the discipline, are reserved for the in-service candidates of Department of Agriculture and Farmers Welfare, Government of Puducherry.

6. LANGUAGE REQUIREMENT

The medium of instruction is English. The postgraduate students should have adequate knowledge in English to read, write and speak in English and able to prepare high quality research papers in English.

7. RESIDENTIAL REQUIREMENT

7.1 The minimum residential requirement for Masters' degree shall be two academic years (four semesters) and the course should be completed within the maximum period of **five academic years (ten semesters)** from the date of admission.

7.2 In case a student fails to complete the degree programme within the maximum duration of residential requirement (five years), his/her admission shall stand cancelled.

8. REGISTRATION

The list of courses offered to the student in each semester shall be sent by the Dean to the Controller of Examinations for Registration of examination as instructed by the University from time to time.

9. DISCONTINUANCE AND READMISSION

As per University Regulations.

10. ADVISORY COMMITTEE

10.1 Each Postgraduate student shall have an advisory committee to guide the student in carrying out the programme. Only recognized teachers are eligible for teaching PG courses and guiding thesis research.

10.2 **Chairman/Guide**:

i. The approved guides by the Dean of the college only can be the guide for the students.

ii. Every student shall have a Chairman of the Advisory Committee who will be from his/her major field of studies.

iii. The Head of the departments will allot the masters students among the recognized guides.

iv. A teacher should have a minimum of two years of service before retirement for

allotment of Master's students.

v. At any given time, a PG teacher shall not be a chairman of Advisory Committee (including Master's and Ph.D. programmes) for more than five students.

10.3 **Chairman/ Co-guide/ Member from other collaborating University/ Institute/ Organization:**

i. The University / Institute may enter into Memorandum of Understanding (MOU) with other Universities / Institutions / Organizations for conducting research.

ii. The proposed faculty member from the partnering institution can be allowed to act as Co-guide / Member of Student Advisory Committee

Note: In special cases the proposed faculty member from the partnering institution can be allowed to act as Chairperson.

10.4 **Members** :

i. The advisory committee shall comprise a Chairman and two members. One member shall be from the concerned department and another member shall be from other department or discipline related to field of thesis research. **Staff having UG teaching experience of four years or more may be included as the members of the Student Advisory Committee.**

ii. In thesis topics involving more of inter-disciplinary approach, the number of advisory committee members from other disciplines may be increased by one with prior approval of the Dean.

10.5 **Formation of advisory committee:**

i. For Master's Programme the advisory Committee Chairman and members will be in the cadre of Professors, Associate Professors and Assistant Professors having three years of experience.

ii. Only recognized teachers are eligible for teaching PG Courses and guiding thesis research.

iii. A proposal for the formation of the advisory committee (Form 1) of the student shall be forwarded by the Heads of the Department to the Dean for approval within one month from the commencement of the first semester.

10.6 **Changes in advisory committee:**

i. The proposal for changes in the advisory committee (Form 1a) is to be sent to the Dean for approval, if it is keenly felt that such changes are absolutely necessary. The reason for such change should be indicated.

ii. The changes may be effected immediately, when the existing members are transferred elsewhere or resigned or retired.

iii. If a guide goes abroad or within India for more than 6 months, to attend any training or on leave for more than six months, the Chairman of the Advisory Committee has to be changed immediately. The same conditions will apply to members also.

10.7 **Absence of member during qualifying/final viva-voce examination**:

i. Conducting qualifying and thesis final viva voce examination in the absence of

members is not allowed.

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

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

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

10.8 **Duties and responsibilities of the advisory committee**:

i. Drawing the student's academic plan for postgraduate programme.

ii. Guidance throughout the programme of the student.

iii. Guiding the student in selecting a topic for thesis research and seminar.

iv. Evaluation of research and seminar credits.

v. Correction and finalization of thesis draft

vi. The members should meet together along with the student for all the above purposes and sign the appropriate documents.

11. PLAN OF COURSE WORK:

The student's plan for postgraduate course work (Form 2) drawn up by advisory committee shall be sent for the approval of the Dean before the commencement of the mid semester examination during the first semester.

12. PROGRAMME OF RESEARCH WORK

The proposal for research programme of the student, in the prescribed format (Form 3) and approved by the advisory committee, shall be sent for approval of the Dean before the end of the semester in which the research credits are registered for the first time or before taking up of the research work whichever is earlier.

13. CREDIT REQUIREMENTS

13.1 **Minimum credit requirement:** A postgraduate student should complete a minimum of 70 credits as detailed below for award of the Master's degree.

Details	Minimum Credits
Major courses	20
Minor courses	08
Supporting courses	06
Common courses*	05
Seminar	01
Research	30
TOTAL	**70**

* List of Common courses

Course code	Course Title	Credit hour
PGS 501	Library and information services	0+1
PGS 502	Technical writing and communication skills	0+1
PGS 503	Intellectual property and its management in agriculture	1+0
PGS 504	Basic Concepts in Laboratory techniques	0+1
PGS 505	Agricultural research, research ethics and rural development programmes	1+0

13.2 **Maximum credit load:** A postgraduate student can register a maximum of 22 credits per semester including common courses, seminar and research. However, research credits registered per semester should not exceed 15.

13.3 **Comprehensive qualifying examination and thesis:** A postgraduate student should successfully complete a comprehensive qualifying examination and thesis in the major field of study and submission of thesis thereon.

13.4 **Extra Credits:**

i. Over and above the prescribed minimum credit requirements, extra course credits up to a maximum of six can be registered for Master's programme.

ii. The extra credits registered will be accounted for calculation of OGPA.

14. ATTENDANCE REQUIREMENTS

14.1 i. A minimum of 80 per cent attendance separately in theory and practical of the concerned course is a must, failing which the student shall not be permitted to appear for both final theory and final practical examinations in the course concerned and grade 'E' (incomplete) will be awarded.

ii. If a student falls short of the required attendance to an extent of 10 per cent or less, the shortage may be condoned by the Dean on the recommendation of the Advisory Committee and the concerned Head of the Department, on the condition that such shortage in attendance was due to unavoidable circumstances (on medical grounds) and such absence was continuous.

14.2 The student securing 'E' grade in a course must re-register the course when offered again with the permission of the University.

14.3 **Calculation of Attendance**

a) THEORY:

i. Number of classes conducted for a course from the first instructional day as per the time table to the last theory class of that semester is to be construed as the total number of theory classes conducted by the course teacher.
ii. The mid-semester examinations are normally conducted during class hours.
iii. The attendance for mid semester examination shall be counted as a theory class for calculating attendance.

b) PRACTICAL:

i. Number of practical classes conducted for a course from the first instructional

day as per the time table to the last practical class of that semester is to be construed as the total number of practical classes conducted by the course teacher.

ii. The final practical examination will be conducted after the completion of 96 working days as per the schedule.

iii. The attendance for practical examination shall not be counted for calculating the attendance for practical.

14.4 For calculating 80 per cent attendance the number of instructional days may be calculated only from the date of joining of the student for first year first semester only.

14.5 The students failing to attend the classes / examinations on non-official ground will be treated as absent.

14.6 Students deputed for sports, cultural meets *etc*., with prior permission of the Dean of the college shall be given attendance for the period of absence. However, students under this category must have attended a minimum of 50 per cent classes in the total theory and practical classes conducted.

15. EVALUATION OF STUDENT'S PERFORMANCE

15.1 Distribution of marks:

i. All students shall abide by the rules for evaluating the course work under the semester system of education, as prescribed from time to time by the university. The weightage of Theory and Practical shall be in the ratio of 80:20 respectively.

ii. The student should secure a minimum of 50 per cent marks in theory as well as in practical with an aggregate of 70 per cent to secure a pass in a course.

iii. The student should secure a minimum of 50 per cent marks in the final theory examination conducted by the University for securing a pass in a course.

iv. In each course, examinations will be conducted for 100 marks as detailed below.

Examination	Courses with theory and practical	Courses with only theory	Courses with only practical
Mid Semester (Internal)	20	30	30
Term paper (Internal)	10	10	10
Final Theory (External)	50	60	--
Final Practical	20	--	60
TOTAL	100	100	100

15.2 Mid Semester Examination (Internal Assessment):

i. Writing the mid-semester examination is a pre-requisite for writing the final theory and final practical examinations.

ii. Student failing to write mid-semester examination(s), shall not be permitted to attend the classes further in the course(s) concerned and the student will be awarded 'E' grade.

iii. The mid-semester examinations shall be conducted for a duration of one hour and for 20 or 30 marks.

iv. The Head of the Department with the help of the concerned PG coordinator shall prepare and announce the schedule of mid-semester examinations.

v. The mid-semester examinations shall be conducted from the 56th working day of the semester.

vi. The mid-semester examination shall be conducted and evaluated internally by the concerned course teacher(s).

vii. The mid-semester examination mark list should be sent by the course teacher to the academic section of the college 10 days prior to the commencement of final practical examinations along with term paper mark.

15.3 **Missing Examination:**

i. Missing examination shall be permitted only for mid-semester examination in deserving cases on the recommendation of the course teacher/Chairman and Head of the department and on prior approval by the Dean.

ii. The missing tests are not allowed for final theory and final practical examinations.

iii. The student shall write, in advance, to the Dean through the Chairman, PG coordinator and Head of the Department stating the reason for missing the mid-semester examination(s). Based on the recommendation of the Chairman, PG coordinator and the Head of the Department, the Dean shall permit the student for missing the mid-semester examination(s).

iv. A student missing mid-semester examination(s) with the prior approval of the Dean shall be permitted to take up missing examination of the particular course, subject to payment of the prescribed missing examination fee for each missing mid-semester examination.

v. Students deputed for official programmes of the College/University are exempted from paying the fee for missing test.

vi. Such missing examinations should be completed outside the regular class hours within 15 working days after the respective examinations.

vii. Attendance will not be given for taking up missing examinations.

15.4 **Final Theory Examination:**

i. An examination schedule prepared by the Controller of Examination for the final theory examinations shall be the final. The schedule of examinations shall be adhered strictly.

ii. The duration of final theory examinations will be two and half hours for courses with theory and practical (50 marks) or three hours for courses with only theory (60 marks).

iii. The final theory examinations shall be conducted by the University. Evaluated by two examiner, one by internal and one by external. However, in case of Non-credit e-courses, the final theory examination shall be conducted internally by the course teacher.

iv. In the evaluation process, if deviation is more than 20 per cent between the first and second evaluator, the paper shall be referred to third examiner who shall also be an external examiner.

15.5 **Final Practical Examination:**

i. The Dean shall announce the commencement of final practical examinations. The Heads of the Departments shall prepare the schedule for practical examination.

ii. The final practical examinations shall be conducted after the completion of minimum of 96 working days.

iii. Submission of bonafide practical records certified by the Course Teacher is a pre-requisite for appearing in a practical examination failing which 'F' grade will be awarded.

iv. For conducting final practical examination in each course, an *external examiner* (faculty of the Department other than the course teacher) shall be nominated by the Dean and the course teacher will be the *internal examiner*.

v. In the event of external/internal examiner nominated for practical examination could not conduct the examination, then the Dean shall nominate an alternative examiner to conduct practical examination.

vi. The duration of final practical examination shall be two and half hours.

vii. The practical examinations shall be jointly conducted by the internal and external examiners with mutual co-operation.

viii. They shall evaluate the candidates appearing at the examination according to their performance and the Forms so prepared shall be signed by both the examiners.

ix. The practical examination marks should be communicated to the University/ uploaded in the university website within 10 days after conduct of examination duly signed by all the examiners and hard copy forwarded to the university thereon.

15.6 **Arrear examination:**

i. Arrear examination is permitted for the final theory and final practical examinations only.

ii. The students are permitted to write the arrear examinations as and when conducted by the University.

iii. A student is permitted to write the final theory and practical examinations only two times during 5 years duration excluding the regular final examination (Mid-semester marks and Term paper marks shall be retained as such).

iv. In the event of a student failing to secure pass in the two arrear examinations permitted, he/she has to re-register the course along with the juniors as and when the course(s) are offered with the permission of the University and on payment of the prescribed fees.

15.7 **Evaluation of course**:

i. Each course shall carry a maximum of 100 marks. The results of the course shall be indicated by the grade points ranging from 0 to 10.

ii. The total marks in percentage obtained by the student in a course shall be divided

by 10 and rounded to two decimal places to get the grade point.

iii. The minimum Grade Point to be secured for the successful completion of a course shall be 7.00.

iv. In case of courses with theory and practical, minimum of 50 per cent mark separately in theory and practical with an aggregate of 70 per cent is essential.

v. Securing a grade point less than 7.00 in a course will be treated as 'F' (Failed) and the Grade Point will be 0.00 for calculating the GPA/OGPA. The following symbols may be used

E - INCOMPLETE (Lack of 80 per cent Attendance/other reasons)
F - FAILED

15.8 **Question paper pattern for theory examinations** :

15.8.1 The question paper pattern for mid semester (internal) examinations are indicated below:

Part	**Type of question**	**Number of questions**	**Number of questions to be answered**	**Mark per question**	**Total marks**
Courses with theory and practical (1+1 or 2+1 courses) (20 Marks & 1 hour duration)					
A	Objective*	20	20	0.5	10
B	Definitions/Concepts	12	10	1.0	10
	TOTAL				**20**
Courses with only theory (1+0 or 2+0 courses) (30 Marks & 1½ hour duration)					
A	Objective*	30	30	0.5	15
B	Definitions/Concepts	18	15	1.0	15
	TOTAL				**30**
Courses with only practical (0+1 courses) (30 Marks & 1½ hour duration)					
A	Objective*	30	30	0.5	15
B	Definitions/Concepts	18	15	1.0	15
	TOTAL				**30**

* Questions should be Fill-up the blanks, Choose the best among four options, True / False or Match the following type with equal number of question in each type and one or two more questions in any one type if examination is conducted for 30 marks

15.8.2 The question paper pattern final theory (external) examinations are indicated below:

Part	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total marks
Courses with theory and practical (1+1 or 2+1 courses) (50 Marks & 2.5 hours duration)					
A	Objective (MCQ's only)	20	20	0.5	10
B	Definitions/Concepts	12	10	1.0	10
C	Paragraph answers	7	5	2.0	10
D	Essay type answers (**EITHER OR** type) - One main question from each unit shall have one choice	5	5	4.0	20
	TOTAL				**50**
Courses with only theory (1+0 or 2+0 courses) Final Theory Examination (60 Marks & 3.0 hours duration)					
A	Objective (MCQ's only)	20	20	0.5	10
B	Definitions/Concepts	18	15	1.0	15
C	Paragraph answers	7	5	2.0	10
D	Essay type answers (**EITHER OR** type) - One main question from each unit shall have one choice.	5	5	5.0	25
	TOTAL				**60**

15.9 **Question paper pattern for final Practical Examination**: The following distribution of marks shall be adopted in conducting the final practical examinations.

Details	Courses with Theory and Practical	Courses with only Practical
Practical Field work / Lab Work / Written exam	20 (2.5 hrs)	60 (3 hrs)
Total	**20**	**60**

For conducting practical examinations, the type and number of questions can be decided by the concerned internal and external examiners. Choice may be given to the extent of 20 per cent under subjective type questions.

15.10 **Term Paper**:

i. Submission of a term paper by the students is a must.

ii. The term paper topics shall be assigned by the course teacher. Term papers should cover a wide range of subjects within the course limits.

iii. The term paper shall be evaluated by the course teacher.

15.11 **Return of evaluated answer papers**:

i. The evaluated answer papers of mid-semester shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification.

ii. The answer paper should be retained by the course teacher for 6 months or declaration of results by Pondicherry University, whichever is earlier and then disposed off.

16. COMPREHENSIVE QUALIFYING EXAMINATION

16.1 i. Only those postgraduate students who successfully complete the comprehensive qualifying examination shall be admitted to candidacy of the degree.

ii. The qualifying examination consists of written and oral examination in major subjects only and the students should be allowed after completion of 80 per cent of total course credit load including major and minor courses.

iii. The qualifying examination shall be conducted only in the major courses as per the norms given below:

Question paper setting	-	External
Evaluation of answer book	-	External
Qualifying marks	-	60 per cent
Viva Voce	-	External
Grading	-	Satisfactory/Not Satisfactory

16.2 **Selection of examiner**:

i. The Head of the concerned PG Department shall send a panel of examiners for conducting the qualifying examination (Form 4). However, the University can draw its own panel of examiners.

ii. The panel of examiners for qualifying examinations shall be given three months before the date of completion of the student's course work.

16.3 **Written examination**:

i. Normally the qualifying examination shall be completed before the end of third semester of the postgraduate programme.

ii. The controller of examination shall conduct the qualifying written examination

iii. The written examination shall be conducted for major courses only.

iv. The question paper for the written examination shall be of 3 hours duration and each question need not be restricted to any particular topic in a course but it should be a comprehensive of the syllabus of each course.

v. The question paper pattern for the written examination is given below.

Part	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total marks
A	Paragraph answers	7	5	5	25
B	Essay type answers	7	5	15	75
				TOTAL	**100**

16.4 **Oral examination:**

i. Only those students who secure 'SATISFACTORY' grade in written qualifying

examination shall be permitted to attend the oral qualifying examination

ii. The advisory committee shall conduct the oral examination with one external examiner, who sets the question paper for the written qualifying examination.

iii. The performance of the student(s) in the qualifying viva-voce examination shall be graded as "Satisfactory" or "Not satisfactory".

iv. If the performance of the student is "Not Satisfactory" in the oral examination, he/she has to appear for the oral examination again.

16.5 **Communication of results of qualifying examination**:

i. The Chairman of the advisory committee shall act as Chairman for the examination committee.

ii. The Chairman of the advisory committee shall be responsible for communicating the results of the examination to the Controller of Examinations in the prescribed format (Form 5).

16.6 **Failure/absence in qualifying examination**:

i. A student is permitted to write the qualifying examination only three times including the regular attempt.

ii. A student who fails or absents in the comprehensive qualifying written/viva-voce examination shall apply to the University with the recommendation of the Chairman of the advisory committee, Head of the Department and the Dean for re-examination.

iii. A student who applies for re-examination should attend written examination and viva-voce after paying the prescribed re-examination fee.

iv. Re-examination shall not take place earlier than three months after the previous qualifying examination.

v. If a student fails even in the second re-examination (third attempt), he/she cannot continue as a student in the University for Award of Master's degree in the University.

vi. The research credits registered in the final semester shall not be evaluated unless he/she successfully completes the qualifying examination.

17. CREDIT SEMINAR

17.1 Seminar is compulsory for all the postgraduate students and each postgraduate student should register and present one seminar with 0+1 credit.

17.2 Registration of seminar credits is not allowed in the first semester.

17.3 **Seminar topic:**

i. The seminar topic should be only from the major field and should not be related to the area of thesis title.

ii. The seminar topics are to be assigned to the students by the Chairman at the beginning of the semester in which he/she registers seminar credits and the progress made by the student should be monitored.

17.4 **Evaluation of seminar:**

i. The students should prepare a seminar paper after reviewing all the available literature and present the seminar after completion of 80 per cent attendance in the semester in the presence of the Advisory committee, staff and postgraduate students of the concerned department.

ii. The circular on the presentation of the seminars by the postgraduate students may be sent to other departments to enable those interested to attend the same.

iii. After carrying out the corrections/suggestions, the student should submit two copies of the seminar papers, one to the Chairman and the other to the department.

iv. The performance of the student in the credit seminar has to be evaluated for 100 marks by the Advisory Committee. Grade Point may be given based on the following norms:

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

17.5 The students who fail to present the seminar must be awarded 'F' grade and the student should again register the seminar credits and present the seminar in the subsequent semester. The minimum of 80 per cent attendance requirement for presenting the seminar after re-registration need not be insisted.

17.6 Presenting a seminar is a must for the award of the degree.

18. THESIS RESEARCH

18.1 **Selection of topic:**

i. With the guidance of the advisory committee the students should identify the tentative area of research and include it in the plan of work.

ii. The advisory committee should guide the students in selecting a specific topic in the identified research area and for preparing a detailed proposal. While selecting the topic for thesis research, the specialization and competency of teachers, thrust area identified by the department, external funded schemes operated in the department and also the aptitude of the student may be taken into consideration.

iii. The topic for thesis research for the students of Master's programme should be of such a nature as to indicate a student's potentialities for conducting research and to train him in research.

iv. The thesis shall be on a topic falling within the field of the major specialization and shall be the result of the student's own work.

v. A certificate to this effect duly endorsed by the Chairman of the Advisory Committee shall accompany the thesis.

18.2 **Research proposal:**

i. The research proposal has to be presented by the student in a meeting organized by the Head of the department to get the opinion/suggestions of the teachers of the department for improving it.

ii. Three copies of the research proposal in the prescribed format (Form 3) should be sent to the Dean through the Head of the department for approval before the end of the semester in which the student has registered research credits for the first time or before taking up the field / laboratory experiments whichever is earlier.

18.3 **Evaluation of thesis research:**

i. After assigning the research problem, for each semester the student has to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma (Proforma-1). After scrutiny and approval, a copy of the programme has to be given to the student for carrying out the work during the semester.

ii. Attendance register must be maintained in the department for all the PG students to monitor whether the student has 80 per cent of attendance in research.

iii. After completion of 80 per cent attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and award '**SATISFACTORY** or **NOT SATISFACTORY**' depending upon quantity and quality of work done by the student during the semester. The procedures of evaluating research credits under different situations are explained hereunder.

a. **SITUATION I**: The student has completed the research credits as per the approved programme and awarded '**SATISFACTORY**' by the advisory committee. Under the said situation the student can be permitted to register fresh block of research credits in the subsequent semester. If the student is awarded '**NOT SATISFACTORY**' he/she has to reregister the same block of research credits in the subsequent semester.

b. **SITUATION II**: If the student has not secured the minimum attendance of 80 percent, then the grade 'E' should be awarded. The student has to reregister the same block of research credits for which 'E' grade was awarded in the following semester with prior permission from the University. Until the completion of re-registered credits, the student should not be allowed to register for fresh block of research credits.

c. **SITUATION III**: The student could not complete the research work as per the approved programme of work for reasons beyond his/her control such as,

- Failure of crop.
- Non-incidence of pests or disease or lack of such necessary experimental conditions.
- Non-availability of treatment materials like planting materials chemicals, *etc*.
- Any other impeding/unfavorable situation for carrying out research.

Under the said situations III, Grade 'E' should be awarded. The student has to

reregister the same block of research credits for which 'E' grade was awarded in the following semester with prior permission from the University. Until the completion of re-registered credits, the student should not be allowed to register for fresh block of research credits.

d. SITUATION IV: When the student failed to complete the work even in the 'Second time' registration, the student will be awarded '**NOT SATISFACTORY**' and he/she has to reregister the same block of research credits in the subsequent semester with the prior permission from the University.

e. SITUATION V: If a student can not complete qualifying examination till the end of final semester, the research credits registered in the final semester shall not be evaluated unless he/she successfully completes the qualifying examination. The research credits registered by the student during the final semester shall be evaluated within 15 days from the date of declaration of result of the qualifying examination.

f. SITUATION VI: If a student secures 'F' grade in one or more course(s) and can not complete the course(s) till the end of final semester, the research credits registered in the final semester shall not be evaluated unless he/she successfully completes the course(s) in which he/she secures 'F' grade. The research credits registered by the student in the final semester shall be evaluated within 15 days from the date of declaration of result of the failed course(s). If the student fails to complete the course even in 1+2 attempts, 'E' grade shall be awarded for the research credits registered in the final semester and the student has to re-register the same block of research credits along with the re-registration of failed courses, with the approval of the University

18.4 **Re-registration of research credits**: Students have to obtain prior permission of the University for re-registering the research credits. However, the University can permit the registration of research credit only three times. Permission to register for the fourth time shall be given only by the Academic Council.

19. SUBMISSION OF THESIS

i. The research credits registered in the last semester of postgraduate programmes should be evaluated only at the time of the submission of thesis by the advisory. committee. Students can submit the thesis at the end of the final semester. The list of enclosures to be submitted along with the thesis is furnished in *Annexure-2*.

ii. If a postgraduate student has completed the thesis before the closure of the final semester, the Chairman can convene the advisory committee meeting and take decision on the submission of the thesis provided the student satisfies 80 per cent attendance requirement.

iii. Copy of the thesis to be sent for evaluation should be submitted in paper pack.

iv. After incorporating the suggestions of the examiners and those received at the time of viva-voce, the thesis should be submitted to the College/university in hard bound copies (four copies) and soft copies (in pdf format) in CDs (two copies).

v. During submission of thesis for external evaluation, it is mandatory to enclose

certificates for plagiarism check and reference management (Proforma-12). Maximum of 20% plagiarism is permitted.

19.1 **Grace period:**

i. Students can avail a grace period upto three months for submission of thesis after the closure of final semester by paying prescribed fine to the University.

ii. If a student is not able to submit the thesis within three months grace period, the student has to re-register the credits in the forthcoming semester.

iii. The student who re-register the credits after availing the grace period will not be permitted to avail grace period for the second time.

iv. The Heads of the Departments can sanction the grace period based on the recommendation of advisory committee and a copy of the permission letter along with the receipt for payment of fine should accompany the thesis while submission.

19.2 **Re-registration and submission of thesis:** The minimum of 80 per cent attendance requirement for submitting the thesis after re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement *i.e*. 2 years (4 semesters) and completed the minimum credit requirements with 80 per cent attendance.

19.3 **Publication of articles:** Part of thesis may also be published in advance with the permission of the Chairman. If any part is published, the fact should be indicated in the certificate given by the Chairman that the work had been published in part/ full in any referred scientific or popular journals, proceedings, *etc*.

20 EVALUATION OF THESIS

20.1 The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner nominated by the Controller of Examinations. However, the Dean can send panel of three examiners (Form 6).

20.2 An oral examination will be conducted by the Advisory Committee after the thesis is recommended by the external examiner and carrying out the corrections/suggestions made by the external examiner by the student.

20.3 The Chairman of the advisory committee shall communicate the date of final thesis viva-voce examination to the student and advisory committee members. The thesis final viva-voce examination shall be completed within three months from the date of receipt of the report from the external examiner.

20.4 The Chairman shall send the recommendations of the advisory committee (Form 7) along with necessary certificate/documents in duplicate to the University.

20.5 i. In case, the External examiner does not recommend the thesis for the award of the degree, the advisory committee may send their recommendation for scrutiny of the thesis by another external examiner, through the Dean to Controller of Examinations within one month from the date of receipt of the thesis. The Controller of Examinations may, on the recommendation of the advisory committee and Dean, refer the thesis for scrutiny and independent judgment to a second external expert chosen by him.

ii. If the second external expert recommends the thesis for acceptance, this recommendation may be accepted.

iii. If the second examiner also does not recommend the thesis for acceptance, the degree shall not be awarded.

21 REVISION OF THESIS

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

i. For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the Dean.

ii. If the revision is recommended for repeating lab experiments, field trial *etc*, resubmission must be after a minimum period of six months.

21.2 At the time of resubmission, the advisory committee should give a certificate for having carried out the corrections/recommendations. The resubmitted copies of thesis should have incorporated the necessary corrections as indicated by the external examiners.

22 FAILURE TO APPEAR FOR FINAL VIVA/NON-SUBMISSION OF THESIS AFTER VIVA

If a candidate fails to appear before the examining committee for final thesis viva-voce, on the date fixed by the Chairman the following are the time-frame and penalty.

22.1 The thesis viva-voce must be completed within **five years from the date of first registration** for Master's programmes. The prescribed penalty/fine must be charged to the candidate.

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

23 MALPRACTICES IN EXAMINATION AND MISCONDUCT OF STUDENTS

23.1 The Dean of the College shall be responsible for dealing all cases of unfair means by students in writing records, term papers and mid-semester examinations.

23.2 In case of final theory and final practical examination, the cases of malpractice will be dealt as per Chapter XV (A) of the Academic Ordinance of the University.

23.3 **Ragging rules:** Students found involved in ragging will be dealt as per the orders of the Supreme Court of India. The matter shall be reported to the University.

23.4 **Unlawful activities:** In case of students found involved in any unlawful activities either within or outside the Hostel/College Campus, besides, expulsion both from the Hostel and College at the discretion of the Dean, the matter will be reported to the Police of the jurisdiction to be dealt with, in accordance with the appropriate law in force. The matter shall be reported to the University.

24 The schedule for the important records to be sent to the Dean is furnished below and should be followed strictly so as to get back the above academic reports in time for maintenance in the students file.

Sl. No.	Particulars	Time Schedule
1	Formation of advisory committee **(Form 1)**	Within one month of the commencement of first semester
2	Plan of course work **(Form 2)**	Before the commencement of mid semester examination in the first semester
3	Programme of research work **(Form 3)**	Before the end of the semester in which the student registers the research credit for the first time or the commencement of the research work whichever is earlier.
4	Proposal for qualifying examination **(Form 4)**	Two months before the completion of the course work.
5	Qualifying examination result **(Form 5)**	Immediately
6	Panel of external examiners for thesis evaluation **(Form 6)**	Three months before the probable date of submission of thesis
7	Final viva-voce result **(Form 7)**	Fifteen days from the examination

25 AWARD OF DEGREE AND ISSUE OF TRANSCRIPT CARD

25.1 **Eligibility for the Award of the Degree:** The successful completion of all the prescribed courses included in the Curricula and Syllabi shall be minimum requirement for the award of the Degree.

25.2 **Class Ranking**: In calculation of Class equivalent for OGPA the following classification will be adopted. First class with Distinction and first class shall be awarded to those students who have completed the course without arrear and all others shall be awarded second class

OGPA	Class
9.00 and above	First class with Distinction
8.00 to 8.99	First class
7.00 to 7.99	Second Class

25.3 **Percentage conversion**: For obtaining the percentage equivalent to the OGPA, the OGPA secured by the student shall be multiplied by 10.

25.4 **Transcript card:**

i. The Transcript card shall contain entry of all the courses and the Grade Points and OGPA obtained by the candidates indicating the number of times appeared. This will have to be prepared for all the students by the Controller of Examinations.

ii. For preparation of Transcript card, the Dean should send recent passport size photograph of the students along with filled in proforma and the prescribed fee.

26 REMOVAL OF DIFFICULTIES:

26.1 If any difficulty arises in giving effect to the provisions of these regulations, the Vice-Chancellor may issue necessary orders which appear to him to be necessary or expedient for removing the difficulty.

26.2 Every order issued by the Vice-Chancellor under this provision shall be laid before the Academic Council of the University in the next meeting after the issuance.

26.3 Not-withstanding anything contained in the regulations, the Board of Studies or Academic Council reserve the right to make changes whenever necessary.

27. REGULATIONS GOVERNED BY PAJANCOA & RI

27.1 ADMISSION

27.1.1 Application for admission:

i. Application for admission shall be made in the prescribed form to be downloaded from the website of the college (www.pajancoa.ac.in) after notification is issued to this effect.

ii. The admissions shall be regulated and made in accordance with the admission rules and regulations in force.

iii. Candidates seeking admission to the various Postgraduate degree courses are permitted to apply for only two subjects. Separate applications should be used for each course.

27.1.2 Admission procedure:

i. The admission is based on the merit category of the candidate and availability of vacancies at the time of counseling.

ii. All admissions made by this Institute are provisional and subject to the approval of the University.

iii. The candidates who have offered admission should report to the college on or before the due date mentioned failing which their right of admission is forfeited

27.2 FEE STRUCTURE

27.2.1 Fee structure is being revised every year with 10% fee hike. Lodging fees and charges for electricity, water and computer are revised based on the requirements and power tariff prevailing from time to time.

27.2.2 In the case of new admissions, the fees for the first semester should be paid at the time of admission.

27.2.3 For the remaining semesters, the fees should be paid on the date of registration of the semester.

27.2.4 Candidates who discontinue after admission are not eligible for refund of fees except caution money deposit.

27.2.5 In case of a student who re-registers with junior batch, he/she has to pay the semester fess applicable to the junior batch in which he/she registers, besides the re-registration fee.

27.3 REGISTRATION

27.3.1 All newly admitted candidates should register during the first semester of the programme. A candidate admitted to the Postgraduate programme should report to the Head of the Department concerned on the date of registration. It is the

responsibility of the candidate to register the courses in person on the due date prescribed for the purpose.

27.3.2 **In ABSENTIA** registration will not be permitted on any circumstances.

27.3.3 The Head of the Department and the PG coordinator shall help the student in selecting the courses for registration.

27.3.4 Admitted candidates shall register with the respective Department at the beginning of each semester and this should be completed within two working days.

27.3.5 **Late registration**:

i. Late registration is permitted by the Dean of college within seven working days from the commencement of the semester provided the prescribed late registration fee is paid before registration.

ii. Registration beyond seven working days is not allowed except for new entrants who are admitted late due to administrative reasons in the first semester.

27.3.6 **Registration cards:**

i. A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate. The format of registration card is given in *Annexure-4*.

ii. The Chairman, PG coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean.

iii. The Dean shall approve the registration cards.

iv. The approved registration cards shall be maintained by the Dean, PG coordinator, Chairman and the student concerned.

v. The list of courses registered by the students in each semester shall be sent by the Dean to the Controller of Examinations/University for preparation of Report Cards

27.3.7 The mess dues clearance certificate has to be produced by the student at the time of registration.

27.4 ARREAR EXAMINATION:

i. The prescribed arrear examination fee should be paid on or before the specified date.

ii. The Registration for the arrear examination shall be done on the date specified by the Dean. Each registration is considered as an attempt even if the student is absent for the examination.

27.5 QUALIFYING EXAMINATION

The Heads of departments will monitor and coordinate the conduct of both the written and oral qualifying examinations.

27.6 SUBMISSION OF THESIS

The research credits registered in the last semester of postgraduate programmes

should be evaluated only at the time of the submission of thesis by the advisory committee. Students can submit the thesis at the end of the final semester. The list of enclosures to be submitted along with the thesis is furnished in *Annexure-5*.

27.7 REVISION OF THESIS

The prescribed fine for late submission of revised thesis may be collected from the students submitting thesis beyond the due date with the recommendation of the Chairman. The Dean shall ensure that the delay is due to the fault of the student.

27.8. MERIT SCHOLARSHIP/RESEARCH ASSISTANTSHIP

27.8.1 PAJANCOA & RI PG fellowship shall be awarded to all the students who are admitted into the Masters programme based on allotment of Government fund. The PG students should be a resident of PAJANCOA & RI hostels. The award of PG fellowship is governed by the approved PG fellowship rules.

27.8.2 The Dean shall call for applications and sanction the scholarship every year.

27.8.3 The students availing any scholarship/fellowship are permitted to switch over to other fellowship/scholarship only one time during the course of study.

27.8.4 **Student SRF/JRF:**

i. The selection of student SRF/JRF in external funded schemes will be made by the existing committee members for selection of regular SRF/JRF.

ii. The PG coordinator of the concerned department will be an additional member of the committee.

iii. The panel of names after the selection has to be sent to the Dean for approval in the prescribed Proforma.

iv. If a student SRF/JRF discontinues before submitting the thesis or switch over to other fellowship/scholarship, the amount already paid has to be recovered in full in one lump sum with 6% penal interest.

27.9 RECOGNITION OF POSTGRADUATE TEACHERS

27.9.1 The Dean normally recognizes teachers for offering courses and guiding the students of Master's programme based on the request of teachers and the recommendation of Head of the department.

27.9.2 The recognized PG teachers shall offer courses to masters students as required by the concerned Heads of departments, normally, in their own field of specialization unless extra-ordinary circumstances demand for offering other courses.

27.9.3 All the recognized guides for Master's programme are competent to guide research work of Master's degree students in their own fields of specialization. The Heads of departments shall assign students to the recognized guides taking into account their specialization. The students should be uniformly distributed instead of all of them taking research topics in one or two specialized branches in the department.

27.9.4 **Teachers for Master's programme:** The following faculty shall be recognized as PG teachers for Master's programme

i. Professors
ii. Associate Professors
iii. Assistant Professors: Persons having Ph.D. degree with one year of active experience in the concerned field (or) Persons having a Master's degree with three years of active experience in the field. In case of contingencies, like start of new PG programme, persons having Ph.D. degree in the concerned field may be recognized as PG Teacher.

27.9.5 **Guides for Masters programme:** PG Teachers after handling PG courses in two semesters are eligible to guide M. Sc. students. In case of contingencies, like start of new PG programme, persons having Ph.D. degree in the concerned field may be recognized as PG Guide.

27.9.6 The Heads of departments will forward the proposals based on the qualification and experience of the teacher as given above. The proposals can be sent when there is acute need for teachers/guide in the prescribed format, given in the *Annexure-6*.

27.9.7 While forwarding the application the Head of the Department should consider the seniority of the teacher, number of courses handled and number of research schemes operated.

27.10 GUIDELINES FOR HEADS OF THE DEPARTMENTS IN MONITORING PROGRESS OF POSTGRADUATE STUDENTS

27.10.1 **Student records:** The "Individual student" file (clip file) containing all the academic records of the student concerned with students bio-data shall be maintained by the PG coordinator on behalf of the Institution. In each file a sheet containing the following information has to be attached.

i) Date of registration :
ii) Date of qualifying examination :
iii) Due date for thesis submission :
iv) Date of submission of thesis :
v) Date of viva-voce :
vi) Remarks :

27.10.2 The activities listed out in the following table must be meticulously taken care by the Professor and Head of the Department concerned

Sl.No.	Particulars	Time Schedule
1	List of courses to be offered along with time table	A week before the commencement of each semester
2	Course registration particulars	Within 10 working days from the date of commencement of each semester
3	Time table for mid-semester examinations	A week before the scheduled date for the examinations notified in the academic calendar
~~4~~	Mark lists after completing examinations	Within 10 days from the date of conduct of examinations
5.	Class grade chart	Within 7 days from the date of closure of each semester

27.10.3 The time table for various examinations and evaluations of research credits should be prepared in advance as indicated in the academic calendar of semester concerned and such dates already fixed should not be postponed or changed subsequently.

27.10.4 The Heads of the Departments should monitor the progress of the postgraduate students. Each department should maintain a list of thesis produced so far with the abstract of the same in both hard and soft copies.

Form – 1

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

FORMATION OF ADVISORY COMMITTEE

(To be sent in triplicate within one month from the commencement of First semester)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Advisory committee :

Sl. No.	Advisory Committee	Name, Designation and Department	Date of Retirement	Signature
1	Chairman			
2	Member 1			
	Member 2			
3	Additional Member			

6. Reason for additional member :

Signature of the student

PG coordinator **Head of the Department**

DEAN

* Additional members may be included only in the allied faculty related to thesis research with full justification at the time of sending proposals (Programme of research) to the Dean for approval.

Form – 1a

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

CHANGE IN ADVISORY COMMITTEE

(To be sent in triplicate)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Proposed change :

		Name and designation	Date of retirement	Signature
a.	Existing Chairman/ member			
b.	Proposed Chairman/ member			

6. Reasons for change :

Signature of the student

Chairman of the Advisory Committee **PG coordinator**

Head of the Department **DEAN**

Form – 2

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PLAN OF COURSE WORK

(To be sent in triplicate before the commencement of mid semester examinations in the first semester)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Course Programme :

S. No	Course No	Course Title	Credit Hour
		MAJOR COURSES	
		MINOR COURSES	
		SUPPORTING COURSES	
		NON-CREDIT COURSES	
		SEMINAR	
		RESEARCH	
		TOTAL	

6. Tentative area of research :
   (indicate the major field of specialization)

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator **Head of the Department**

DEAN

Form – 3

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROGRAMME OF RESEARCH WORK

(To be sent in triplicate before the end of the semester in which the student registers research credit for the first time or the commencement of research work whichever is earlier)

1. Name :
2. Registration No. :
3. Degree :
4. Subject :
5. Date of joining :
6. Title of the research project :
7. Objective(s) :
8. Duration :
9. Location (campus/station) :
10. Review of work done :
11. Broad outline of work/methodology :
12. Semester wise break up of work :

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator **Head of the Department**

DEAN

Form – 3a

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

CHANGE IN PROGRAMME OF RESEARCH

(To be sent in triplicate)

1. Name :
2. Registration No. :
3. Degree :
4. Subject :
5. Reason for change :
6. Proposed change in the approved : programme of research
7. Number of credits completed so far : under the approved programme
8. a) Whether already earned credits are : to be retained or to be deleted

   b) If retained, justification :

Signature of the student

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

PG coordinator **Head of the Department**

DEAN

Form – 4

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROPOSAL OF QUALIFYING EXAMINATION

(To be sent in triplicate)

1. Name of the Department :
2. Degree :
3. Subject :
4. Whether all the courses have been completed :
5. Number of credits completed :
6. Whether the students have an OGPA of not less than 7.00/10.00 :
7. List of PG students appearing for qualifying examination :

Sl. No.	Name	Registration No.	OGPA

8. Panel of External examiners :

Sl. No.	Name and Designation	Address	Area of specialization
1.			
2.			
3.			

9. Remarks :

PG coordinator **Head of the Department**

DEAN

Form – 5

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

COMMUNICATION OF RESULT OF QUALIFYING EXAMINATION

(To be sent in triplicate)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Date of examination :
6. Date of previous examination (only in case of re-examination) :
7. Result (Successful/ Not successful*) :

(*) to be written by the external examiner

EXAMINATION COMMITTEE

	Name in block letters	**Signature**
Chairman		
Members	1.	
	2.	
	3.	
External Examiner		

Signature of Chairman with name and designation

PG coordinator

Head of the Department

DEAN

Form – 6

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

PROPOSAL OF EXTERNAL EXAMINERS FOR THESIS EVALUATION

(To be sent in duplicate in Confidential cover)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Thesis title :
6. Name of the Chairman :
7. Panel of external examiners* :

Sl. No.	Name and Designation	Address	Area of specialization
1.			
2.			
3.			

*Three external examiners should be given

8. Remarks :

Signature of the Chairman of the advisory committee

DEAN

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Form – 7

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

RESULT OF FINAL THESIS VIVA-VOCE EXAMINATION

(To be sent in duplicate)

1. Name of the student :
2. Registration No. :
3. Degree :
4. Subject :
5. Thesis title as in final copy of the thesis :
6. Date and time of *viva-voce* :
7. Particulars of the External examiner(s) who has/have evaluated the thesis :

Name and Designation of the External Examiner	**Remarks of the External Examiner**
	RECOMMENDED / RECOMMENDED FOR REVISION / NOT RECOMMENDED

8. **Recommendation of the Examining committee present at the time of final *viva voce* examination**:
   a. Recommends/ does not recommend unanimously the award of degree
   b. The performance of the candidate in final *viva voce* is assessed as _____ (very good/ good/ satisfactory/ not satisfactory)

Sl. No.	**Capacity of examiner**	**Name in block letters**	**Signature**
1.	Chairman/Co-opted Chairman*		
2.	Member 1.		
3.	2.		
4.	Additional member		
5.	Co-opted member*		

* If co-opted in the absence of Chairman/Member

The original report(s) from the external examiner(s) is/ are enclosed

Head of the Department

Chairman of the Examining committee / Advisory committee with designation

Annexure – 1

DETAILS ON FEE TO BE PAID BY THE STUDENT

(Other than admission fee and semester fee)

Sl. No.	Particulars	Amount (Rs.)
1.	Late Registration fee	1000
2.	Missing mid-semester examination fee (per course)	1000
3.	Re-registration fee with juniors	1000
4.	Duplicate Hall ticket	200
5.	Fee for Transfer Certificate and Conduct Certificate	200
6.	Re-examination fee for qualifying exam	5000
7.	Fee for availing grace period for submission of thesis	
	a) Upto one month	1000
	b) Up to three months	2500
8.	Penalty for re-viva voce examination for thesis	5000
9.	Fee for late submission of thesis after final viva-voce	5000
10.	Examination fee (per course)	*
11.	Arrear Examination fee (per course)	*
12.	Revaluation fee (per course)	*
13.	Re-totaling fee (per course)	*
14.	Fee for Provisional Degree Certificate	*
15.	Fee for Transcript Card	*
16.	Fee for Degree Certificate	*
17.	Fee for Migration Certificate	*

*** As fixed by Pondicherry University from time to time**

Annexure – 2

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARAIKAL – 609 603

STUDENT REGISTRATION CARD - PG

Name of the student _____ Academic Year _____

Registration No. _____ Semester _____

Degree Programme _____ Date of Registration _____

Year of Admission _____ Date of Commencement _____

COURSES REGISTERED

Sl. No.	Course Code	Course Title	Credit Hours	Remarks
		TOTAL CREDIT HOURS REGISTERED		

Signature of the Student	**Signature of the Chairman**	**Signature of the Head of the Department**	**Coordinator of Examinations**

APPROVED BY

DEAN
PAJANCOA&RI, KARAIKAL

Annexure-3

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

LIST OF ENCLOSURES TO BE SUBMITTED ALONG WITH THESIS

A. At the time of sending thesis for External Evaluation:

To be submitted to the university

1. One copy of abstract of thesis
2. One copy of the summary of research finding in English (within one page)
3. One copy of the summary of research finding in Tamil (within one page)
4. One page abstract of thesis with key words
5. Result of comprehensive qualifying examination
6. Permission and fee receipt for availing grace period, if any.

To be submitted to the college along with above list

7. Clearance certificates from Hostel
8. Clearance certificates from Library
9. Clearance certificates from Department
10. Clearance certificates from Staff advisor
11. Clearance certificates from Physical Education
12. Approved registration cards (One set)
13. Report cards (one set)
14. Course completion certificate (signed by Chairman and HOD)
15. Attendance Certificate

B. At the time of submission after final viva-voce:

1. Report of the final thesis viva voce examination (To be sent in duplicate)
2. External Examiners thesis evaluation report (Two copies – original + Xerox)
3. Certificate for having carried out the suggestions of the external examiner and advisory committee
4. Thesis in hard bound copy – One Number.
5. Soft copy the thesis in CD (cover to cover in PDF format) - Two Number.

Annexure - 4

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROPOSAL FOR RECOGNITION OF TEACHERS FOR TEACHING/GUIDING PG STUDENTS

1. Particulars of the teacher seeking recognition

a. Name of the teacher :

b. Date of birth of the teacher :

c. Designation & present official address of the teacher :

d. Date of joining service in the entry cadre :

e. Academic qualifications

Date of acquiring Bachelor's Degree :

Date of acquiring Master's Degree :

Date of acquiring Ph.D degree :

f. Total service as on the date of this proposal (excluding extraordinary leave) :

g. Date of retirement :

2. Recognition proposal submitted for (tick any one)

a. Recognition as teacher for Masters Programme

b. Recognition as Guide for Masters Programme

3. Teaching experience as on the date of Application

a. No. of UG courses offered :

c. No. of M.Sc courses offered :

Signature of the teacher with date

4. Particulars to be furnished by Head of the Department

No. of existing recognized teachers/guides pertaining to this proposal in your department :

Justification for additional requirement of teachers/guide :

Signature of the Head of Department

Approval of the Dean

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR REGISTRATION OF RESEARCH CREDITS

PART- A : PROGRAMME

Semester : I / II Year : Date of registration :

1. Name of the student :
2. Registration No.
3. Total research credits completed so for :
4. Research credits registered during the semester :
5. Programme of work for this semester :
   (list out the items of research work to be undertaken during the semester)
   i)
   ii)
   iii)
   iv)

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	Name	Signature
Chairman		
Members	1.	
	2.	
	3.	

(Approval may be accorded within 10 days of registration)

PROFORMA FOR EVALUATION OF RESEARCH CREDITS

PART - B EVALUATION

(Evaluation to be done before the closure of semester)

Date of closure of semester :

Date of evaluation :

1. Whether the research work has been carried out as per the approved programme :
2. If there is deviation specify the reasons :
3. Performance * :

(*) Performance may be indicated as **SATISFACTORY /NOT SATISFACTORY**

APPROVAL OF THE ADVISORY COMMITTEE

Advisory committee	**Name**	**Signature**
Chairman		
Members	1.	
	2.	
	3.	

Proforma-2

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PERMISSION FOR LATE REGISTRATION

1.	Name of the student	:
2.	Registration No.	:
3.	Degree	:
4.	Department	:
5.	Semester and Academic year	:
6.	Date of commencement	:
7.	Date of registration without fine	:
8.	Last date for registration with fine	:
9.	Date on which registration is sought	:
10.	Reason	:
11.	Signature of the student	:
12.	Remarks and recommendation of the Chairman	:

Signature of the Chairman

PG Coordinator **Head of the department**

DEAN

Proforma-3

PONDICHERRY UNIVERSITY
PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

WILLINGNESS TO BE GIVEN BY THE STUDENTS TO AVAIL FELLOWSHIP FROM EXTERNALLY FUNDED SCHEMES

1.	Name of the student	:
2.	Registration No.	:
3.	Degree	:
4.	Subject	:
5.	OGPA of Bachelor degree	:
6.	Name of the Chairman	:
7.	Discipline/Department	:
8.	Thesis topic, if allotted	:
9.	Current semester and year in which studying	:
10.	Whether all the course works have been completed , if not indicate the pending courses with credit loads	:

Undertaking by the student:

i. I am willing to avail the proposed fellowship under the scheme entitled_____ _____.

ii. If I leave in the middle of the tenure of the fellowship, I am willing to repay the fellowship availed with 6% penal interest or any levy/fine imposed by the College/University.

iii. I am fully aware that in case of campus transfer due the award of the fellowship that I have to loose the research credits already registered.

iv. I am fully aware that there is no guarantee for the continuation of the courses, which I currently undergo, in the other campus to which I am likely to be transferred.

v. I am willing to abide by all the rules and regulations laid down by the College/University in this regard.

Date: **Signature of Student**

Chairman of the Advisory Committee **Head of the Department**

DEAN

Proforma-4

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

ALLOTMENT OF STUDENTS UNDER JRF/SRF STUDENT FELLOWSHIP

(To be submitted to the Dean)

1.	Title of the scheme	:	
2.	Location of the scheme (Department)	:	
3.	Date of sanction of the scheme	:	
4.	Period of the scheme	:	
5.	Type of fellowship	:	JRF/SRF
6.	Period of fellowship (only for the period of research credits registered)	:	
7.	Amount of fellowship	:	Rs……..p.m
8.	Amount of contingent grant	:	Rs……p.a.
9.	Amount of T.A. provided	:	Rs……..p.a.
10.a.	Whether the technical programme submitted by the student to Dean is the same as envisaged in the scheme proposal	:	Yes / No
b.	If not, whether the revised programme of research is submitted (If yes, date of approval by the Dean)	:	
11.	No. of research credit(s) completed so far by the proposed fellowship awardees (student)	:	
12.	Whether the credits earned earlier are to be retained or to be cancelled?	:	
13.	Whether funds received	:	Yes / No
14.	Name of the student(s) & ID.No.	:	
15.	Number of semesters for which fellowship may be sanctioned	:	
16.	Can the fellowship be sanctioned for grace period also.	:	Yes / No

Principal Investigator **Head of the Department** **Dean**

List of Enclosures

1. Copy of concurrence of the sponsor of the sponsor to avail student fellowship
2. Copy of administrative sanction by Dean
3. Student's willingness and undertaking

Proforma-5

PONDICHERRY UNIVERSITY
PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

SPONSOR'S CONCURRENCE (PROFORMA)

1.	Title of the scheme	:	
2.	Location of the scheme (Department)	:	
3. a.	Name & Designation of the PI	:	
b.	Name and designation of the Co-PI	:	
4.	Type of fellowship	:	JRF/SRF
5.	Period of fellowship	:	
a.	Indicate the period of fellowship to be awarded	:	
b.	Amount of fellowship	:	Rs……p.m.
c.	Amount of contingent grant	:	Rs……p.a.
d.	Amount of T.A. Provided	:	Rs……p.a.
e.	Whether Institutional charges paid	:	Yes/No Rs……

Signature of the Sponsor

To
The Dean
PAJANCOA&RI
Karaikal – 609 603

Proforma-6

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

DEPARTMENT OF _____

COURSE COMPLETION CERTIFICATE

This is to certify that Thiru./Selvi/Tmt. _____ Registration No. _____ has completed all the course and research credit requirements on _____ for the award of _____ degree.

Professor and Head

Signature of the Chairman
(with Name and designation)

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

JUSTIFICATION FOR LATE SUBMISSION OF THESIS (if applicable)

1. Name of the student :
2. I.D. No. :
3. Degree :
4. Subject :
5. Date of first registration for the degree :
6. Number of semesters for which the candidate could not register :
7. Reason for not registering and continuing the study :
8. Period of delay in submission of thesis :
9. Period lost due to transfer/ill health :
10. Date of submission of thesis :

Signature of the student

11. Specific remarks and recommendation of the Chairman :

Signature of the Chairman with designation

12. Specific remarks and recommendation of the Head of department :

Signature of the Head

13. Approval of the Dean :

Signature of the Dean

Proforma-8

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR EVALUATION OF THESIS

Name of the degree programme: _____.

1. Name and Designation of the examiner :

2. Address of the Examiner :

   Telephone/Mobile :
   Fax :
   e-mail :

3. Name of the candidate :

4. Registration No. :

5. Title of the thesis :

6. Date of receipt of the thesis copy :

7. Date of despatch of the detailed report and thesis by the examiner to the Dean :

8. Examiner's recommendations choosing one of the following based on quality of thesis :
   a. Recommended for award
   b. Recommended for revision

9. Please state whether a list of questions if any to be asked at the viva-voce examination (Questions to be attached) :

Date :
Official Seal :

Signature of the Examiner

Note : Please enclose a detailed report in duplicate duly signed by you giving the merits and demerits of the thesis on the choice of problem, review of literature, methods followed, results and discussion etc.

Proforma-9

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

DEPARTMENT OF _____

CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE EXTERNAL EXAMINER AND ADVISORY COMMITTEE

(To be enclosed along with result of the final viva voce examination)

Certified that Thiru/Selvi/Tmt _____

Registration No. _____ has carried out all the corrections and suggestions as pointed out by the external examiners(s) and the advisory committee and has submitted **FOUR** copies of his/her M.Sc. thesis in hard bound cover and **TWO** soft copies of thesis in PDF format in CDs.

Head of the department

Signature of the Chairman with Name and designation

Proforma-10

PONDICHERRY UNIVERSITY
PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

PROFORMA FOR OBTAINING PERMISSION TO PRESENT PAPERS IN SEMINAR/SYMPOSIA/TRAINING

(To be sent in triplicate)

1.		Name of the student	:
2.		Registration No.	
3.		Department & College	:
4.		Name of the Chairman with designation	:
5.		Whether course work has been completed?	
6.		Title of paper/poster to be presented (enclose copy)	:
7.	a.	Name of the seminar/symposium	:
	b.	Venue	:
	c.	Dates(From-To)	:
8.		Period of absence (in days) inclusive of travel time	:
9.		Whether the paper was sent through proper channel (copy to be enclosed)	:
10.		Cost of travel & registration fee borne by the student himself (or) supported by the scheme in which he is drawing fellowship?	:

Date: Signature of the Student

Specific Recommendations:

Chairman **Professor and Head**

PERMISSION TO ATTEND THE SEMINAR/SYMPOSIA

(to be issued by the Dean)

1. Permitted without any financial commitment to the College/ University / **Not permitted**
2. Period of absence from_____ to _____(_____ days) is to be treated as duty and can be counted for attendance.
3. Period of absence from _____to _____(_____days) **is not treated as duty and cannot be counted for attendance.**
4. The student should submit a report to the Dean, within 3 days after his return.

DEAN

Proforma-11

PONDICHERRY UNIVERSITY
PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

APPLICATION FOR ISSUE OF CONDUCT AND TRANSFER CERTIFICATES

(To be submitted by the student with the recommendation of the Chairman/Head)

1. Name of the student :
2. Registration No. :
3. Name of the Chairman :
4. Designation of the Chairman :
5. Name of the course undergone :
6. Year of joining course :
7. Year of leaving the course :
8. Whether copy of the PC enclosed :
9. Whether original clearance certificate from warden enclosed :

Date: **Signature of the Student**

Recommendations:

Certified that the conduct and characters of Mr/Ms. _____ were _____ during the period of his/her studies. The certificates may be issued accordingly.

Chairman **PG Co-ordinator** **Professor & Head**

Proforma-12

PONDICHERRY UNIVERSITY

PANDIT JAWAHARLAL NEHRU COLLEGE OF AGRICULTURE AND RESEARCH INSTITUTE, KARIAKAL – 609 603

CERTIFICATE FOR HAVING CARRIED OUT PLAGIARISM CHECK

1	Name of the Student	
2	Registration Number	
3	Degree	
4	Title of the Thesis	
5	Name of the Chairman	
6	Total Word Count in the Document	
7	Initial Submission	Yes / No
	If No	Provide the number of times plagiarism checked along with their plagiarism percent
8	Date of Submission	

Signature of the Student

Signature of the Chairman/Chairperson

Signature of the Head of the Department

COURSE CURRICULA AND SYLLABI

DESCRIPTION OF TERMINOLOGIES

Major Course The subject of Department or discipline in which the student takes admission. Among the listed courses, the core courses compulsorily to be registered shall be given '*' mark

Minor Course The course closely related to a student's major subject

Supporting Course The course not related to the major course. It could be any course considered relevant for student's research work or necessary for building his/her overall competence

Common course Course which is compulsorily registered by the postgraduate student for the completion of postgraduate degree programme. The marks obtained by the student in a common course will also be taken into account for calculating OGPA

Credit Requirements

	Particulars	Credits
(i)	**Course Work**	
	Major courses	20
	Minor courses	08
	Supporting courses	06
	Common courses	05
	Seminar	01
(ii)	**Thesis Research**	30
	TOTAL	**70**

COMMON COURSES

Sl No.	Course Code	Course Title	Credits
1	PGS 501	Library and Information Services	0+1
2	PGS 502	Technical Writing and Communication Skill	0+1
3	PGS 503	Intellectual Property and its Management in Agriculture	1+0
4	PGS 504	Basic Concepts in Laboratory Techniques	0+1
5	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

AIM OF THE COURSE

To equip the library users with skills, to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

PRACTICAL

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary -Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services - (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing - information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized - library services; Use of Internet including search engines and its resources; e-resources access methods.

PRACTICAL SCHEDULE

1. Introduction to library and its services
2. Role of libraries in education, research and technology transfer;
3. Classification systems and organization of library
4. Sources of information- Primary Sources, Secondary Sources and Tertiary Sources
5. Intricacies of abstracting and indexing services
6. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);

7. Tracing - information from reference sources;
8. Literature survey
9. **Mid- Semester**
10. Citation techniques/Preparation of bibliography;
11. Use of CD-ROM Databases,
12. Online Public Access Catalogue and other computerized - library services
13. Online Public Access Catalogue and other computerized - library services
14. Use of Internet including search engines and its resources
15. Use of Internetincluding search engines and its resources
16. E-resources access methods.
17. Final practical examination

PGS 502 TECHNICAL WRITING AND COMMUNICATION SKILLS 0+1

AIM OF THE COURSE

To equip the students with skills *Viz.,* writing of dissertations, research papers, etc. andto communicate and articulate in English (verbal as well as writing)

PRACTICAL

Grammar - Tenses, parts of speech, clauses, punctuation marks; Error analysis Common errors; Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Proof reading. Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

PRACTICAL SCHEDULE

1. Grammar (Tenses, parts of speech)
2. Grammar (clauses, punctuation marks)
3. Error analysis (Common errors); Concord; Collocation;
4. Phonetic symbols and transcription;
5. Accentual pattern: Weak forms in connected speech
6. Participation in group discussion
7. Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers

9. **Mid -semester examination**
10. Technical Writing- reviews, manuals
11. Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion)
12. Writing of abstracts, summaries, précis, citations etc
13. Commonly used abbreviations in the theses and research communications
14. Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustration
15. Writing numbers and dates in scientific write-ups
16. Editing and proof-reading, writing of a review article.
17. **Final practical examination**

SUGGESTED READING

1. Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
2. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
3. *Collins' Cobuild English Dictionary*. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner'sDictionary of Current English*. 6th Ed. Oxford University Press.
6. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
7. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. AffiliatedEast-West Press.
8. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
9. Richard WS. 1969. *Technical Writing*.
10. Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed.Prentice Hall of India.
11. Wren PC and Martin H. 2006. *High School English Grammar and Composition*.S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE 1+0

AIM OF THE COURSE

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

THEORY

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

SUGGESTED READING

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
3. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
4. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
5. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
6. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1
(For Social Science)

PRACTICAL

Use of R / SPSS / equivalent for Frequency distribution, Summarization and tabulation of data, F test, Correlation, Pearson Correlation, Spearman Correlation, ANOVA, ANCOVA

Use of R / SPSS / equivalent for Regression: Simple, Multiple Linear regression, Estimation of regression by OLS & MLE method, Logit, Probit, Stepwise regression, Coefficient of determination

Use of R / SPSS / equivalent for Kolmogorov-Smirnov test, Wilcoxon signed rank test, Mann-Whitney U, Kruskal-Wallis, McNemar's test

Use of R / SPSS / equivalent for Discriminant analysis - fitting of discriminant functions, identification of important variables, Factor analysis. Principal component analysis - obtaining principal component.

Use of R / SPSS / equivalent for Analysis of time series data - AR, MA, ARIMA models

SUGGESTED READING

1. Anderson CW & Loynes RM. 1987. The Teaching of Practical Statistics. John Wiley.
2. Atkinson AC. 1985. Plots Transformations and Regression. Oxford University Press.
3. Chambers JM, Cleveland WS, Kleiner B & Tukey PA. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmount, California.
4. Chatfield C & Collins AJ. 1980. Introduction to Multivariate Analysis. Chapman & Hall.
5. Chatfield C. 1983. Statistics for Technology. 3 rd Ed. Chapman & Hall.
6. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
7. Cleveland WS. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
8. Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
9. Erickson BH & Nosanchuk TA. 1992. Understanding Data. 2 nd Ed. Open University Press, Milton Keynes.
10. Snell EJ & Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman & Hall
11. Sprent P. 1993. Applied Non-parametric Statistical Methods. 2 nd Ed. Chapman & Hall.
12. Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
13. Velleman PF & Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
14. Weisberg S. 1985. Applied Linear Regression. John Wiley.
15. Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
16. Wetherill GB.1986. Regression Analysis with Applications. Chapman & Hall.
17. Learning Statistics: http://freestatistics.altervista.org/en/learning.php.
18. Free Statistical Soft wares: http://freestatistics.altervista.org/en/stat.php.
19. Statistics Glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1
(For Plant Sciences)

AIM OF THE COURSE

To acquaint the students about the basics of commonly used techniques in laboratory.

PRACTICAL

Unit I

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separator funnel, condensers, micropipettes and vaccupets. Ashing, drying and sterilization of glassware; Drying of solvents/chemicals.

Unit II

Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions. Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values.

Unit III

Preparation of different agro-chemical doses in field and pot applications. Principles and handling techniques of Chromatography.

Unit IV

Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath. Preparation of media and methods of sterilization.

Unit V

Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy. Specific methodologies concerning each discipline

PRACTICAL SCHEDULE

1. Safety measures while in Lab; Handling of chemical substances
2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micro pipettes and vaccupets
3. Washing, drying and sterilization of glassware
4. Drying of solvents/chemicals
5. Weighingandpreparationofsolutionsofdifferentstrengthsandtheirdilution
6. Handling techniques of solution; Preparation and neutralisation of acid and bases
7. Preparation of buffers of different strengths and pH values
8. **Mid semester examination**
9. Preparationofdifferentagro-chemicaldosesinfieldandpotapplications (Herbicides and Fertilizers)

10. Preparationofdifferentagro-chemicaldosesinfieldandpotapplications (Pesticides)
11. Principles and Handling techniques of Chromatography.
12. Use and handling of microscope, laminar flow, vacuum pumps viscometer, thermometer, magnetic stirrer, micro-ovens, incubator, sand bath, water bath, oil bath etc.
13. Preparation of media and methods of sterilization
14. Seed viability testing, testing of pollen viability
15. Tissue culture of crop plants. Description of flowering plants in botanical term sin relation to taxonomy
16. Specific methodologies of each discipline concerned.
17. **Final Practical Examination**

SUGGESTED READING

1. FurrAK.2000.*CRC Hand Book of Laboratory Safety*. CRC Press.
2. Gabb MH and Latchem WE.1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

AIM OF THE COURSE

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

THEORY

Unit I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions.

Unit II

Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit III

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit IV

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme.

Unit V

Integrated Rural Development Programme (IRDP) Panchayat Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

LECTURE SCHEDULE

1. History of agriculture in brief; Global agricultural research system: need, scope, opportunities
2. Role in promoting food security, reducing poverty and protecting the environment
3. National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions
4. Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC)
5. Partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels
6. International fellowships for scientific mobility.
7. Research ethics: research integrity, research safety in laboratories
8. Welfare of animals used in research, computer ethics, standards and problems in research ethics.
9. **Mid semester examination**
10. Social trends on research ethics, adequate codes of conduct to regulate researchactivity
11. Concept and connotations of rural development, rural development policies and strategies.
12. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme
13. Special group – Area Specific Programme
14. Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations.
15. Critical evaluation of rural development policies and programmes
16. Constraints in implementation of rural policies and programmes
17. Final Examination.

SUGGESTED READING

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publication. Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

2. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publication.
3. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publication.

SUPPORTING COURSES

Sl No.	Course Code	Course Title	Credits
1	COM 501	R and Python Programming	2+1
2	MAT 501	Mathematics For Agricultural Economics	2+1
3	STA 501	Statistical Methods for Applied Sciences	2+1
4	STA 502	Design of Experiments	2+1

COM 501 R AND PYTHON PROGRAMMING 2+1

WHY THIS COURSE?

This course is all about R which is mainly used for statistical analysis while Python provides a more general approach to data science. R and Python are state of the art in terms of programming language oriented towards data science. Learning both of them gives an idea for handling agricultural data.

AIM OF THE COURSE

The objective of the course is partly to give an introduction to python and software R and how to handle data analysis using R.

THEORY

Unit I

Introduction to Python – Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Reading Input, Print Output, Type Conversions - Control Flow Statements, Looping Statements, Functions - Built-In Functions, Commonly Used Modules, Packages - Strings and Lists – Iterators.

Unit II

Regular Expression - pattern matching and searching using regex - validations using regular expressions - Exception handling - Python Database Interaction - SQL Database connection using python - Creating, Reading, storing and searching information on tables.

Unit III

R Console; R Data types; R Vector creation using c (); R Assignment operators = <- ; R Arithmetic Operators; R Logical Operators; R Relational Operators;

Unit IV

R Matrix- Create, Print, Add Column using cbind (), Add Row using rbind (), Slice using [,]; R Data Frame - Create using data.frame (), Edit using edit (), Append using cbind (), rbind (), select (), subset (), sort using order (); List in R - Create using list (), Select; Data

Importing and Exporting in R Using read. table () and write. table (); install. packages (), library

Unit V

R script If, Else, Else If statements in R; For Loop and While Loop in R; Scatter Plot, Bar Chart and Histogram in R; Data Visualization with R ggplot2; Publishing Data Visualizations with R Shiny;

PRACTICALS

Implementation of Control Flow Statements, Looping Statements, Functions, Regular Expression, pattern matching and searching using regex. Validations using regular expressions. Python Database Interaction - SQL Database connection using python. Creating, Reading, storing and searching information on tables. R Console; R Vector creation using c(); R Assignment operators = <- ; R Matrix- Create, Print, Add Column using cbind(), Add Row using rbind(), Slice using [,]; R Data Frame - Create using data.frame(), Edit using edit(), Append using cbind(), rbind(), select(), subset(), sort using order(); List in R - Create using list(), Select; Data Importing and Exporting in R Using read.table() and write.table(); install.packages(), library(); Rscript, If, Else, Else If statements in R; For Loop and While Loop in R; Scatter Plot, Bar Chart and Histogram in R; Data Visualization with R ggplot2; Publishing Data Visualizations with R Shiny;

LECTURE SCHEDULE

Unit I

1 Introduction to Python – Identifiers, Keywords, Statements and Expressions
2 Operators, Precedence and Associativity, Data Types
3 Reading Input, Print Output, Type Conversions
4 Control Flow Statements, Looping Statements
5 Functions - Built-In Functions, Commonly Used Modules, Packages
6 Strings and Lists
7 Iterators

Unit II

8 Regular Expression
9 Pattern matching and searching using regex
10 Validations using regular expressions
11 Exception handling
12 Python Database Interaction - SQL Database connection using python
13 Creating, Reading, storing and searching information on tables.

Unit III

14 R Console; R Data types; R Vector creation using c();
15 R Assignment operators = <- ;
16 R Arithmetic Operators;
17 **Mid semester examination**

18 R Logical Operators;

19 R Relational Operators;

Unit IV

20 R Matrix- Create, Print,

21 Add Column using cbind(), Add Row using rbind(), Slice using [,];

22 R Data Frame - Create using data.frame (), Edit using edit(), Append using cbind (), rbind(),

23 Select (), subset(), sort using order();

24 List in R - Create using list(), Select;

25 Data Importing and Exporting in R Using read.table() and write.table();

26 install. packages(), library();

Unit V

27 Rscript

28 If, Else in R

29 Else If statements in R;

30 For Loop in R;

31 While Loop in R;

32 Scatter Plot, Bar Chart and Histogram in R;

33 Data Visualization with R ggplot2

34 Publishing Data Visualizations with R Shiny;

PRACTICAL SCHEDULE

1 Implementation of Control Flow Statements, Looping Statements, Functions

2 Regular Expression

3 Pattern matching and searching using regex

4 Validations using regular expressions

5 Python Database Interaction - SQL Database connection using python

6 Creating, Reading, storing and searching information on tables

7 R Console; R Vector creation using c(); R Assignment operators = <- ;

8 R Matrix- Create, Print, Add Column using cbind (), Add Row using rbind (), Slice using [,];

9 R Data Frame - Create using data. frame (), Edit using edit(), Append using cbind (), rbind (), select (), subset (), sort using order();

10 List in R - Create using list(), Select; Data Importing and Exporting in R Using read.table () and write. Table ();

11 Install. packages(), library(); Rscript,

12 If, Else, Else If statements in R;

13 For Loop in R; While Loop in R;

14 Scatter Plot, Bar Chart and Histogram in R;

15 Data Visualization with R ggplot2;

16 Publishing Data Visualizations with R Shiny;

17 **Final practical examination**

LEARNING OUTCOME

This course will impart knowledge on how to interpret and analyze data using R and Python programming.

SUGGESTED READING

1 Michael J. Crawley (2013). The R Book. 2nd Edition. John Wiley.
2 Robert Gentleman (2008). R Programming For Bioinformatics. Chapman and Hall/CRC
3 Brian S. Everitt and Torsten Hothorn (2009). A Handbook of Statistical Analyses Using R. Second Edition. Chapman and Hall/CRC
4 Bassi, S. (2017). Python for bioinformatics. Chapman and Hall/CRC.

SUGGESTED WEBSITES

1 https://www.python.org/doc/
2 https://www.r-project.org/other-docs.html
3 https://www.r-exercises.com/
4 RStudio.com Shiny Tutorial - https://shiny.rstudio.com/tutorial/ - https:// shiny. rstudio.com /articles/

MAT 501 MATHEMATICS FOR AGRICULTURAL ECONOMICS 2+1

WHY THIS COURSE?

This course provides a strong quantitative basis for the students to understand various Micro and Macroeconomic concepts

AIM OF THE COURSE

This course exposure student of Agricultural Economics to calculus and its applications in Agricultural Economics. It covers applications of Differential calculus, Integral calculus and Differential equations. This course provides a strong quantitative basis for the students to understand various Micro and Macro economic concepts.

THEORY

Unit I

Matrices – types - algebra of matrices. Determinants – properties - solution of simultaneous equations. Inverse of a matrix. Caylay Hamilton theorem- Eigen values and Eigen vectors.

Unit II

Definition and examples of variables and functions- basic theorems on limits and continuity (without proof). Revision of methods of differentiation. Maxima and minima of single. Application of differentiation - Elasticity of demand in terms of differentiation.

Average and marginal functions. Cost and Revenue curves- relationship. Conditions for profit maximization, Effects of taxation and subsidy.

Unit III

Revision of Partial differentiation - Maxima and minima of several variables with and without constraints -Marginal demands, partial elasticitics and utility analysis. Theory of consumer behavior- Rate of commodity substitution, Maximization of utility – slut sky equation (Income and substitution effects). Production functions and their mathematical properties- Isoquants and Ridge lines- Least cost combination – Constrained profit Maximization- Properties of linear homogenous functions- Euler's theorem.

Unit IV

Definite integrals, methods of integration definite integral; - Capital formation. Present value of continuous equal income stream. Consumer's and producer's surplus.

Unit V

Differential equations-meaning-types of differential equations-order and degree of the differential equations-formation and solution of first order and first degree linear differential equations . Solution of linear homogeneous equations. Applications in Micro economics – Utility and Demand analysis- Cost functions, Market equilibrium Harood Domor model, basic neo classic models, Solow models Domar debit models and some further applications**.**

PRACTICALS

Problems in algebra of matrices and determinants, simultaneous equation, eigen values and eigen vectors, simple differentiation, maxima and minima for single variables. Application of differentiation in Agricultural Economics. Simple problems in partial differentiation & Maxima and minima for several variables, Maxima and minima for several variables with constraints-Lagrange's method, Application of partial differentiation in agricultural economics, simple integral, calculation of consumer's and producer's surplus, formation of differential equation, solution of first order and first degree linear differential, solution of linear homogeneous equations.

LECTURE SCHEDULE

Unit I

1 Matrices – types of matrices, Algebra of matrices and determinant
2 Inverse of a matrix, Solution of simultaneous linear equations
3 Caylay Hamilton theorem
4 Eigen Values and Eigen Vector

Unit II

5 Definition and examples of variables and functions
6 Basic theorems on limits and continuity (without proof).
7 Revision and Simple Problems in differentiation

8 Maxima and minima of function of single with out constraints
9 Definitions of Elasticity, Total average and Marginal cost curve – relations
10 Total average and Marginal Revenue curves – Conditions for profit maximization

Unit III

11 Revision and Simple Problems in partial differentiation.
12 Maxima and minima of function of several variables – without constraints
13 Maxima and minima of function of several variables – with constraints - Lagrange's Multiplier's method
14 Partial elasticties and utility Analysis - Theory of consumer behavior
15 Rate of commodity substitution
16 **Mid semester examination**
17 Maximization of utility
18 Slutsky equation (Income and substitution effects).
19 Production functions and their mathematical properties
20 Isoquants and Ridge lines
21 Least cost combination Constrained profit Maximization
22 Properties of linear homogeneous functions - Euler's theorem

Unit IV

23 Definite integrals and their geometrical applications
24 Capital formation - Capital growth equation
25 Present value of continuous equal income stream
26 Calculations of consumer's and producer's surplus

Unit V

27 Solution of first order differential equations and Homogeneous
28 Linear differential equation with constant coefficients
29 Applications in Micro economics – Utility and Demand analysis
30 Applications in Micro economics - Cost functions, , Market equilibrium
31 Applications in Macro growth economics - Dynamic multiplier models
32 Applications in Macro growth economics - Harood Domor model
33 Applications in Macro growth economics - Basic neo classic models
34 Applications in Macro growth economics - Solow models Domar debit models

PRACTICAL SCHEDULE

1 Simple Problems in Matrices, Inverse Matrix
2 Problems in Solution of simultaneous linear equations
3 Problems in cayley Hamilton
4 Problems in Eigen value and Eigen verctor
5 Simple Problems in Differentiation
6 Maximum and minimum of function of single variables without constraints
7 Problems in Elasticity, Total average and Marginal cost/Revenue curves

8 Problems in Marginal demands, Partial elasticties and utility Analysis.
9 Simple Problems in partial differentiation
10 Maximum and minimum of function of several variables without constraints
11 Maximum and minimum of function of several variables with constraints
12 Problems in Maximization of utility and slut sky equation (Income and substitution effects) and Constrained profit Maximization
13 Homogeneous functions and Euler's theorem on homogenous functions
14 Problems in Definite integrals – geometrical applications
15 Calculations of consumer's and producer's surplus
16 Problems in Homogeneous, Linear differential equations
17 **Final practical examination**

LEARNING OUTCOME

Students can get exposure in basic knowledge in set theory, cost curve, supply curves and asticity with the applications in Agricultural Economics. Students can know to solve macro and micro economic models. Also this course provides a strong quantitative basis for the students to understand various Micro and Macro economic concepts

SUGGESTED READING

1 Metha, B.C. and Madani, G.M.K. (Reprint2008) Mathematics for Economists, Sultan Chand & Sons Educational Publishers, New Delhi.

2 ArumugamS. And Thangapandi Isaac (2002), Advanced Calculus, New Gamma Publishing house, Chennai.

SUGGESTED WEBSITES

1 http://en.wikipedia.org/wiki/Set_theory mathworld.wolfram.com /Newtons Divided Difference Interpolation Formula.html
2 http://en.wikipedia.org/wiki/Taylor_series

STA 501 STATISTICAL METHODS FOR APPLIED SCIENCES 2+1

WHY THIS COURSE?

- This course will help the students
- To study the exploratory data analysis
- To understand the various probability distributions and their application in their respective fields
- To perform the parametric and non-parametric tests based on the data
- To learn the relationship of the variables using correlation and regression techniques

AIM OF THE COURSE

The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, parametric and non-parametric tests, selection of sampling techniques and correlation, regression and ANOVA techniques.

THEORY

Unit I

Descriptive Statistics: Measure of Central Tendency, Measure of Dispersion, Skewness and Kurtosis for raw data only. Graphical and Diagrammatical representation: Bar Chart, Pie Chart, Frequency curve, Box Plot. Theory of Probability: axioms and properties, Addition and Multiplication Theorems on probability, Random Variable and Mathematical Expectation.

Unit II

Discrete and continuous probability distribution: Binomial, Poisson, Normal Distribution. Sampling theory: Population, parameter, sample and statistics; Sampling, need for sampling; Probability sampling: Simple random sampling (SRS), stratified random sampling, systematic sampling, cluster sampling; Non Probability sampling: Purposive and judgment sampling.

Unit III

Sampling distribution: Standard error and its uses, chi-square, t and F distributions. Theory of Estimation: Point Estimation, properties of good estimators; Properties of good estimators – unbiasedness, consistency, efficiency and sufficiency. Interval estimation: confidence limit, confidence interval. Test of significance based on Normal, t, F and Chi-square distributions.

Unit IV

Correlation and Regression: Correlation, types of correlation, pearson's correlation, testing the significance of correlation coefficient, rank correlation. Simple linear regression: assumption and fitting of simple linear regression, testing and interpretation of regression coefficient, coefficient of determination. Multiple linear regression and testing of coefficients.

Unit V

Introduction to ANOVA: One Way and Two way ANOVA. Non-parametric test: Sign test, Wilcoxon Test, Mann-Whitney U-test, Run test for the randomness of the sequence, Median test, Kruskalwallis test, Friedman's test.

PRACTICAL

Descriptive Statistics: Measure of central tendency, Measure of dispersion, Skewness and Kurtosis for raw data. Graphical and diagrammatical representation, Problems on Binomial, Poisson, Normal Distribution. Confidence interval estimation, Large sample test – testing mean and proportion, t-Test for single mean and two means, F-test for two variance, Test based on chi-square distributions. Correlation and Regression analysis. One Way ANOVA and Two way ANOVA. Non Parametric test: Wilcoxon Test, Mann-Whitney U-test, Run test for the randomness of the sequence, Median test, Kruskalwallis test, Friedman's test

LECTURE SCHEDULE

Unit I

1 Descriptive Statistics: Measure of central tendency for raw data
2 Descriptive Statistics: Measure of dispersion for raw data
3 Skewness and Kurtosis for raw data
4 Graphical and diagrammatical representation – Bar Chart, Pie Chart, frequency curve, Box Plot
5 Theory of Probability: axioms and properties, Addition and Multiplication Theorems on probability
6 Random Variable and Mathematical Expectation

Unit II

7 Discrete distribution: Binomial distribution
8 Discrete distribution: Poisson distribution
9 Continuous probability distribution: Normal Distribution
10 Sampling theory: Population, parameter, sample and statistics; Sampling, need for sampling
11 Probability sampling: Simple random sampling (SRS) – with and without replacement
12 Probability sampling: stratified random sampling and its method of allocation, Systematic sampling, cluster sampling
13 Non Probability sampling: Purposive and judgment sampling

Unit III

14 Sampling distribution: Standard error and its uses, chi-square, t and F distributions
15 Theory of Estimation: Point Estimation, Properties of good estimators: unbiasedness, consistency, efficiency and sufficiency
16 Interval estimation: confidence limit, confidence interval for single and two sample mean (t and Z)
17 **Mid Semester Examination**
18 Test of significance based on Normal distribution
19 Test of significance based on t distribution
20 Test of significance based on F distribution

21 Test of significance based on chi-square distributions

Unit IV

22 Correlation, Types of correlation, Pearson's correlation and its properties

23 Rank correlation

24 Simple linear regression: assumption and fitting of simple linear regression

25 Testing and interpretation of regression coefficient, coefficient of determination

26 Multiple linear regression model – Matrix approach and

27 Testingthe significance of correlation coefficient and regression coefficients, coefficient of determination

Unit V

28 Introduction to ANOVA: One Way ANOVA

29 Two way ANOVA

30 Introduction to Non-parametric test: Sign test

31 Wilcoxon Test, Mann-Whitney U-test

32 Run test for the randomness of the sequence, Median test

33 Kruskalwallis test

34 Friedman's test

PRACTICAL SCHEDULE

1 Descriptive Statistics: Measure of central tendency, Measure of dispersion, Skewness and Kurtosis for raw data.

2 Graphical and diagrammatical representation – Bar Chart, Pie Chart, frequency curve, Box Plot

3 Problems on Binomial distribution, Poisson distribution

4 Problems on Normal Distribution

5 Confidence interval estimation for single and two sample mean (t and Z)

6 Large sample test – testing mean and proportion of single and two sample

7 t-Test for single mean, two means (paired t-test)

8 t-Test for two means (independent t-test), F-test for two variance

9 Test of significance based on chi-square distributions

10 Correlation and testing of correlation coefficient

11 Regression analysis and testing the significance of regression coefficient

12 One Way ANOVA and Two way ANOVA

13 Wilcoxon Test, Mann-Whitney U-test

14 Run test for the randomness of the sequence, Median test

15 Kruskalwallis test

16 Friedman's test

17 **Practical Examination**

LEARNING OUTCOME

After successful completion of the course the students will be able to understand the exploratory data analysis, sampling and probability distribution, perform parametric and non parametric tests, well versed with regression and correlation analysis.

SUGGESTED READING

1 Goon A M, Gupta MK and Das Gupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

2 Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley

3 Hogg RV and Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan

4 Robert V. Hogg, Joseph W. McKean, Allen T. Craig (2012). Introduction to Mathematical Statistics (7th Edition)

5 Siegel S, Johan N and Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley

6 Gupta. S.P, 2005, Statistical Methods, Sultan Chand & Sons, New Delhi

7 Rangaswamy, R, 2009, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi.

8 K.P. Dhamu and K. Ramamoorthy, 2007, Statistical Methods, Agrobios (India), Jodhpur.

9 R. GangaiSelvi and C. Kailasam, 2017, Applied Statistics, Kalyani Publishers, New Delhi.

SUGGESTED WEBSITES

1 https://online.stat.psu.edu/statprogram/statistical%20methods

2 https://home.iitk.ac.in/~kundu/Statistical-Methods.pdf

3 https://www.nature.com/subjects/statistical-methods

4 https://sccn.ucsd.edu/~arno/mypapers/statistics.pdf

5 https://www.sciencedirect.com/book/9780123749703/statistical-methods

STA 502 DESIGN OF EXPEREIEMNTS 2+1

AIM OF THE COURSE

Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to various Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

THEORY

Unit I

Need for designing of experiments, Characteristics of good design. Basic principles of designs- randomization, replication and local control. Uniformity trails, size and shape of plots and blocks – determination of optimum plot size.

Unit II

Analysis of Variance, Data Transformation – Logrithmic, angular and square root transformation. Multiple comparison procedures – Least significant difference and Duncan's multiple range test. Completely randomized design, randomized block design and Latin square design.

Unit III

Factorial Experiments: 2^n and 3^n factorial experiments, analysis using regular method, Yates algorithm (2^n, upto three factors), Asymmetric factorial experiments (upto three factors). orthogonality and partitioning of degrees of freedom. Concept of confounding in symmetric factorial experiments, complete and partial confounding. Split plot and strip plot designs.

Unit IV

Missing plot techniques in randomized block design and Latin square designs. Analysis of covariance.

Unit V

Balanced Incomplete Block Design (BIBD), Partially Balanced Incomplete Block Design (PBIBD), Lattice design, alpha design: concept, randomization procedure, analysis and interpretation. Introduction to resolvable designs and their applications. Combined analysis. Response surface design.

PRACTICAL

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments; Analysis of covariance; Analysis with missing data; Data transformation - Split plot and strip plot designs - Analysis of data obtained from BIBD, PBIBD.

LECTURE SCHEDULE

Unit I

1. Introduction to principles of Experimental designs; need for designing of experiments
2. Characteristics of good design
3. Basic principles of designs- randomization, replication and local control.
4. Uniformity trails, size and shape of plots and blocks – determination of optimum plot size

Unit II

5. Analysis of Variance
6. Data Transformation – Logrithmic and angular transformation
7. Square root transformation
8. Multiple comparison procedures – Least significant difference and Duncan's multiple range test

9. Completely randomized design: Layout, randomization, analysis, advantage and disadvantage
10. Randomized block design: Layout, randomization, analysis, advantage and disadvantage
11. Latin square design: Layout, randomization, analysis, advantage and disadvantage
12. Introduction to Factorial Experiments and its type

Unit III

13. 2^n factorial experiments using regular method (up to three factors)
14. 3^n factorial experiments using regular method (up to three factors)
15. Yates algorithm: 2^n factorial experiments (up to three factors)
16. Asymmetric factorial experiments (up to three factors)
17. **Mid Semester Examination**
18. Orthogonality : orthogonal Latin squares, Mutually orthogonal Latin squares (MOLS)
19. Partitioning of degrees of freedom
20. Concept of confounding in symmetric factorial experiments (in 2^3 factorial), advantage and disadvantage
21. Complete and Partial confounding (in 2^3 factorial)
22. Split plot designs: Layout, Randomization, Analysis, Advantage, Disadvantage.
23. Strip plot designs: Layout, Randomization, Analysis, Advantage, Disadvantage

Unit IV

24. Missing plot techniques in randomized block design – one and two missing observation
25. Missing plot techniques in Latin square designs. – one missing observation
26. Analysis of covariance (with one covariate)

Unit V

27. Balanced Incomplete Block Design (BIBD) – concept, randomization procedure
28. Balanced Incomplete Block Design (BIBD) – analysis and interpretation
29. Partially Balanced Incomplete Block Design (PBIBD): concept, randomization procedure, analysis and interpretation.
30. Introduction to Lattice design: Square lattice design, randomization, analysis and their application
31. Introduction to Alpha design: concept, randomization procedure, analysis and interpretation.
32. Introduction to resolvable designs and their applications.
33. Concepts of Combined analysis.
34. Response surface design and application: second order response surface design

PRACTICAL SCHEDULE

1. Uniformity trial data analysis
2. Formation of plots and blocks
3. Fairfield Smith Law

4. Analysis of data obtained from CRD
5. Analysis of data obtained from RBD
6. Analysis of data obtained from LSD
7. Data transformation: logarithmic, angular transformation
8. Square root transformations
9. Analysis with missing data (RBD one missing value only)
10. Analysis of factorial experiments - symmetrical
11. Analysis of factorial experiments - symmetrical
12. Split plot design
13. Strip plot design
14. Analysis of covariance in case of RBD
15. Analysis of data generated from a BIB design
16. Analysis of data generated from a PBIB design
17. **Final practical examination**

SUGGESTED READING

1. Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
2. Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
3. Douglas C. Montgomery (2012). Design and Analysis of Experiments, 8th Ed. John Wiley.
4. Federer WT. 1985. Experimental Designs. MacMillan.
5. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
6. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
7. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley
8. Gomez, K.A. and Gomez, A.A., 1993, Statistical Procedures for Agricultural Research, John Wiley & Sons, New Delhi.
9. Rangaswamy, R, 2009, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi.
10. K.P. Dhamu and K. Ramamoorthy, 2007, Statistical Methods, Agrobios (India), Jodhpur.

SUGGESTED WEBSITES

1. www.drs.icar.gov.in
2. https://www.moresteam.com/toolbox/design-of-experiments.cfm
3. https://www.coursera.org/specializations/design-experiments
4. https://online.stat.psu.edu/statprogram/stat503
5. https://www.labmanager.com/laboratory-technology/online-resources-for-experimental-design-21103

M.Sc. (Agri.) Entomology

M.Sc. (Agri.) Entomology

Sl No.	Course Code	Course Title	Credits
Major courses			
1.	ENT 501*	Insect Morphology	2+1
2.	ENT 502*	Insect Anatomy and Physiology	2+1
3.	ENT 503*	Insect Taxonomy	1+2
4.	ENT 504*	Insect Ecology	2+1
5.	ENT 505*	Biological Control of Insect Pests and Weeds	2+1
6.	ENT 506*	Toxicology of Insecticides	2+1
7.	ENT 507	Host Plant Resistance	1+1
8.	ENT 508	Concepts of Integrated Pest Management	2+0
9.	ENT 509	Pests of Field Crops	2+1
10.	ENT 510	Pests of Horticultural and Plantation Crops	2+1
11.	ENT 511*	Post-Harvest Entomology	1+1
12.	ENT 512	Insect Vectors of Plant Pathogens	1+1
13.	ENT 513	Principles of Acarology	1+1
14.	ENT 514	Vertebrate Pest Management	1+1
15.	ENT 515	Techniques in Plant Protection	0+1
16.	ENT 516	Apiculture	2+1
17.	ENT 517	Sericulture	2+1
18.	ENT 518	Lac culture	2+1
19.	ENT 519	Molecular Approaches in Entomology	2+1
20.	ENT 520	Plant Quarantine, Biosafety and Biosecurity	2+0
21.	ENT 521	Edible and Therapeutic Insects	1+1
22.	ENT 522	Medical and Veterinary Entomology	1+1
23.	ENT 523	Forest Entomology	1+1
Seminar and Research			
1.	ENT 591	Master's seminar	0+1
2.	ENT 599	Master's research	**30 (0+30)**

***** Courses to be compulsorily registered

SEMESTER WISE DISTRIBUTION OF COURSES

SEMESTSER I

Sl.No.	Course No.	Course Title	Credits
I.	Major Courses to be registered		
1	ENT 501	Insect Morphology	2+1
2	ENT 502	Insect Anatomy and Physiology	2+1
3	ENT 503	Insect Taxonomy	1+2
4	ENT 505	Biological Control of Insect Pests and Weeds	2+1
II.	Minor Courses to be registered		3
III.	Supporting Course		
1	STA 501	Statistical Methods for Applied Sciences	2+1
IV.	Common Courses		
1	PGS 501	Library and Information Services	0+1
2	PGS 503	Intellectual Property and its Management in Agriculture	1+0
3	PGS 504	Basic Concepts in Laboratory Techniques	0+1

SEMESTSER II

Sl.No.	Course No.	Course Title	Credits
I.	Major Courses to be registered		
1	ENT 504	Insect Ecology	2+1
2	ENT 506	Toxicology of Insecticides	2+1
3	ENT 511	Post Harvest Entomology	1+1
II.	Minor Courses to be registered		5 or 6
III.	Supporting Course		
1	STA 502	Design of Experiments	2+1
IV.	Common Courses		
1	PGS 502	Technical Writing and Communication Skill	0+1
2	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0

SEMESTER III

Sl.No.	Course No.	Course Title	Credits
1	ENT 591	Master's Seminar	0+1
2	ENT 599	Master's Research	0+15

SEMESTER IV

Sl.No.	Course No.	Course Title	Credits
1	ENT 599	Master's Research	0+15

ENT 501 INSECT MORPHOLOGY 2+1

AIM OF THE COURSE

To acquaint the students with the external morphology of the insect's body and the functioning of various body parts.

THEORY

Unit I

External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, **s**tructure and modification

Unit II

Head-mouthparts, antennae, their types and functioning; tentorium and neck sclerites. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modifications.

Unit III

Thorax, wing venation, wing coupling apparatus and mechanism of flight; legs: structure and modifications. Abdomen - Segmentation and appendages; genitalia and their modifications; embryonic and post-embryonic development.

Unit IV

Insect sense organs (mechano-, photo- and chemo- receptors); organogenesis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology. Types of metamorphosis: Types of immature stages in insect orders.

Unit V

Metamorphosis, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects. Comparative study of life history strategies in hemi- metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

PRACTICAL

Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia; dissection of genitalia. Types of immature stages in insects; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

LECTURE SCHEDULE

Unit I

1 Insect body wall structure and function
2 Cuticular outgrowths – Unicellular& Multicellular appendages
3 Insect colouration (physical & pigmentary) and its importance
4 Special integumentary structures in insects
5 Body tagmata, sclerites and segmentation.
6 Head- Origin, structure and modification

Unit II

7 Insect mouthparts – Mandibulate type
8 Insect mouthparts - Haustellate type
9 Insect eyes, antennae, their types and functioning
10 Tentorium and neck sclerites.
11 Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax
12 Wings: structure and modifications
13 Wings: wing venations – basics – wing venations in different insects

Unit III

14 Wing coupling apparatus and Mechanism of flight
15 Legs: basic structure and modifications
16 Abdomen- Segmentation, genital and pre-genital abdominal appendages
17 **Mid semester examination**
18 Genitalia and its modifications
19 Embryonic development in insects
20 Post-embryonic development in insects

Unit IV

21 Insect sense organs (mechano-, photo- and chemo- receptors)
22 Stridulatory organs in insects
23 Organogenesis at pupal stage
24 Insect defense
25 Morphological traits in relation to forensic entomology- Chaetotaxy
26 Types of metamorphosis.
27 Types of immature stages in insect orders

Unit V

28 Morphology of egg, nymph/larva and pupa
29 Identification of different immature stages of crop pests
30 Identification of different immature stages of stored product insects.
31 Comparative study of life history strategies in hemimetabola
32 Comparative study of life history strategies in holometabola
33 Immature stages as ecological and evolutionary adaptations
34 Significance of immature stages for pest management

PRACTICAL SCHEDULE

1 Preparation of permanent mounts of different body parts - mandibulate and haustellate mouth parts of insects
2 Study of antenna, leg, modifications and significance
3 Study of insect wings, venation, modifications, types of wing coupling
4 Structure and modification of insect abdomen and pregenital appendages in apterygotes and pterygotes
5 Preparation of permanent mounts of different body parts and their appendages (antennae, leg, setae, etc.)
6 Preparation of permanent mounts of taxonomic importance including male and Female genitalia; dissection of genitalia
7 Preparation of permanent mounts of whole insect specimens - thrips, aphids
8 Preparation of permanent mounts of whole insect specimens' scales, mealybugs
9 Types of immature stages in insects; their collection, rearing and preservation
10 Identification of immature insects to orders and families, in endopterygote order viz., Diptera using key
11 Identification of immature insects to orders and families, in endopterygote order viz., Lepidoptera using key
12 Identification of immature insects to orders and families, in endopterygote order viz., Hymenoptera using key
13 Identification of immature insects to orders and families, in endopterygote order viz., Hymenoptera using key
4 Examination of setal arrangement in an endopterygote larva
15 Group Discussion on general collection of insects, rearing, immature stages, etc
16 Morphological description of special organs in insects
17 **Final practical examination**

LEARNING OUTCOMES

Students are expected to have a complete understanding of the comparative morphology of the external features of insects that can be utilized in taxonomy, ecology and applied entomology. The dissection and mounting of different body appendages and whole insect specimens will help them in preparing permanent mounts which is a prerequisite for insect identification. Identification of immature stages of economically important orders will help them in diagnosing field problems effectively.

SUGGESTED READING

1. Antony Youdeowei (1997). A laboratory manual of Entomology. Ibadan Oxford University Press.
2. Chapman, RF. 2013. The Insects: Structure and Function. (Eds: Stephen J Simpson, AngelaE. Douglas), Cambridge Univ. Press, Cambridge, UK.

3. Vasantharaj David, B. 2004. General and Applied Entomology. Tata-McGraw Hill Education Pvt. Ltd., New Delhi.
4. Dunston P Ambrose. 2015. The Insects - Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
5. Evans JW and AD Imms. 2004. Outlines of Agricultural Entomology. Asiatic Publishing House, New Delhi.
6. Richards O.W& Davies R.G.1977.Imm's General Text Book of Entomology. 10th Ed.
7. Snodgross, RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press, Ithaca.
8. Tembhare, D.B. 2000. *Modern Entomology*, Himalaya Publishing House, Mumbai.
9. Chu, HF. 1992. *How to Know Immature Insects*. William Brown Publication, Iowa.
10. Peterson, A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
11. Stehr, FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publication, Iowa.

SUGGESTED WEBSITES

1. https://**www.ndsu.edu/pubweb/~rider/Pentatomoidea/Teaching%20Structure/Teaching_St**ructure.htm
2. **http://www.faculty.ucr.edu/~legneref/biotact/bc-51b.htm**
3. **http://blog-rkp.kellerperez.com/2009/11/eickworts-manual-of-insect-morphology/**

ENT 502 INSECT ANATOMY AND PHYSIOLOGY 3 (2+1)

AIM OF THE COURSE

To impart knowledge about the anatomy and physiology of insect body systems; nutritional physiology; and their applications in entomology.

THEORY

Unit I

Scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosynthesis of chitin; growth, hormonal control, metamorphosis and diapause; pheromone secretion, transmission, perception and reception.

Unit II

Physiology and mechanism of digestion, circulation, respiration, excretion.

Unit III

Reproduction, Secretion (exocrine& endocrine glands) and nerve impulse transmission in insects.

Unit IV

Importance of insect nutrition- role of carbohydrates, lipids Role of vitamins, proteins, amino acids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology.

Unit V

Artificial diets, Sensory system in insects, sensilla, receptors, functions; Color, sound and light production and reception Communication in insects, Defense behaviour in insects, Thermoregulation

PRACTICAL

Latest analytical techniques for analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination and count of insect haemocytes; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

LECTURE SCHEDULE

Unit I

1 Scope and importance of insect physiology and its role in applied Entomology
2 Physiology of integument
3 Moulting in insects
4 Biosynthesis of chitin
5 Physiology of Growth and hormonal control of metamorphosis and diapause
6 Pheromone secretion, transmission, perception and reception

Unit II

7 Structure and function of alimentary system in a typical insect and it modifications
8 Physiology and mechanism of digestion
9 Structure and functions of circulatory system in a typical insect
10 Mechanism of blood circulation and variations in circulatory system in aquatic, parasitic and blood sucking insects
11 Structure and functions of respiratory system
12 Mechanism of respiration in aquatic and endoparasitic insects, assessment of respiratory rates
13 Structure and function of excretory system, mechanism of excretion, Variations of excretory systems in terrestrial, aquatic and high-altitude insects

Unit III

14 Structure and function of reproductive system in insects
15 Kinds of reproduction in insects; Spermatogenesis and oogenesis
16. Exocrine glands in insects
17 **Mid semester examination**
18 Endocrine glands in insects
19 Structure of nervous system in insects

20 Nervous system and nerve impulse transmission in insects

Unit IV

21 Importance of insect nutrition
22 Role of carbohydrates in insect nutrition
23 Role of lipids in insect nutrition
24 Role of proteins and amino acids in insect nutrition
25 Role of vitamins, minerals and other food constituents in insect nutrition
26 Role of extra-cellular microorganisms in insect nutrition
27 Role of intra-cellular microorganisms in insect nutrition

Unit V

28 Artificial diets and their role in growth and development of insects
29 Structures of insect sense organs, sensilla
30 Functions of mechano-, photo-, and chemo-receptors
31 Thermoregulation in insects, circadian rhythms, degree day concept
32 Communication in insects
33 Behavioural defence in insects
34 Chemical defence in insects

PRACTICAL SCHEDULE

1 Dissection and study of digestive system in grasshopper, pentatomid, butterfly, lepidopteran larva and rhinoceros grub
2 Dissection and study of circulatory system in cockroach
3 Dissection and study of respiratory system in grasshopper
4 Dissection, study of nervous system in grasshopper, blister beetle, housefly and lepidopterous larva
5 Dissection, study of male reproductive system in cockroach, blister beetle and pentatomid bug
6 Dissection, study of female reproductive system in cockroach, blister beetle and pentatomid bug
7 Dissection and study of endocrine glands in cockroach and lepidopterous larva
8 Examination of haemolymph of cockroach and lepidopterous larva using haemocytometer
9 Observations on immature stages of insect development
10 Chromatographic analysis of free amino acids of lepidopterous larva
11 Determination of respiratory quotient in cockroach, mosquito and water beetle
12 Preparation of artificial diets for insects
13 Assessment of feeding efficiency and food utilization in a lepidopterous larva in natural diet
14 Assessment of feeding efficiency and food utilization in a lepidopterous larva in artificial diet
15 Estimation of chitin in honeybee/ lepidopterous caterpillar

16 Observation of physiological special features of insects

17 **Final practical examination**

Learning outcome

Students are expected to have a thorough understanding of insect growth and development, physiology of exoskeleton, endoskeleton and different organ systems; action and role of hormones, pheromones, physiology of nutrition and its application, communication and defence.

SUGGESTED READING

1. Chapman.RF.1998.*Insects: Structure and Function*. ELBS Ed., London.
2. Gullan, P.J.and Cranston, P.S. 2000*. The Insects: An Outline of Entomology*, 2nd Ed.Blackwell Science, U.K.
3. Kerkut GA and Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology*. Vols.XIII. Pergamon Press, New York.
4. Patnaik, BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi.
5. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1.
6. Rockstein, M. 1973. *Physiology of Insecta*. Vol.I-IV, Academic Press, New York.
7. Simpson, SJ. 2007*. Advances in Insect Physiology*, Vol. 33, Academic Press (Elsevier), London, UK.
8. Wigglesworth VB.1984. *Insect Physiology*. 8th Ed. Chapman and Hall, New York.

SUGGESTED WEBSITES

1. **www.entsoc.org**
2. **http://ianrhome.uni.edu**
3. **www.colostate.edu/Depts/Entomology**

ENT 503 INSECT TAXONOMY 1+2

AIM OF THE COURSE

To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same. To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects with an emphasis on the practical aspects.

THEORY

Unit I

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s

convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

Unit II

Brief evolutionary history of insects- introduction to phylogeny of insects and Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta - and the Orders contained. International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses. Process of speciation and interbreeding allopatric species. Molecular systematics, DNA bar-coding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

Unit III

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera.

Unit IV

Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera,Mantodea,Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

Unit V

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

PRACTICAL

Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

LECTURE SCHEDULE

Unit I

1. History of insect classification; principles of systematics and its importance
2. Identification, purpose, methods character matrix, taxonomic keys.

3. Subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism

Unit II

4. Brief evolutionary history of Insects, introduction to phylogeny of insects and Major Classification of Superclass Hexapoda
5. Introduction to the Classes: Ellipura (Collembola, Protura, Diplura), Insecta and their Orders contained. International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses
6. Process of speciation and interbreeding allopatric species. Molecularsystematics, NA bar-coding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

Unit III

7. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in: Collembola, Protura, Diplura
8. **Mid semester examination**
9. Subclass Apterygota: Archaeognatha, Thysanura, Subclass: Pterygota, Division Palaeoptera - Odonata, Ephemeroptera
10. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (Oligoneoptera: Plecoptera

Unit IV

11. Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera
12. Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera)
13. Subdivision: Hemipteroid Orders (Paraneoptera): Psocoptera, Phthiraptera Thysanoptera and Hemiptera.

Unit V

14. Division Neoptera — Subdivision Endopterygota, Section Neuropteroid, Coleopteroid Orders: Strepsiptera, Megaloptera and Raphidioptera, Neuroptera
15. Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Trichoptera, Diptera
16. Lepidoptera
17. Section Hymenopteroid Orders: Hymenoptera

PRACTICAL SCHEDULE

1 Different methods of insect collection techniques, preservation and curation
2 Distinguishing characters, general biology, habits and habitats of insect orders Collembola, Protura, Diplura
3 Archaeognatha, Thysanura
4 Ephemeroptera and Odonata and Keying out families of insects
5 Keying out families of insects of the order odonata
6 Orthoptera and keying out families of insects
7 Blattodea, Mantodea Isoptera and Keying out families of insects

8 Oligoneoptera: Plecoptera
9 Grylloblattodea, Dermaptera
10 Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera
11 Hemiptera
12 Hemiptera (Heteroptera) and keying out families of insects
13 Hemiptera (Homoptera) and keying out families of insects
14 Thysanoptera and keying out families of insects
15 Phthiraptera and keying out families of insects
16 Neuroptera and keying out families of insects
17 Strepsiptera, Megaloptera, Raphidioptera
18 Diptera
19 Diptera and keying out families of insects
20 Mecoptera, Siphonaptera, Trichoptera
21 Coleoptera
22 Coleoptera
23. Coleoptera and keying out families of insects
24 Lepidoptera
25 Lepidoptera
26 Lepidoptera
27 Lepidoptera and keying out families of insects
28 Hymenoptera
29 Hymenoptera
30 Hymenoptera and keying out families of insects
31 Field visits to collect insects of different orders.
32 Field visits to collect insects of different orders.
33 Field visits to collect insects of different orders.
34 Final practical examination

Learning Outcome

The students will be kept abreast of the recent changes in the classification of insects in addition to the know-how of insect identification. Students are expected to know the evolution of arthropods, especially insects and other hexapods, and their hierarchical classification. Acquire working skills for collecting, mounting, and preserving insects. Understand the basic concepts of taxonomic hierarchy, identification, taxonomic characters, variations, taxonomic keys and preparation of taxonomicpapers. Identify insects of economic importance up to family levels, taking up the insect orders of agriculture and veterinary importance.

SUGGESTED READING

1. CSIRO 1990. The Insects of Australia: *A Text Book for Students and Researchers*. 2nd Ed.Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca.

2. Girmaldi, D.& Engel, MS. 2005. *Evolution of the Insects*. Cambridge University Press, Cambridge / New York / Melbourne.
3. Freeman S and Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.
4. Gullan, P.J. and Cranston, P.S. 2010. *The Insects: An outline of Entomology*. 4th Ed. Wiley-Blackwell Publications, West Sussex, UK.
5. Mayr, E. 1971. *Principles of Systematic Zoology*. Tata McGraw Hill, New Delhi.
6. Richards OW and Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed.Chapman and Hall, London.
7. Ross HH.1974. *Biological Systematics*. Addison Wesley Publ. Company. Triplehorn CA and
8. Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of* Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

SUGGESTED WEBSITES

1. **http://www.antbase.org/**
2. https://**www.antweb.org/about.do**
3. https://eol.org/
4. https://**www.nhm.ac.uk/our-science/data/lepindex/**
5. https://**www.itis.gov/**

ENT 504 INSECT ECOLOGY 2+1

AIM OF THE COURSE

To teach the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, constructing life tables, organization of communities, diversity indices. Train students in sampling methodology, calculation of diversity indices, relating insect population fluctuations to biotic and/or abiotic causes.

THEORY

Unit I

History and definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology. Carrying capacity- concepts.

Unit II

Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration.

Unit III

Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios.

Unit IV

Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management.

Unit V

Pest management as applied ecology. Climate change and insect pest/ natural enemy population; ecological engineering. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes.

PRACTICAL

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of diversity

indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

LECTURE SCHEDULE

Unit

1 History, Definition and Basic Concepts of ecology - Organisationof the Biological world - Plato's Natural Balance vs Ecological Dynamics as the modern view

2 Basic principles of abiotic factors and their generalised action on insects - Biogeochemical recycling - biological succession and Degree Day concept

3 Abundance and diversity of insects - Estimates and Causal factors - Study of abundance, distribution and relation between the two

4 Implications for abundance and distribution of organisms including insects

5 Law of the Minimum - Law of Tolerance and bio-coenosis - Systems approach to ecology

6 Concepts of Carrying capacity

Unit I Basic concepts of abundance - Model vs Real world. Population growthbasic

7. models - Exponential vs Logistic models - Discrete vs Continuous growth models

8. Environmental Resistance and Optimal yield

9 Vital Statistics - Life Tables and their application to insect biology

10. Survivorship curves - Case studies of insect life tables

11 Population dynamics - Factors affecting abundance -

12 Environmental factors - Dispersal and migration of insects and their classifications

Unit II

13 Seasonality in insects - Classification and mechanisms of achieving different

14 seasonality - Diapause (Quiescence), aestivation, hibernation

15. Nutritional Ecology: Biotic factors - Food as a limiting factor for distribution and abundance. Food chain web - ecological succession

16 Interspecific interactions - Basic factors governing the interspecific interactions

17 **Mid semester examination**

18 Classification of interspecific interactions - The argument of cost-benefit ratios

Unit V

19 Competition - Lotka-Volterra model - Concept of niche - competitive exclusion Prey-predator interactions –

20 Basic model - Lotka-Volterra Model - Volterra's principle Functional and numerical response

21 Defense mechanisms against predators/parasitoids

22 Evolution of mimicry, colouration, concept of predator satiation - evolution of life history strategies

23 Community ecology - Concept of guild

24 Organisation of communities - Hutchinson Ratio - Mayr's discussed with Relation between the two and their association with Dyar's Law and Przibram's law

25 Relative distribution of organisms - Concept of diversity - the Wallacian view Assessment of diversity – Diversity - stability debate - relevance to pest management

Unit V

26 Pest management as applied ecology Pest Management - Definition - Objectives and Principles - Scope for Pest Management

27 Pest surveillance and forecasting pest outbreaks -Collaboration between TNAU and State Departments - Remote sensing to study pest - outbreak - crop damage

28 Assessment of Insect Population, Types of distribution - Random, clumping, Aggregate -

29 Estimation of intensity of pest damage and yield losses - Direct Losses - Indirect Losses - Potential Losses - Unavoidable Losses

30 Pest Monitoring and Forecasting - Use of computers for surveillance Methods

31 Organisation- Collaboration between TNAU and State Departments

32 Remote Sensing to Study Pest - outbreak - Crop Damage - Crop Modelling - Designing and implementation of IPM

33 Determination of Economic Injury Level, Economic Threshold level - Action Threshold Level - Significance in Pest Management

34 Risk Analysis - Pest - Pesticide - Cost benefit ratios and Partial Budgeting - Case studies of successful IPM programmes

PRACTICAL SCHEDULE

1 Types of distributions of organisms - Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters - Assessment of damage and estimation of yield loss in rice / cotton caused by an internal feeder - Flight interception traps - sticky trap, light trap, malaise trap, pheromone trap, suction trap, water trap, Mc Phail trap - their use and erection

2 Sampling of insects from the ground and vegetation - Direct inspection, knockdown sampling, pitfall traps, quadrats, shaking and beating, soil and leaf litter samples and sweep nets - Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size

3 Learning of fit basic population growth models and testing the goodness of fit - Fitting Holling's Disc equation - Assessment of prey-predator densities from natural systems and understanding the correlation between the two

4 Assessing and describing niche of some insects of a single guild - Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms

5 Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index - understanding their associations and parameters that affect their values

6 Establishing the relationship of weather factors with selected pest population and developing prediction models - Problem solving in ecology- mathematical models

7 Field visits to understand different ecosystems and to study insect occurrence in these systems

8 Characterisation of Agro-ecosystems - Visit to Paddy Breeding Station and Orchard - Practicing different methods of Insect Sampling - Flight interception traps like sticky trap, light trap, malaise trap, pheromone trap, suction trap, water trap, Mc Phail trap - their use and erection

9 Exercise on sampling of insects from the ground and vegetation - Direct inspection, knockdown sampling, pit fall traps, quadrats, shaking and beating, soil and leaf litter samples and sweep nets - Quantification of pest population - Direct sampling of insects, population of leaf hopper, aphid and mite - Assessment of damage and estimation of yield loss in rice - cotton caused by an internal feeder

10 Surveillance methodology in rice - cotton - millets for major pests and natural enemies – Life table construction for lepidopterous or homopterous pest through field and green house experimentation

11 Practicing different mechanical and physical methods used in pest management – collection of eggs, larvae and adults - Observation on cultural efforts on pest population

12 Establishing relationship of weather factors with selected pest population and developing prediction models (the information gathered on pest population and weather factors in different research projects will be made use of) Crop Loss assessment - direct loss – indirect loss - Avoidable loss - Unavoidable los

13 Estimation of EIL, ETL - Regression analysis - Weather Factors on Pest Population / Damage - Experiment to determine the Antifeedant effects of neem products on foliage feeders

14 Safe handling of Pesticides and Pesticide Application Methods - Study of quarantine measures - Sample Examination - Treatment - Phytosanitary certificate - Proforma and Procedures

15 Case studies of Successful IPM - Field Visits I

16 Case studies of Successful IPM - Field Visits II

17 **Final practical examination**

LEARNING OUTCOME

The students are expected to be well versed with the basic concepts of ecology, ecological succession, population ecology, community ecology, nutritional ecology and different insect- ecosystem interactions. Quantification of insect diversity and abundance,

life table analyses, predator-prey and host-parasitoid relations, functional and numerical responses, niche breadth and overlap

SUGGESTED READING

1. Begon, M., Townsend, C.R. and Harper, J. L. 2006. Ecology: From Individuals to Ecosystems.4th Ed. Blackwell Publishing, USA/ UK/ Australia.
2. Chapman J. L. and Reiss MJ. 2006. Ecology: Principles and Applications. 2nd Ed. Cambridge Univ. Press, Cambridge.
3. Fowler, J., Cohen, L. and Jarvis, P. 1998. Practical Statistics for Field Biology. 2nd Ed. John Wiley& Sons, Chichester, West Sussex PO19 8SQ, England.
4. Gotelli N. J and Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, MA.
5. Gotelli N. J. 2001. A Primer of Ecology. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA.
6. Gupta RK. 2004. Advances in Insect Biodiversity. Agrobios, Jodhpur.
7. Krebs CJ. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
8. Krebs CJ. 2001. Ecology: The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin Cummings Publ. Co., New York.
9. Magurran AE. 1988. Ecological Diversity and its Measurement. Princeton Univ. Press, Princeton.
10. Price PW. 1997. Insect Ecology. 3rd Ed. John Wiley, New York.

SUGGESTED WEBSITES

1. http://eagri.org/eagri50/ENTO232/index.html
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=12427
3. https://www.mlsu.ac.in/econtents/1214_Insect%20Ecology-I&II
4. https://www.agribsc.kkwagh.edu.in/uploads/department_course/Ecology, IPM and Beneficial Insects

ENT 505 BIOLOGICAL CONTROL OF INSECT PESTS AND WEEDS 2+1

AIM OF THE COURSE

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.

THEORY

Unit I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

Unit II

Insect pathology: viruses, protozoa, rickettsiae, spiroplasma and nematodes. 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.

Unit III

Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

Unit IV

Mass production of quality bio-control agents- techniques, formulations, economics, field release/application and evaluation. Development of insectaries, their maintenance. Successful biological control projects, analysis, trends and future possibilities of biological control.

Unit V

Importation of natural enemies - Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

PRACTICAL

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits 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. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

LECTURE SCHEDULE

Unit

1 History, Principles and scope of biological control
2 Groups of economically important parasitoids

3 Groups of economically important predators
4 Principles of classical biological control
5 Importation, Conservation and augmentation of natural enemies
6 History of insect pathology
7 Infection of insects by bacteria andfungi

Unit I

8 Infection of insects by viruses and protozoa
9 Infection of insects by rickettsiae, spiroplasma and nematodes
10 Biology and adaptation of Host selection process in entomophages
11 Symptoms of disease, disease development and mode of action of viruses
12 Symptoms of disease, disease development and mode of action of fungi
13 Symptoms of disease, disease development and mode of action of bacteria
14 Symptoms of disease, disease development and mode of action of protozoa and entomopathogenic nematodes

Unit II

15 Weed killers of economic importance and case histories in biological control
16 Epizootology, symptomatology and etiology of diseases
17 **Mid semester examination**
18 Factors controlling epizootics
19 Defense mechanisms in insects against pathogens
20 Mass production techniques of laboratory hosts for the production of entomophages and entomopathogens

Unit V

21 Mass Production techniques of predators
22 Mass Production techniques of parasitoids
23 Mass Production techniques of entomopathogenic fungi
24 Mass Production techniques of bacteria and protozoa
25 Mass Production techniques of viruses
26 Development of formulations of entomopathogens
27 Techniques in release and evaluation of biocontrol agents

Unit V

28 Establishment of biocontrol production facility
29 Successful biological control projects
30 Successful instances of exploitation of pathogens for pest management
31 Trends and future possibilities of biological control
32 Importation of natural enemies and Quarantine regulations
33 Biotechnology in Biological control
34 Semiochemicals in biological control

PRACTICAL SCHEDULE

1 Identification and description of key groups of parasitoids - morphological features
2 Identification and description of key groups of predators - morphological features
3 Characterization of viruses, bacteria, fungi and protozoans of importance
4 Techniques of mass production of entomophages
5 Techniques of mass production of entomopathogens
6 Biology and parasitic potential of *Trichogramma*and *Braconhebetor*
7 Biology and predatory potential of important predators *Cryptolaemus* and *Chrysoperla*
8 Field release and evaluation of *Trichogramma*and *Chrysoperla*
9 Role of semiochemical in host selection
10 Pathogenicity of NPV to *Helicoverpa*and *Spodoptera*
11 Pathogenicity of *B.t*. to *Plutella*sp. *Helicoverpaarmigera*
12 Pathogenicity of *Metarhizium*and *Beauveria bassiana*to lepidopterans
13 Pathogenicity of *Isaria*sp. / *Beauveria bassiana*on hemipterans
14 Quality control and registration standards for biocontrol agents
15 Experiment on efficacy of weed killers
16 Visit to National/Commercial Biocontrol Laboratories- biocontrol lab, TNAU, Coimbatore
NBAIR, Bengaluru / Bio control lab, Sugarcane Breeding Institute, Coimbatore
17 **Final practical examination**

LEARNING OUTCOME

Students will be empowered with the knowledge on entomophages, entomopathogens of insects, techniques for mass production of quality bio-agents and their optimal use in insect pest management.

SUGGESTED READING

1. Burges HD and Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites*. Academic Press, London.
2. De Bach P. 1964. *Biological Control of Insect Pests and Weeds*. Chapman and Hall, New York.
3. Dhaliwal GS and Arora R. 2001. *Integrated Pest Management: Concepts and Approaches*. Kalyani Publ., New Delhi.
4. Gerson H and Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman and Hall, New York.
5. Huffaker CB and Messenger PS. 1976. *Theory and Practices of Biological Control*. Academic Press, London.
6. Ignacimuthu SS and Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.
7. Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

8. Van Driesche and Bellows TS. Jr. 1996. *Biological Control*. Chapman andHall, New York.
9. Boucias, D.G.and C.P. Jacquelyn. **(**2004). Principles *of Insect Pathology*. Publisher: Springer Netherland.235 pp.
10. Burges,H.D.**(**1981). *Microbial Control of Pests and Plant Diseases*. Academic Press, New York. 949 pp. 346
11. Drion, G., D.G. Boucias and C.P.Jacquelyn. **(**2004). *Principles of Insect Pathology*. Springer Netherland. 235 pp.
12. Gautam,R.D.**(**2008).*Biological Pest Suppression*. Westville Publishing House, Delhi.304p.
13. Lacey,L.L.**(**1997).*Manual of Techniques in Insect Pathology*.AcademicPress.409pp.Stock, S.P., I. Vandenberg, I. Glazer and N. Boemare. **(**2009). Insect *Pathogens: Molecular Approaches and Techniques*. CABI, Oxin, UK.
14. Tanada, Y. and H.K.Kaya. **(**1992). Insect *Pathology*. Academia press, SanDiego.666pp.

SUGGESTED WEBSITES

1. https://pubmed.ncbi.nlm.nih.gov ›
2. https://**www.sciencedirect.com/science/article/pii/S1049964401909387**
3. https://agris.fao.org/agris-search/search.do?recordID=BG9400267
4. **https://solidstatetechnology.us/index.php/JSST/article/view/1162**

ENT 506 TOXICOLOGY OF INSECTICIDES 2+1

AIM OF THE COURSE

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.

THEORY

Unit I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Unit II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organ chlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrazoles, insect growth regulators, microbials,

botanicals, new promising compounds/ new insecticide molecules; nano pesticides; drawbacks of insecticide abuse.

Unit III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. bioassay definition, objectives, criteria, factors, problems and solutions.

Unit IV

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

Unit V

Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

PRACTICAL

Insecticide formulations and mixtures; laboratory and field evaluation of bio-efficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides. Procedures of residue analysis.

LECTURE SCHEDULE

Unit I

1 Definition and scope of insecticide toxicology; history of chemical control
2 Pesticide use and pesticide industry in India
3 Classification of insecticides and acaricides based on organism, mode of entry, mode of action, chemical nature, IRAC classification
4 Categorisation based on toxicity- bees, beneficial insects and other insects

Unit II

5 Structure and mode of action of organ chlorines
6 Structure and mode of action of organ chlorines.
7 Structure and mode of action of organophosphates
8 Structure and mode of action of carbamates
9 Structure and mode of action of pyrethroids
10 Structure and mode of action of tertiary amines
11 Structure and mode of action of neonicotinoids
12 Structure and mode of action of oxadiazines, phenyl pyrazoles
13 Structure and mode of action of new insecticide molecules

14 Structure and mode of action of insect growth regulators,
15 Structure and mode of action of microbials
16 Structure and mode of action of botanicals
17 **Mid semester examination**

Unit III

18 Nano pesticides
19 Drawbacks of insecticide abuses
20 Principles of toxicology
21 Evaluation of insecticide toxicity
22 Joint action of insecticides- synergism, potentiation and antagonism
23 Factors affecting toxicity of insecticides
24 Insecticide compatibility, selectivity
25 Phytotoxicity
26 Bioassay definition, objectives, criteria, factors, problems and solutions

Unit IV

27 Insecticide metabolism
28 Insecticide metabolism
29 Insect pest resistance to insecticides; mechanisms and types of resistance
30 Insecticide resistance management and pest resurgence

Unit V

31 Insecticide residues, their significance, its determination and environmental Implications
32 Procedures for insecticide residue analysis
33 Insecticide Act, registration, label claim and quality control of insecticides
34 Safe use of insecticides, diagnosis and treatment of insecticide poisoning

PRACTICAL SCHEDULE

1 Insecticide formulations and mixtures
2 Laboratory evaluation of bioefficacy of insecticides.
3 Field evaluation of bioefficacy of insecticides
4 Bioassay techniques
5 Probit analysis – Dragstedt – Behren's and graphical method
6 Probit analysis – Finney's method
7 Evaluation of insecticide toxicity
8 Toxicity to beneficial insects
9 Supervised trials to fix waiting periods for safe harvest
10 Pesticide appliances
11 Working out doses and concentrations of pesticides
12 Procedures of residue analysis – fruits and vegetables
13 Procedures of residue analysis – spices
14 Procedures of residue analysis – cereals and pulses

15 Procedures of residue analysis – fish
16 Procedures of residue analysis – soil and water
17 **Final practical examination**

LEARNING OUTCOME

Students are expected understand the concept of toxicity, bio-efficacy, insecticide formulations, modes of action of insecticides, estimation of insecticide residues and have significant know-how about the functioning of various types of spray equipment's.

SUGGESTED READING

1. Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford and IBH, New Delhi.
2. Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.
3. Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
4. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York.
5. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
6. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publication, New York.
7. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
8. Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA.
9. Dodia, D.A.Petel, I.S.and Petal, G.M. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India), Jodhpur.
10. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi.
11. Mathews G.A. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK.
12. Otto, D. and Weber, B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., U.K.
13. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.
14. Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando
15. Florida.
16. Regupathy, A and K.P. Dhamu. 2001. Statistical work book for Insecticide Toxicology. Softech Computers, Coimbatore. 206 p.

SUGGESTED WEBSITES

1. http:/ppqs.gov.in

ENT 507 HOST PLANT RESISTANCE 1+1

THEORY

Unit I

History and importance of resistance; principles, classification, components, types and mechanisms of resistance.

Unit II

Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit III

Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

Unit IV

Factors affecting plant resistance including biotypes and measures to combat them. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Unit V

Role of biotechnology in plant resistance to insects.

PRACTICAL

Screening techniques for measuring resistance; measurement of plant characters and working out their correlations with plant resistance; testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties; demonstration of antibiosis, tolerance and antixenosis.

LECTURE SCHEDULE

Unit I

1 History and Importance of Plant Resistant and its scope in IPM

2 Mechanism of resistance and its components - antixenosis, antibiosis and tolerance –Induced Resistance

Unit II

3 Insect host plant relationship- phytophagous insects' behavior

4 Theories of host plant selection in phytophagous insects

5 Host selection by phytophagous insects - Factors - steps in host selection process

6 Types of resistance - Ecological and genetic – Induced resistance and acquired resistance

Unit III

7 Secondary plant substances and volatiles, biochemical bases of resistance

8 Mid semester examination

9 Tritrophic interaction

10 Bio physical bases and nutritional bases of resistance

Unit IV

11 Factors affecting the expression of resistance - physical, biological and others, Bt expression in crops

12 Screening techniques-Genetics of resistance - stability of resistance

13 Organisation of resistance breeding programme for developing of resistance varieties

14 Transfer of resistance - Utilization of wild species in resistance breeding

15 New / innovative methods in the development of resistant varieties – Genetic engineering

16 Success in resistance programme

Unit V

17 Interventions with biotechnological approaches for plant resistance

PRACTICAL SCHEDULE

1 Mass culturing techniques- rice BPH, rice leaf folder

2 Greenhouse screening of rice varieties against brown plant hopper

3 Standard seed box seedling test and modified seed box seedling technique – Grading and classification

4 Evaluation of rice varieties for resistance to leaf folder and stem borer in greenhouse

5 Field screening of rice varieties against major pests of rice (Observations to be made in the varietal screening plots of entomology and plant pathology departments)

6 Correlation studies to determine the feeding activity of BPH / WBPH on resistant and susceptible rice varieties by honeydew method (ninhydrin) and by recording feeding marks

7 Technique to find out the feeding site of green leafhopper using Safranine dye technique on resistant and susceptible rice varieties

8 No choice test for studying the preference or non-preference of rice varieties for BPH

9 Testing resistance on rice, cotton and other crop varieties for major pests

10 Bioassay studies of plant extracts of susceptible and resistant varieties

11 No-choice test for studying the preference / non-preference of for studying antibiosis, tolerance and antixenosis

12 Antixenosis and antibiosis studies by artificial diet method

13 Biochemical analysis of resistant and susceptible rice varieties - Estimation of proteins/carbohydrates

14 Estimation of phenols in resistant and susceptible rice varieties

15 Estimation of amino acids in resistant and susceptible rice varieties

16 Visit to National / International Institutes

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to acquire a thorough knowledge of the types and basis of mechanisms involved in host plant resistance, screening techniques to measure resistance and insect resistance breeding.

SUGGESTED READING

1. Chelliah, S. and Uthamasamy, S.1995. Plant Resistance to Plants: Principles and Practices.APC Publications Pvt Ltd., New Delhi, 488p.
2. Dhaliwal GS and Singh R. (Eds). 2004. Host Plant Resistance to Insects - Concepts and Applications. Panima Publ., New Delhi.Maxwell FG and Jennings PR. (Eds). 1980. Breeding Plants Resistant to Insects. John Wiley and Sons, New York.
3. Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, London.
4. Panda N and Khush GS. 1995. Plant Resistance to Insects. CABI, London.
5. Smith CM. 2005. Plant Resistance to Arthropods – Molecular and Conventional Approaches. Springer, Berlin.
6. Hari C. Sharma. 2009. Biotechnological approaches for pest management and ecological sustainability. CRC Press, New York.
7. Heinrichs, E.N., Medrano, E. G. & H. R. Rapusa. Genetic Evaluation for insect resistance in rice. International Rice Research Institute.
8. Andreas Schaller (Ed.). 2008. Induced Plant Resistance to herbivory. Springer science.
9. Clement, S. L. and Cuisenberry, S. S. 1999.Global Plant Genetic resources for insect resistant crops. CRC Press, New York.

SUGGESTED WEBSITES

1. https://edepot.wur.nl/121996
2. https://egyankosh.ac.in/handle/123456789/13957: IGNOU National Digital Library
3. https://centaur.reading.ac.uk/72415
4. **http://oar.icrisat.org/2100** : ICRISAT Open Access library

ENT 508 CONCEPTS OF INTEGRATED PEST MANAGEMENT 2+0

THEORY

Unit I

Integrated Pest Management: History, origin, definition and evolution of various terminologies. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

Unit II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Importance of resistance, principles, classification, components, types and mechanisms of resistance.

Unit IV

Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

Unit V

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world. Integration of insect pest management methods.

LECTURE SCHEDULE

Unit I

1. Integrated Pest Management: History, origin, definition and evolution of various Terminologies
2. National and international level crop protection organizations; Insecticide regulatory bodies
3. Synthetic insecticide, bio-pesticide and pheromone registration procedures
4. Label claim of pesticides – the pros and cons
5. Concept and philosophy, ecological principles, economic threshold concept and economic consideration
6. Insect host plant relationships; theories and basis of host plant selection in phytophagous insects

Unit II

7. Tools of pest management, Legislative methods and quarantine regulations
8. Cultural methods
9. Physical, Mechanical methods

10. Semiochemicals in pest management
11. Biotechnological and bio-rational approaches in IPM
12. Importance of resistance, principles, classification, components
13. Types and mechanisms of resistance

Unit III

14. Pest survey and surveillance
15. Forecasting, types of surveys including remote sensing methods
16. Factors affecting surveys; political, social and legal implications of IPM
17. **Mid semester examination**
18. Pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting
19. Case studies of successful IPM programmes
20. ITK-s in IPM
21. Area-wide IPM
22. IPM for organic farming

Unit IV

23. Components of ecological engineering with successful examples
24. Characterization of agro-ecosystems
25. Sampling methods and factors affecting sampling
26. Population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses
27. Global and Indian scenario of crop losses
28. Computation of EIL and ETL

Unit V

29. Crop modeling; designing and implementing IPM system
30. Screening techniques; breeding for insect resistance in crop plants
31. Exploitation of wild plant species; gene transfer
32. Successful examples of resistant crop varieties in India
33. Successful examples of resistant crop varieties in the world
34. Integration of insect pest management methods

LEARNING OUTCOME

Students are expected to have significant knowledge of IPM concepts, estimation of losses due to insect pests, computation of ETL, EIL and should be able take management decisions.

SUGGESTED READING

1. Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.
2. Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
3. Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.

4. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.
5. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
6. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

SUGGESTED WEBSITES

1. **https://www2.ipm.ucanr.edu/What-is-IPM/**
2. **https://www.epa.gov/ipm/introduction-integrated-pest-management**

ENT 509 PESTS OF FIELD CROPS 2+1

AIM OF THE COURSE

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

THEORY

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pest scenario in relation to climate change.

Unit I

Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars.

Unit II

Non-insect pests (mites, birds, rodents, snails, slugs etc.).

Unit III

Insect pests of cereals and millets and their management.

Unit IV

Insect pests of pulses, tobacco, oilseeds and their management.

Unit V

Insect pests of fibre crops, forage crops, sugarcane and their management.

PRACTICAL

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

LECTURE SCHEDULE

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

Unit I

1	Grasshoppers
2	Locusts
3	Locusts
4	Termites
5	White grubs
6	Hairy caterpillars
7	Hairy caterpillars

Unit II

8	Mites
9	Birds
10	Rodents
11	Rodents
12	Snail and Slugs

Unit III

13	Rice
14	Rice
15	Sorghum
16	Maize
17	Mid semester examination
18	Wheat
19	Cumbu, Ragi and Tenai

Unit IV

20	Blackgram and Greengram
21	Pigeonpea
22	Groundnut
23	Castor
24	Gingelly
25	Sunflower, Safflower
26	Mustard, Soybean

Unit V

27	Tobacco
28	Cotton
29	Cotton and Jute
30	Sugarcane
31	Sugarcane
32	Forage crops - Lucerne, subabul

33 Green manures - Agathi, Sesbania, Daincha, sunhemp

PRACTICAL SCHEDULE

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

1 Grasshoppers and Locusts
2 Termites and White grubs
3 Hairy caterpillars
4 Mites
5 Birds
6 Rodents, Snail and Slugs
7 Rice
8 Sorghum, Maize and wheat
9 Cumbu, Ragi, Tenai and Other minor millets
10 Pigeonpea, Black and green gram
11 Groundnut, Castor, Gingelly and Sunflower
12 Cotton
13 Sugarcane
14 Tobacco
15 Forage crops
16 Green manures
17 **Final practical examination**

LEARNING OUTCOME

Students are expected to acquire knowledge of insect pests of field crops, their nature of damage, life history traits and effective management.

SUGGESTED READING

1. David, BV and Ramamurthy, VV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.
2. Dhaliwal GS, Singh R and Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., NewDelhi.
3. Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi
4. Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.
5. Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi.
6. Prakash I and Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.
7. Saxena RC and Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Udaipur.

SUGGESTED WEBSITES

1. https://entomology.ca.uky.edu/fieldcrop
2. https://**www.ag.ndsu.edu/extensionentomology/field-crops-insect-pests**
3. **http://oar.icrisat.org/7258/1/InsectAndOtherAnimalPest_1988.pdf**
4. https://**www.knowledgebank.irri.org/**
5. **https://iimr.icar.gov.in/pest-management-2/**

ENT 510 PESTS OF HORTICULTURAL AND PLANTATION CROPS 2+1

AIM OF THE COURSE

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

THEORY

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

Unit I

Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, ber, fig, citrus, aonla, pineapple, apple, peach and other temperate fruits.

Unit II

Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, French beans, chow-chow, brinjal, okra, all gourds, drumstick, leafy vegetables etc.

Unit III

Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.

Unit IV

Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, betel vine etc.

Unit V

Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.

PRACTICAL

Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non-insect pests.

LECTURE SCHEDULE

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

Unit I

1 Mango
2 Guava
3 Banana
4 Jack
5 Papaya
6 Pomegranate and Litchi
7 Grapes
8 Ber, Fig, Aonla and Pineapple
9 Apple, Peach and Other temperate fruits

Unit II

10 Tomato
11 Potato, Radish, Carrot and Beetroot
12 Cole crops, French beans, Chow-chow
13 Brinjal
14 Okra
15 All gourds
16 Drumstick and Leafy vegetables
17 Mid semester examination
18 Onion and Garlic

Unit III

19 Coffee, Tea and Rubber
20 Coconut
21 Arecanut
22 Cashew and cocoa

Unit IV

23 Pepper
24 Cardamom Clove and Nutmeg
25 Chillies
26 Turmeric and Ginger
27 Betelvine

Unit V

28 Jasmine
29 Rose
30 Crossandra and Nerium
31 Crotons, Lilly & Coleus
32 Pest management in protected cultivation
33 Pest management in protected cultivation

34 Medicinal plants

PRACTICAL SCHEDULE

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

1 Mango, Guava and Banana
2 Jack and Papaya
3 Pomegranate and Litchi
4 Grapes, Ber, Fig, Aonla and Pineapple
5 Apple, Peach and Other temperate fruits
6 Tomato, Brinjal, Chillies and Okra
7 Potato, Radish, Carrot, Beetroot, Cole crops, French beans, chow-chow
8 All gourds, Drumstick and Leafy vegetables
9 Onion and Garlic
10 Coffee, Tea and Rubber
11 Coconut, Arecanut, Cashew and cocoa
12 Pepper, Cardamom Clove and Nutmeg
13 Turmeric, Ginger and Betelvine
14 Jasmine, Rose, Crossandra, Nerium, Crotons, Lilly and Coleus
15 Pest management in protected cultivation
16 Medicinal plants
17 Final practical examination

LEARNING OUTCOME

Students are expected to acquire knowledge of insect pests of horticultural, medicinal and plantation crops, their nature of damage, life history traits and effective management.

SUGGESTED READING

1. David, BV and Ramamurthy, VV. 2018. Elements of Economic Entomology. Popular Book Depot, Chennai.
2. Evans JW. 2005. Insect Pests and their Control. Asiatic Publ., New Delhi.
3. Nair MRGK. 1986. Insect and Mites of Crops in India. ICAR, New Delhi.
4. Prakash I and Mathur RP. 1987. Management of Rodent Pests. ICAR, New Delhi.
5. Saxena RC and Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Udaipur.
6. Omkar. 2018. Pests and their Management. Springer Publications. 585p.
7. Regupathy, A. and Ayyasamy, R. 2016. A guide on crop pests. Namrutha publ., Chennai. P.368.(6th edition).

SUGGESTED WEBISITES

1. https://agricoop.nic.in/sites/default/files/ICAR_7.pdf
2. https://**www.mdpi.com/journal/insects/special_issues/ipm_horticultural**
3. https://**www.farmbiosecurity.com.au/crops/fruit-nuts/fruit-nut-pests/banana-pests/**
4. https://**www.agricultureinindia.net/pest-control/temperate-fruits-pest-control/pests-of-**temperate-fruits-and-its-control-agriculture/16028

ENT 511 POST HARVEST ENTOMOLOGY 1+1

AIM OF THE COURSE

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.

THEORY

Unit I

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto vis-à-vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Concept of seed vault.

Unit II

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

Unit III

Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

Unit IV

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.

Unit V

Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Insecticide resistance in stored product pests and its management; recent advances (MAS, PPP, HS) in storage pest management; integrated approaches to stored grain pest management.

PRACTICAL

Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of hidden insect infestation in stored food grains; estimation of uric acid content in infested produce; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

LECTURE SCHEDULE

Unit I

1 Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests

2 Post-harvest losses in relation to total production of food grains in India. Scientific and socio- economic factors responsible for grain losses

Unit II

3 Important insect pests associated with stored grains - internal feeders, systematic position, identification, distribution, host range - biology - nature and extent of damage

4 Important insects pests associated with stored grains - external and secondary feeders, systematic position. identification, distribution host range - biology - nature and extent of damage

5 Sources of infestation - field carryover infestation - cross infestation

6 Infestation by mites, rodents, birds and microorganisms

7 Type of losses in stored grains and their effect on quality including biochemical changes

8 **Mid semester examination**

Unit III

9 Ecology of insect pests of stored commodities / grains with special emphasis on role of moisture, temperature and humidity

10 Stored grain deterioration process - physical and biochemical changes and consequences

11 Grain storage - types of storage structure - traditional, improved and modern storage structures in current usage

12 Ideal seed and commodities storage conditions. Preservation of seeds on long term basis (cold storage)

Unit IV

13 Rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows - Role of bird pest and their management

14 Control of infestation of insect pests, mites and microorganisms, preventive measures - Hygiene / sanitation, disinfestation of stored receptacles, legal methods

Unit V

15 Curative measures - non-chemical control measures - ecological, mechanical, physical, cultural, biological and engineering

16 Chemical control - prophylactic and curative characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants

17 Recent advances in storage pest management. Integrated approaches to stored grain pest management

PRACTICAL SCHEDULE

1 Observations on the external features and morphological characters of storage pests - external feeders - Immature and adult stages

2 Observations on the external features and morphological characters o storage pests - Internal feeders - Immature and adult stages

3 Physical and chemical methods of detection of insect infestation in stored commodities - Physical methods - Visual, Sieving, Flotation methods, X ray, Organoleptic and staining technique for locating egg plugs

4 Estimation of grain / seed moisture content

5 Estimation of storage loss due to pulse beetle/paddy moth - sources of insect infestation

6 Experiment to study the development of pulse beetle / paddy moth under different moisture and temperature regimes

7 Determination of field carry over damage in rice / pulse due to paddy moth / Pulse beetle by adopting pre-harvest spray

8 Physical poisons / inert dusts - Activated clay - Principles - mode of action – production processes and methods of application

9 Experiment on various non-chemical and inert materials for grain and processed food protection - Gunny bag impregnation

10 Techniques for evaluation of plant products like neem, notchi, jatropa oil and palmarosa oil by cup bio assay technique. Assessing the settling behaviour and damage

11 Treatment of package material and their effect on seed quality

12 Methods of storage - Evaluation of new storage containers with reference to insect removal and damage in pulses / cereals

13 Gadgets used in storage pest control - plastic probe trap, pitfall plastic trap, light traps, insect removal bins, indicator devices, TNAU stored grain insect management kit

14 Detection of rodent damage in ware houses / farm storage and its management - trapping, baiting and other methods

15 Visit to Central / State warehouse / Private seed godowns to observe the method of storage of grains, stacking methods and fumigation - collection of storage pests

16 Demonstration of fumigation techniques

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to acquire knowledge of pestiferous insects, mites, rats and birds affecting stored produce, their nature of damage, life history traits and effective management. Detection of insect infestation and familiarization with different storage structures. Learning preventive and curative measures to manage infestation in storage houses.

SUGGESTING READING

1. Hall DW. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas.* FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.
2. Jayas DV, White NDG and Muir WE. 1995. *Stored Grain Ecosystem.* Marcel Dekker, New York.
3. Khader V. 2004. *Textbook on Food Storage and Preservation*. Kalyani Publ., New Delhi.
4. Khare BP. 1994. *Stored Grain Pests and Their Management.* Kalyani Publ., New Delhi.
5. Subramanyam B and Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products.* Marcel Dekker, New York.
6. Narayanasamy, P., Mohan S. and Awaknavar J.S. 2009. Pest management in stored grains. Satish Serial Publishing House, New Delhi.

SUGGESTING WEBSITES

1. **http://www.fao.org**
2. **http://www.storedgrain.com.au**
3. **http://www.grainscanada.gc.ca**
4. **http://www.storedproductinsects.com**

ENT 512 INSECT VECTORS OF PLANT PATHOGENS 1+1

AIM OF THE COURSE

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

THEORY

Unit T-I

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.

Unit II

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

Unit III

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

Unit IV

Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

Unit V

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, nematodes; culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies. Vector rearing and maintenance; estimating vector transmission efficiency, studying vector-virus host interaction.

LECTURE SCHEDULE

Unit I

1 History of developments in the areas of insects as vectors of plant pathogens
2 Importance of phytophagous insects and mites as vectors of plant diseases in Agricultural / Horticultural / Green house crops
3 Toxicogenic insects and mites - feeding process and their salivary secretions
4 Primary, secondary and systemic effects and histological changes and malformation in different field / horticultural crops

Unit II

5 Mechanisms of insect transmission of plant pathogens
6 Ecological aspects of insect transmission of plant pathogens
7 Kinds and types insects and mite vectors and their relationship in plant diseases caused by virus and bacteria
8 Mid semester examination

Unit III

9 Kinds and types insects and mite vectors and their relationship in plant diseases caused by fungi and MLO
10 Role of insect vectors - aphids and aphid transmitted viruses, in field, horticultural, spices and plantation crops including banana

Unit IV

11 Leaf and plant hoppers as vectors of plant diseases rice, brinjal, gingelly, ragi and maize
12 Significance of whitefly as vector of crop diseases - okra, cotton, pulses and tapioca
13 Importance of grasshoppers, mealybugs and thrips as vectors of field and horticultural crops

Unit V

14 Psyllid, beetles and Mites as vectors of crop diseases – sugarcane, jasmine, rice, redgram, mango and chillies
15 Ecological and environmental aspects of transmission of plant diseases
16 Management of vectors of plant diseases - cultural, mechanical, biological and chemical
17 Management of plant diseases through resistant varieties and molecular approaches for vector and pathogens

PRACTICAL SCHEDULE

1 Identification of phytotoxemia symptoms in crops - rice, pulses, cotton, okra and jasmine
2 Gall forming insects and eriophyid mites - vegetables cotton, pungam and mango
3 Identification of characteristic features of vectors - leafhopper, plant hoppers and aphids
4 Identification of characteristic features of vectors - whiteflies, thrips, grasshopper, nematodes and mites

5 Culturing and handling of vectors
6 An experiment on transmission efficiency - YVM in okra / RTV in rice (This will be a continuous experiment throughout the course)
7 An experiment on transmission efficiency of mite transmitted disease
8 Recording of vector population in cotton / rice and relating to disease intensity and weather factors
9 Recording of vectors infesting major vegetables and viral disease incidence
10 Microtomy to fix the phytotoxemic pathway
11 Histological changes in healthy and diseased plants
12 Identification of insect transmitted plan diseases through molecular techniques
13 Practising physical and mechanical methods of vector control
14 An experiment with plant products and mineral oils on vector transmission efficiency
15 Disease control through chemical control of vectors - insecticides and acaricides
16 Visit to endemic areas - assessment of intensity of vectors and diseases - Analysis of epidemics
17 **Final practical examination**

LEARNING OUTCOME

Students are expected to be well versed with insect vectors of plant pathogens, acquire knowledge on disease transmission and vector management techniques.

SUGGESTED READING

1. Basu AN. 1995. *Bemisia tabaci* (Gennadius) - *Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford and IBH, NewDelhi.
2. Harris KF and Maramarosh K. (Eds.).1980. *Vectors of Plant Pathogens*. Academic Press, London.
3. Maramorosch K and Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*. Academic Press, London.
4. Youdeovei A and Service MW. 1983. *Pest and Vector Management in the Tropics*. English Language Books Series, Longman, London.
5. Basu, A.N. and B.K. Giri. 1993. The essentials of viruses, vectors and plant diseases. Wiley Eastern Limited, New Delhi.242 p.

SUGGESTED WEBSITES

1. https://projects.ncsu.edu/cals/course/ent425/text18/plantvectors.html
2. https://**www.scielo.br/j/bn/a/S4dJymHZB9rTxsYn4K6vrLn/?lang=en**

ENT 513 PRINCIPLES OF ACAROLOGY 1+1

AIM OF THE COURSE

To acquaint 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.

THEORY

Unit I

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Soil arthropods and their classification, habitats and their identification.

Unit II

Introduction to morphology and biology of mites and ticks. Broad classification-major orders and important families of Acari including diagnostic characteristics.

Unit III

Estimation of populations; sampling and extraction methods for soil arthropods. 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. Mites as vectors of diseases in different crop plants.

Unit IV

Management of mites using acaricides, bio-pesticides, phytoseiid predators, fungal pathogens etc. in open field and protected conditions.

Unit V

Culturing of phytophagous, parasitic and predatory mites. Mode of action of acaricides, resistance of mites and ticks to acaricides, its management

PRACTICAL

Collection of mites from plants, soil and animals; extraction of mites from soil, plants and stored 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.

LECTURE SCHEDULE

Unit I

1 Introduction - History and development of Acarology in India and abroad
2 Importance of mites as a group and their habitats
3 Collection and preservation of mites

Unit II

4 General morphology of mites
5 Studies of important orders of mites, families with their diagnostic characters
6 Studies of important orders of mites, families with their diagnostic characters

Unit III

7 Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops
8 **Mid semester examination**

9 Mites as vectors of diseases in different crop plants

10 Bionomics and major mite pests of field crops

Unit IV

11 Mite pests of vegetables and fruit crops

12 Mites pests of Plantation crops

13 Mite pests of Ornamentals, polyhouse and mushrooms

14 Mite pests of honey bees and stored products

Unit V

15 Management of mites using acaricides, bio-pesticides and bio-control agents including phytoseiid predators in open field and protected conditions

16 Acaricide resistance in mites-monitoring and management

17 Techniques for culturing of phytophagous, parasitic and predatory mites

PRACTICAL SCHEDULE

1 Collection of mites from plants, soil and animals

2 Extraction of mites from soil, plants and stored products

3 Preparation of mounting media and slide mounts

4 External morphology of mites

5 Identification of mites using keys – family (Tetranychidae)

6 Identification of mites using keys – family (Eriophyidae)

7 Identification of mites using keys – family (Tenupalpidae and Tarsonemidae)

8 Identification of mites using keys – family (Phytoseiidae)

9 Rearing techniques for phytophagous mites

10 Rearing techniques for predatory mites

11 Use of micrometry, camera lucida and Image Analysis system

12 Studies on morphometric characters (Chaetotaxy)

13 Studies on symptoms of injury / damage caused by phytophagous mites I

14 Studies on symptoms of injury / damage caused by phytophagous mites II

15 Estimation of mite population by different methods

16 Bio-assay techniques for testing of acaricides

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to identify mites up to familylevel.Acquire knowledge of mite pests of cultivated crops, their nature of damage, life history traits and effective management.

SUGGESTED READING

1. Anderson JM and Ingram JSI. 1993. *Tropical Soil Biology and Fertility: A Handbook of Methods.* CABI, London.
2. Chhillar BS, Gulati R and Bhatnagar P. 2007. *Agricultural Acarology*. Daya Publ. House, New Delhi.

3. Dindal DL. 1990. *Soil Biology Guide*. A Wiley-InterScience Publ., John Wiley and Sons, New York.
4. Gerson U and Smiley RL. 1990. *Acarine Biocontrol Agents - An Illustrated Key and Manual*. Chapman and Hall, NewYork.
5. Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.
6. Gwilyn O and Evans GO. 1998. *Principles of Acarology*. CABI, London.
7. Jeppson LR, Keifer HH and Baker EW. 1975. *Mites Injurious to Economic Plants*. University of California Press,Berkeley.
8. Krantz GW. 1970. *A Manual of Acarology.* Oregon State Univ. Book Stores, Corvallis, Oregon.
9. Pankhurst C, Dube B and Gupta, V. 1997. *Biological Indicators of Soil Health.* CSIRO, Australia.
10. Qiang Zhiang Z. 2003. *Mites of Green Houses- Identification, Biology and Control*. CABI, London.
11. Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi. Walter DE and Proctor HC. 1999. *Mites- Ecology, Evolution and Behaviou*r. CABI, London.
12. Veeresh GK and Rajagopal D.1988.*Applied Soil Biology and Ecology*. Oxford and IBH Publ., New Delhi.

SUGGESTED WEBSITES

1. Spider mites web- **https://www1.montpellier.inra.fr/CBGP/spmweb/**
2. **https://keys.lucidcentral.org/keys/v3/spider_mites_australia/index.html.**
3. **https://keys.lucidcentral.org/keys/v3/spider_mites_australia/index.html**
4. https://**www.nhm.ac.uk/hosted_sites/acarology/**
5. **http://www.nhm.ac.uk/hosted_sites/acarology/saas/e-library/**
6. https://**www.awe.gov.au/search?search_api_fulltext=mites**

ENT 514 VERTEBRATE PEST MANAGEMENT 1+1

AIM OF THE COURSE

To impart knowledge on vertebrate pests like birds, rodents, mammals and others of different crops, their biology, damage they cause and management strategies.

THEORY

Unit I

Introduction to vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals.

Unit II

Bio-ecology of birds of agricultural importance, patterns of pest damage and assessment, roosting and nesting systems in birds; management of pestiferous birds; conservation of predatory birds.

Unit III

Bio-ecology of rodents of agricultural importance, patterns of pest damage and assessment, burrowing pattern and habitat of rodents; management of pestiferous rodents.

Unit IV

Bio-ecology of higher vertebrates of agricultural importance, patterns of damage and assessment, their habitat; management of pestiferous vertebrates.

Unit V

Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods - Operational practices- baiting, equipments and educative programmes.

PRACTICAL

Identification of important rodents, birds and other vertebrate pests of agriculture, food preference and hoarding, social behaviour, damage assessment, field survey, population estimation, management strategies: preventive and curative methods.

LECTURE SCHEDULE

Unit I

1 Introduction to vertebrate pests of different crops
2 Biology of rodents
3 Biology of birds and other mammals

Unit II

4 Bio-ecology of birds of agricultural importance
5 Patterns of pest damage by birds and assessment
6 Roosting and nesting systems in birds
7 Management of pestiferous birds
8 **Mid semester examination**
9 Conservation of predatory birds

Unit III

10 Bio-ecology of rodents of agricultural importance and patterns of pest damage by rodents and assessment
11 Burrowing pattern and habitat of rodents, management of pestiferous rodents

Unit IV

12 Bio-ecology of higher vertebrates of agricultural importance

13 Patterns of damage and assessment, their habitat

14 Management of pestiferous vertebrates

Unit V

15 Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites)

16 Management strategies- cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods

17 Operational practices - baiting, equipments and educative programmes

PRACTICAL SCHEDULE

1 Identification of important rodent pests of agriculture

2 Identification of important bird pests of agriculture

3 Identification of important vertebrate pests of agriculture

4 Food preference and hoarding, social behaviour of rodents

5 Food preference and hoarding, social behaviour of birds

6 Food preference and hoarding, social behaviour of vertebrate pests of agriculture

7 Damage assessment by rodent pests of agriculture

8 Damage assessment by rodent pests of agriculture

9 Damage assessment by birds pests of agriculture

10 Damage assessment by vertebrate pests of agriculture

11 Field survey, population estimation of rodents

12 Field survey, population estimation of bird pests of agriculture

13 Field survey, population estimation of vertebrate pests of agriculture

14 Management strategies: preventive and curative methods for rodents

15 Management strategies: preventive and curative methods for birds

16 Management strategies: preventive and curative methods for vertebrate pests of agriculture

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to be well versed with vertebrate pest diversity, their nature of damage, life history traits, behaviour and effective management.

SUGGESTED READING

1. Rahman, A. 2020. *Protective and Productive Entomology* Narendra Publishing House, New Delhi
2. Fitzwater WD and Prakash I. 1989. *Handbook of Vertebrate Pest Control.* ICAR, New Delhi.
3. Prakash I and Ghosh PK.1997. *Rodents in Indian Agriculture*. Vol. I. State of Art Scientific Publ., Jodhpur.
4. Prakash I and Ghosh RP.1987. *Management of Rodent Pests.* ICAR, New Delhi.

5. Prater SH. 1971. *The Book of Indian Animals*. The Bombay Natural History Society, Bombay.
6. Ali S. 1965. *The Book of Indian Birds*. The Bombay Natural History Society, Bombay.

SUGGESTED WEBSITES

1. https://escholarship.org/content/qt7hw2r9p9/qt7hw2r9p9.pdf?t=plu1fh
2. https://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harve_Pests-Vertebrates.pdf

ENT 515 TECHNIQUES IN PLANT PROTECTION 0+1

AIM OF THE COURSE

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopy, computation, pest forecasting, etc.

PRACTICALS

Unit I

Pest control equipments, principles, operation, maintenance, selection, and application of pesticides; release of bio-control agents; seed dressing, soaking, root-dip treatment, dusting, spraying, and pesticide application through irrigation water; application of drones in plant protection.

Unit II

Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers.

Unit III

Uses of light, transmission and scanning electron microscopy.

Unit IV

Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

Unit V

Use of tissue culture techniques in plant protection. Computer application for predicting/ forecasting pest attack and identification.

LECTURE SCHEDULE

Unit I

1 Knowledge of pest problem. Pest control equipments - principles, operation, maintenance, spray nozzles and their classification, spray droplets, sampling and measurement

2 Different types of pesticide formulation, Selection and pesticide application methods – Seed dressing, soaking, root-dip treatment

3 Different types of release techniques in bio-control agents

Unit II

4 Dusters and dust applications and pestigation techniques

5 Types and techniques of sprayers and spraying

6 Application of drones in plant protection

Unit III

7 Soil sterilization, solarization techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers. Deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers

8 **Mid semester examination**

9 Microscopic techniques, Electron microscopy – SEM and TEM

10 Protein isolation from the pest and host plant and its quantification using spectrophotometer

Unit IV

11 Molecular weight determination of Protein using SDS PAGE

12 Use of tissue culture techniques in plant protection

13 Forecasting models, EIL, ETL and methods

Unit V

14 Computer application for forecasting pest occurrence

15 Computer application for identification of insects

16 Computer application for identification of insect damages

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to have a good knowledge of different plant protection equipments and techniques related to pest forecasting.

SUGGESTED READING

1. Alford DV. 1999. *A Textbook of Agricultural Entomology.* Blackwell Science, London.
2. Crampton JM and Eggleston P. 1992. *Insect Molecular Science.* Academic Press, London.

SUGGESTED WEBSITES

1. https://niphm.gov.in/Recruitments/PHE-ASO-Manual-22042013.pdf

ENT 516 APICULTURE 2+1

AIM OF THE COURSE

To impart knowledge about the honey bees, and their behaviour and activities; bee husbandry, bee multiplication, bee enemies and diseases and their management; hive products, and managed bee pollination of crops.

Unit I

Historical development of apiculture at global level and in India; Classification of bees; global distribution of genus *Apis* and races; Morphology and anatomy of honey bee; Honey bee biology, ecology, adaptations; Honey bee behaviour – nest founding, comb construction, brood care, defense, other in-house and foraging activities; Bee pheromones; Honey bee communication.

Unit II

Commercial beekeeping as an enterprise; Design and use of bee hives; Apicultural equipment; Seasonal bee husbandry; Honey bee nutrition and artificial diets; Absconding, swarming, drifting – causes and management; Curbing drone rearing; Laying worker menace – causes, signs and management

Unit III

Bee genetics; Principles and procedures of bee breeding; Screening of honey bee colonies; Techniques in mass queen bee rearing; Mating nuclei and their establishment; Selective mating; Queen bee management; Bee packages

Unit IV

Ectoparasitic and endo parasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics; Wax moths, wasps and ants - biology, ecology, nature and symptoms of damage, management tactics; Predatory birds, their damage potential and management tactics; Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees

Unit V

Honey – composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification – potential and profitability; Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling; Apitherapy; Value addition of hive products; Development of apiculture project. Non-*Apis* pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops

PRACTICAL

Morphological characteristics of honey bee; mouthparts; digestive, respiratory and reproductive adaptations in different castes of honey bees; recording of colony performance; seasonal bee husbandry practices; swarming, queenlessness, swarming, laying workers menaces, etc. & their remedies; innovative techniques in mass queen bee rearing; selection and breeding of honey bees; instrumental insemination; formulation of

artificial diets and their feeding; production technologies for various hive products; bee enemies and diseases and their management; recording pollination efficiency; application of various models for determining pollination requirement of crop; developing a beekeeping project.

LECTURE SCHEDULE

Unit I

1 Historical development of apiculture at global level and in India
2 Classification of bees; global distribution of genus Apis and races
3 Morphology and anatomy of honey bee
4 Honey bee biology, ecology, adaptations
5 Honey bee behaviour – nest founding, comb construction, brood care, defense, other in- house and foraging activities
6 Bee pheromones
7 Honey bee communication

Unit II

8 Commercial beekeeping as an enterprise
9 Design and use of bee hives
10 Apicultural equipment
11 Seasonal bee husbandry
12 Honey bee nutrition and artificial diets
13 Absconding, swarming, drifting – causes and management
14 Non-Apis pollinators, their augmentation and conservation
15 Curbing drone rearing; Laying worker menace – causes, signs and management

Unit III

16 Bee genetics; Principles and procedures of bee breeding
17 **Mid semester examination**
18 Screening of honey bee colonies
19 Techniques in mass queen bee rearing
20 Mating nuclei and their establishment
21 Selective mating; Queen bee management
22 Bee packages

Unit IV

23 Ectoparasitic and endoparasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics
24 Wax moths, wasps and ants - biology, ecology, nature and symptoms of damage, management tactics
25 Predatory birds, their damage potential and management tactics
26 Pesticide poisoning to honey bees, signs and protection
27 Protocols in evaluation of pesticide toxicity to honey bees
28 Honey – composition, properties, crystallization, post-harvest handling and

processing

Unit V

29 Honey quality standards and assessment

30 Apicultural diversification – potential and profitability

31 Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling

32 Apitherapy; Value addition of hive products

33 Development of apiculture project

34 Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops

PRACTICAL SCHEDULE

1 Morphological characteristics of honey bee; mouthparts

2 Digestive system, respiratory and reproductive adaptations in different castes of honey bees

3 Recording of colony performance

4 Seasonal bee husbandry practices

5 Swarming management

6 Queenlessness, laying workers menaces, etc. & their remedies

7 Innovative techniques in mass queen bee rearing

8 Selection and breeding of honey bees

9 Instrumental insemination

10 Formulation of artificial diets and their feeding

11 Production technologies for various hive products; honey, pollen, beeswax

12 Production technologies for various hive products; royal jelly, propolis and bee venom

13 Bee enemies and their management

14 Bee diseases and their management

15 Recording pollination efficiency, Application of various models for determining pollination requirement of crop

16 Developing a beekeeping project

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to have a comprehensive knowledge of bee biology, physiology and beekeeping/ apiculture. With practical training it is expected that students develop entrepreneurial skills for apiculture.

SUGGESTED READING

1. Abrol DP & Sharma D. 2009. *Honey Bee Mites & Their Management.* Kalyani Publishers, New Delhi, India.

2. Abrol DP. 2009. *Honey bee Diseases & Their Management*. Kalyani Publishers, New Delhi, India.
3. Abrol DP. 2010. *Beekeeping: A Compressive Guide to Bees and Beekeeping*. Scientific Publishers, India.
4. Abrol DP. 2010. *Bees and Beekeeping in India*. Kalyani Publishers, New Delhi, India.
5. Abrol DP. 2012. *Pollination Biology: Biodiversity Conservation and Agricultural Production.* Springer
6. Atwal AS 2001. *World of Honey Bees.* Kalyani Publishers, New Delhi- Ludhiana, India.
7. Atwal AS. 2000. *Essentials of Beekeeping and Pollination*. Kalyani Publishers, New Delhi-Ludhiana, India.
8. Bailey L & Ball BV. 1991. *Honey Bee Pathology*. Academic Press, London.
9. Crane Eva & Walker Penelope. 1983. *The Impact of Pest Management on Bees and Pollination.* Tropical Development and Research and Institute, London.
10. Free JB. 1987. *Pheromones of Social Bees.* Chapman and Hall, London.
11. Gatoria GS, Gupta JK, Thakur RK & Singh Jaspal. 2011. *Mass Multiplication of Honey Bee Colonies.* ICAR, New Delhi, India.
12. Grahm Joe M. 1992. *Hive and the Honey Bee.* Dadant & Sons, Hamilton, Illinois, USA.
13. Grout RA. 1975. *Hive and the Honey Bee.* Dadant & Sons, Hamilton, Illinois, USA. Holm E. 1995. *Queen Rearing Genetics & Breeding of Honey Bees.* Gedved, Denmark.
14. Laidlaw HH Jr & Eckert JE 1962. *Queen Rearing*. Berkeley, University of California Press.
15. Laidlaw HH. 1979. *Contemporary Queen Rearing.* Dadant & Sons, Hamilton, Illinois, USA.
16. Mishra RC 2002. *Perspectives in Indian Apiculture*. Agro-Botanica, Jodhpur, India.
17. Mishra RC. 1995. *Honey Bees and their Management in India.* I.C.A.R., New Delhi, India.
18. Morse AA. 1978. *Honey Bee Pests, Predators and Diseases*. Cornell University Press, Ithaca and London.
19. Rahman, A. 2017. *Apiculture in India*, ICAR, New Delhi
20. Ribbands CR. 1953. *The Behaviour and Social Life of Honey Bees*. Bee Research Association Ltd., London, UK.
21. Rinderer, TE. 1986. *Bee Genetics and Breeding.* Academic Press, Orlando.
22. Sardar Singh 1962. *Beekeeping in India*. I.C.A.R., New Delhi, India (Reprint: 1982).
23. Seeley TD. 1985. *Honey Bee* Ecology. Princeton University Press, 216 pp.
24. Snodgrass RE. 1925. *Anatomy and Physiology of the Honey Bee*. Mc Graw Hill Book Co., New York & London.
25. Snodgrass RE. 1956. *Anatomy of the Honey Bee*. Comstock Publishing Associates, Cornell Univ. Press, Ithaca, New York

SUGGESTED WEBSITES

1. https://www.nal.usda.gov/legacy/afsic/beekeeping
2. https://www.thespruce.com/beekeeping-for-beginners-step-by-step-3016540
3. Bee Built: Beekeeping For Beginners**:**https://beebuilt.com/pages/beekeeping-for-beginners

ENT 517 SERICULTURE 2+1

AIM OF THE COURSE

To familiarize the students with entrepreneurial opportunities in entomology, sericulture in particular, and providing information on silk worm rearing, production and management.

THEORY

Unit I

History of Sericulture, importance, organizations involved in sericulture activities, silkworm types, distribution, area and silk production.

Unit II

Mulberry species, ecological requirements, cultivation, improved varieties, propagation methods, sapling production, planting and pruning techniques; pest and diseases, management strategies; intercropping, water and weed management. Food plants of eri silkworm, castor cultivation, intercultural operations, nutrient and water management; method of harvest; host plants of Tasar, nursery and cultivation, selection of seed, soaking and heap making, pruning techniques. Food plants of Muga silkworm, Som and Soalu propagation methods; nursery techniques; intercultural operations and weed management.

Unit III

Silkworm origin – classification based on voltinism, moultinism, geographical distribution and genetic nature – pure races –multivoltine and bivoltine races –cross breeds – bivoltine hybrids –Races and hybrids of mulberry, eri, tasar and muga silkworm-Morphology and biology of silkworm, sex limited characters; anatomy of digestive and excretory systems of larva; structure and function of silk glands.

Unit IV

Rearing house, types, disinfection, room and bed disinfectants; egg incubation methods, Chawki rearing, feeding, cleaning and spacing; rearing of late age worms, feeding, cleaning, spacing and moulting care; mountages, cocoon harvesting and marketing; pests and diseases of silkworms and their management.

Unit V

Post cocoon technology, stifling, cocoon cooking, brushing, reeling, re-reeling, bleaching, degumming, dyeing, printing and weaving, different reeling machines; value addition in sericulture; economics of sericulture.

PRACTICAL

Morphology of mulberry plants – Identification of popular mulberry genotypes – Nursery bed and main field preparation – planting methods – Identification of nutrient deficiency symptoms – Identification of weeds– pruning and harvesting methods – Identification of pests and diseases of mulberry–*Terminalia arjuna, Terminalia tomentosa,* Som and Soalu- Nursery and pruning techniques – Intercultural operations.

Morphology of silkworm – Identification of races – Dissection of mouth parts and silk glands – Disinfection techniques – rearing facilities – silkworm rearing – feeding, cleaning and spacing – Identification of pests and diseases of mulberry silkworm – hyperparasitoids and mass multiplication techniques – silkworm egg production technology –Tasar, Eri and muga silkworms – rearing methods–pests and diseases of non-mulberry silkworms - Visit to grainage, cocoon market and silk reeling centre – Economics of silkworm rearing.

LECTURE SCHEDULE

Unit I

1 History of sericulture and its importance
2 Organizations involved in sericulture activities
3 Silkworm types, distribution
4 Status of silk production in India
5 Mulberry species and ecological requirements for mulberry cultivation
6 Improved varieties, propagation methods, sapling production, planting and pruning techniques in mulberry cultivation
7 Pests of mulberry and their management

Unit II

8 Diseases of mulberry and their management
9 Intercropping, water and weed management in mulberry
10 Food plants of Eri silkworm - castor cultivation, intercultural operations, nutrient and water management; method of harvest
11 Host plants of Tasar silkworm - nursery and cultivation, selection of seed, soaking and heap making, pruning techniques
12 Food plants of Muga silkworm - Som and Soalu propagation methods; nursery techniques - intercultural operations and weed management
13 Silkworm origin – classification based on voltinism and moultinism
14 Silkworm origin – classification based on geographical distribution and genetic nature

Unit III

15 Pure races - multivoltine and bivoltine races; Cross breeds - bivoltine hybrids

16 Races and hybrids of mulberry and eri silk worm

17 **Mid semester examination**

18 Races and hybrids of tasar and muga silkworm

19 Morphology and biology of silkworm, sex limited characters

20 Anatomy of digestive systems of larva

21 Anatomy of excretory systems of larva

Unit IV

22 Structure and function of silk glands

23 Silk worm rearing house and types

24 Disinfection in silk worm rearing - room and bed disinfectants

25 Egg incubation methods in silk worm rearing

26 Chawki rearing - feeding, cleaning and spacing

27 Rearing of late age worms - feeding, cleaning, spacing

28 Moulting care in silk worm rearing

Unit V

29 Mountages, cocoon harvesting and marketing

30 Pests of silkworms and their management

31 Diseases of silkworms and their management

32 Post cocoon technology - stifling, cocoon cooking, brushing, reeling, re-reeling, bleaching, degumming, dyeing, printing and weaving - different reeling machines

33 Value addition in sericulture

34 Economics of sericulture

PRACTICAL SCHEDULE

1 Morphology of mulberry plants and identification of popular mulberry genotypes

2 Nursery bed and main field preparation and planting methods

3 Identification of nutrient deficiency symptoms, identification of weeds, pruning and harvesting methods

4 Identification of pests and diseases of mulberry

5 Nursery and pruning techniques - Intercultural operations - *Terminalia arjuna, Terminalia tomentosa*

6 Nursery and pruning techniques - Intercultural operations - Som and Soalu

7 Morphology of silkworm and identification of races

8 Dissection of mouth parts and silk glands

9 Rearing facilities in silkworm rearing - feeding, cleaning, spacing and disinfection techniques

10 Identification of pests and diseases of mulberry silkworm

11 Hyper parasitoids and mass multiplication techniques

12 Silkworm egg production technology - Tasar, Eri and muga silkworms

13 Rearing methods - Tasar, Eri and Muga silkworms
14 Pests and diseases of non-mulberry silkworms
15 Visit to grain age, cocoon market and silk reeling centre
16 Economics of silkworm rearing
17 **Final practical examination**

LEARNING OUTCOME

Students taking up sericulture are expected to have a thorough knowledge of silkworm morphology, races, biology, and all the practices of rearing for silk production. They should be well versed with the pests and diseases of silkworm and their management. With practical training it is expected that students develop entrepreneurial skills for sericulture or link up with industries to sell cocoons for silk production or guide farmers engaged in silk worm rearing/sericulture.

SUGGESTED READING

1. Dandin, S.B. and K. Giridhar. 2014. *Hand book of Sericulture Technologies*. Central Silk Board, Bangalore, 423p.
2. Govindaiah., G, V.P., Sharma, D.D., Rajadurai, S. and V. NishitaNaik. 2005. *A text book on mulberry crop protection*. Central Silk Board, Bangalore.450 p.
3. Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar. 2005. *Silkworm crop protection*. CSB, Bangalore. 412 pp.
4. Mohanty, Prafulla Kumar. 2003. *Tropical wild cocoons of India*. Daya Publications, Tri Nagar, New Delhi, 197 p.
5. Mahadevappa, D., V.G. Halliyal, D.G. Shankar and Ravindra Bhandiwad. 2000. *Mulberry Silk Reeling Technology*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. 234 p.
6. Jolly, M.S., S.K. Sen, T.N. Sonwalkar and G.K. Prasad 1980. *Non–mulberry Silks*. FAO Agicultural Services Bulletin 29. Food and Agriculture Organization of the United Nations, Rome, 178 p.
7. Rangaswami,G., Narasimhanna, M.N., Kasiviswanathan.K., Sastry, C.R. and M.S. Jolly. 1976.*Food Plants of non-mulberry silkworms. In: Mulberry cultivation*. FAO Agricultural Services Bulletin .Vol.1, Chapter-13. Rome, Italy. 96 p.
8. Tribhuvan Singh and Saratchandra, B. 2004. *Principles and Techniques of silkworm seed production*. Discovery publishing House, New Delhi, 360 pp.

SUGGESTED WEBSITES:

1. www.silkwormgenomics.org**;**
2. www.silkboard.com**;**
3. www.silkgermplasm.com;

ENT 518 LAC CULTURE 2+1

AIM OF THE COURSE

To familiarize the students with entrepreneurial opportunities in entomology with an emphasis on lac culture in particular. To provide information on lac insect rearing, production and management.

THEORY

Unit I

History of lac production; importance, potential of lac production in India; organizations involved in lac production activities; strains of lac insects and lac crops – distribution, area and production of different strains of lac.

Unit II

Steps and operation of lac production; lac host plant species, ecological requirements, their cultivation; seasons of host plants, harvest time of host plants, rearing seasons; grouping of host trees, pruning methods, timing; lac host plant pests and diseases; management strategies.

Unit III

Basic morphology and taxonomy of lac insect, strains of lac insect and their characteristics; composition of lac; biology of lac insect, species diversity and distribution

Unit IV

Introduction, lac insect-host plant interaction; selection of brood lac, local practices, improved alternatives, coupe system; propagation of lac insects: natural self inoculation, artificial inoculation; inoculation process and duration; removal of phunki, harvesting of lac, immature harvesting, mature harvesting and time of harvesting. Predators and parasitoids of lac insect, hyperparasites, diseases and their management.

Unit V

Lac production stages; factors affecting yield and quality of shellac. Pure stock of host plants (*kusum*, *palas*, *ber*, pigeonpea, semialata); alternative method; technology of brood preserving. Host-specific technologies - cultivation on specific host plants; integration of lac cultivation with agro-forestry and horticulture; socio- economic potential of lac; export-import of lac/ lac products; marketing of lac and its products. Lac processing and value addition; entrepreneurship development.

PRACTICAL

Lac host cultivation and lac production practices; equipments for lac production; conventional and advanced methods; coupe system of lac production; cultivation of suitable host plants; pruning of host trees; herbarium of host plants; strains of lac insects; brood lac selection and treatment for pest management; slide preparation of adult and immature stages; inoculation of host tree; identification of natural enemies of lac insect and their management; molecular characterization of lac insect where possible;

harvesting; process of manufacture of seed lac, shell lac from stick lac; grading of seed lac and shellac; marketing of lac products and by products.

LECTURE SCHEDULE

Unit	
1	History of lac production; importance, potential of lac production in India
2	Organizations involved in lac production activities
3	Strains of lac insects and lac crops – distribution, area and production of different strains of lac
4	Steps and operation of lac production
5	Lac host plant species, ecological requirements, their cultivation
6	Seasons of host plants, harvest time of host plants, rearing seasons grouping of host trees.
7	Different pruning methods, timing of pruning
Unit I	
8	Lac host plant pests and diseases and management strategies
9	Basic morphology and taxonomy of lac insect
10	Strains of lac insect
11	Characteristics of lac insect and composition of lac
12	Biology, species diversity and distribution of lac insect
13	Lac insect-host plant interaction
14	Selection of brood lac, local practices, improved alternatives
Unit III	
15	Coupe system of brood lac cultivation
16	Propagation of lac insects - natural self inoculation
17	**Mid semester examination**
18	Propagation of lac insects - artificial inoculation
19	Lac insect inoculation process and duration; removal of phunki
20	Harvesting of lac - immature harvesting
21	Harvesting of lac - mature harvesting and time of harvesting
Unit IV	
22	Predators of lac insect
23	Parasitoids of lac insect
24	Hyperparasites, diseases and their management
25	Stages of lac production
26	Factors affecting yield and quality of shellac
27	Cultivation of pure stock of host plants (kusum, palas, ber, pigeonpea, semialata) - alternative method
28	Brood preserving technologies
Unit V	

29 Host-specific technologies - cultivation on specific host plants
30 Integration of lac cultivation with agro-forestry and horticulture
31 Socioeconomic potential of lac
32 Export - import of lac/ lac products
33 Marketing of lac and its products
34 Lac processing and value addition; entrepreneurship development

PRACTICAL SCHEDULE

1 & 2 Practising different lac host cultivation methods
3 Learning different lac production practices
4 & 5 Learning about different lac culture appliances
6 Practising coupe system of lac production
7 Learning different host plant cultivation and pruning methods
8 Observing different strains of lac insects
9 Learning brood lac selection methods
10 Practising slide preparation of adult and immature stages of lac insects
11 & 12 Practising different methods of lac insect inoculation
13 Identification of natural enemies of lac insect
14 Molecular characterization of lac insect
15 Learning different process of manufacture of seed lac, shell lac from stick lac
16 Studying the grading seed lac and shellac
17 **Final practical examination**

LEARNING OUTCOME

- The students are expected to have good knowledge of lac host trees and their maintenance for lacproduction.
- It is expected that they should perfect the most suitable techniques for lac producton with a good knowledge about diseases and natural enemies of the lac insect.
- With practical training it is expected that students are able to guide landless labourers, who bring stick lac as forest produce.

SUGGESTED READING

1. David, B. V. and Ramamurthy, V. V. 2011. *Elements of Economic Entomology*, 6th Edition, Namrutha Publications, Chennai.
2. Sharma, K.K. and Ramani, S. 2010. *Recent advances in lac culture*. ICAR – IINRG, Ranchi.
3. Ghorai, N. 2020. Lac culture in India. Sathish Serial Publishing House, New Delhi.

SUGGESTED WEBSITES

1. **www.nsdl.niscair.res.in** / **www.** egov.uok.edu.in

ENT 519 BIOTECHNOLOGICAL APPROACHES IN ENTOMOLOGY 2+1

AIM OF THE COURSE

To acquaint students the latest techniques used in molecular biology.

THEORY

Unit I

Introduction to molecular biology, techniques used in molecular biology.

Unit II

DNA recombinant technology, identification of genes/nucleotide sequences for traits of interest, techniques of interest in plants and microbes.

Unit III

Genes of interest in entomological research- marker genes for sex identification, peptides and neuropeptides, JH esterase, St toxins and venoms, chitinase, Plant-derived enzyme inhibitors, protease inhibitors, trypsin inhibitors, α-amylase inhibitors, lectins, terepenes and terpenoids; genes of non-plant origin, *Bacillus thuringiensis* endotoxins, mode of action of cry genes, classification and properties, synthetic Bt toxin genes, Other toxin genes, genes derived from entomophagous viruses, transgenic plants for pest resistance.

Unit IV

Genetically engineered microbes and parasitoids in biological control-Genetic engineering in baculoviruses and fungal biocontrol agents for greater efficacy against insect pests. Effects of transgenic plants on pest biology and development, resistance management strategies in transgenic crops, molecular mechanism of insecticide resistance.

Unit V

Genetic-based methods for agricultural insect pest management-insect pest management through sterile insect technique and release of insects carrying a dominant lethal gene. Methods and application of insect transgenesis, transgenics in silkworm and honeybees. Molecular tools for taxonomy and phylogeny of insect- pests, DNA-based diagnostics. Nano technology and its application.

PRACTICAL

Isolation of DNA/RNA; agarose gel electrophoresis of DNA, quantification of DNA by spectrophotometirc and agarose gel analysis, PCR amplification of mitochondrial cytochrome oxidase sub unit I gene (cox1) and 16 Sr RNA gene, cloning of PCR amplicons in standard plasmid vectors for sequencing, confirmation of the insert, miniprep of recombinant plasmid DNA, BLAST analysis and multiple sequence alignment of the

sequence with sequences already available in GenBank; isolation of host plant proteins, SDS-PAGE of the isolated proteins.

LECTURE SCHEDULE

Unit I

1 Introduction to molecular biology
2 Basic structure of DNA and RNA
3 Central dogma of life – DNA Replication
4 Central dogma of life – Transcription
5 Central dogma of life – Translation
6 Techniques used in molecular biology

Unit II

7 Recombinant DNA technology and vectors used in DNA technology
8 DNA modifying enzymes
9 Identification of genes/nucleotide sequences for traits of interest in plants and microbes
10 Genes of interest in entomological research
11 Marker genes for sex identification
12 Genes for Peptides and neuropeptides
13 JH esterase, St toxins and venoms, chitinase genes

Unit III

14 Plant-derived enzyme inhibitors, protease inhibitors, trypsin inhibitors, α-amylase inhibitors, lectins
15 Terpenes and terpenoids
16 Genes of non-plant origin, *Bacillus thuringiensis* α-endotoxins, mode of action of cry genes
17 **Mid semester examination**
18 Classification and properties of Cry proteins, synthetic Bt toxin genes
19 Other toxin genes, genes derived from entomophathogenic viruses
20 Transgenic plants for pest resistance

Unit IV

21 Genetically engineered microbes and parasitoids in biological control
22 Genetic engineering in baculoviruses for greater efficacy
23 Genetic engineering in fungal biocontrol agents for greater efficacy
24 Effects of transgenic plants on pest biology and development
25 Resistance management strategies in transgenic crops
26 Molecular mechanism of insecticide resistance
27 Genetic-based methods for agricultural insect pest management

Unit V

28 Insect pest management through sterile insect technique and release of insects carrying a dominant lethal gene

29 Methods and application of insect trangenesis
30 Transgenics in silkworm
31 Transgenics in honeybees
32 Molecular tools for taxonomy and phylogeny of insect pests
33 DNA-based diagnostics and DNA bar coding
34 Nano-technology and its application

PRACTICAL SCHEDULE

1 Preparation of buffers and solutions for DNA isolation
2 Isolation of DNA/RNA
3 Agarose gel electrophoresis of DNA
4 Quantification of DNA by spectrophotometer and agarose gel analysis
5 PCR amplification of mitochondrial cytochrome oxidase sub gene (COI) in insects and 16Sr RNA gene from Bt
6 PCR amplification of *cry* genes from Bt
7 Cloning of PCR amplicons in standard plasmid vectors for sequencing
8 Confirmation of the insert
9 Miniprep of recombinant plasmid DNA
10 Restriction digestion of DNA and agarose gel electrophoresis
11 Isolation of host plant proteins/Cry proteins from Bt
12 SDS-PAGE of the isolated proteins
13 RFLP analysis of genomic DNA from insects
14 RAPD analysis of insect DNA from insects
15 BLAST analysis and multiple sequence alignment of the sequence with sequences already available in Gen Bank
16 NTSys diversity analysis and tree joining
17 **Final practical examination**

LEARNING OUTCOME

The students are expected to be well versed with the basic techniques used in molecular biology.

SUGGESTED READING

1. Bhattacharya TK, Kumar P and Sharma A. 2007. *Animal Biotechnology*. 1st Ed., Kalyani Publication, New Delhi.
2. Hagedon HH, Hilderbrand JG, Kidwell MG and Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.
3. Oakeshott J and Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer Verlag.
4. Rechcigl JE and Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.* Lewis Publ., NorthCarolina.
5. Roy U and Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ.,

New Delhi.
6. Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ., New Delhi.
7. Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.
8. Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.

SUGGESTED WEBSITES

1. http://www.ncbi.nlm.nih.gov/books/NBK143764/
2. https://www.isaaa.org/resources/publications/agricultural_biotechnology/download/ Agricultural_Biotechnology.pdf
3. https://freebookcentre.net/Biology/BioTechnology-Books.html
4. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1057&context= entodistmasters
5. https://q-more.chemeurope.com/q-more-articles/207/learning-from-insects.html

ENT 520 PLANT QUARANTINE, BIO-SAFETY AND BIO-SECURITY 2+0

AIM OF THE COURSE

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up. Also, to facilitate students to have a good understanding of the aspects of biosafety and biosecurity.

THEORY

Unit I

Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

Unit II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. Insecticide regulatory bodies, synthetic insecticides, bio-pesticides and pheromone registration procdures. History of quarantine legislations, PQ Order 2003.Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

Unit III

Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to

detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

Unit IV

WTO regulations; non-tariff barriers; pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; sanitary and phytosanitary measures.

Unit IV

Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agro terrorism event, mitigation planning, integrated approach for biosecurity. Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, issues related to release of genetically modified crops.

LECTURE SCHEDULE

Unit I

1 History of Plant quarantine at national level - Definition of pest, pesticides and transgenics as per Govt. notification
2 History of Plant quarantine at international level
3 Basic concepts of bio safety and biosecurity
4 Case histories of exotic pests/diseases and their status
5 Domestic quarantine regulations in the movement of agricultural produce, seeds, planting materials and bioinoculants
6 International quarantine regulations in the movement of agricultural produce, seeds, planting materials and bioinoculants
7 Plant Protection Organization in India

Unit II

8 Acts related to registration of pesticides and transgenics
9 Insecticide regulatory bodies, synthetic insecticides, bio-pesticides and pheromone registration procedures
10 History of quarantine legislations
11 PQ Order 2003
12 Post Entry Quarantine
13 Environmental Acts, Industrial registration
14 APEDA, Import and Export of bio-control agents

Unit III

15 Identification of pest/disease free areas
16 Identification of pest/disease free areas
17 **Mid semester examination**
18 Contamination of food with toxicogens, microorganisms and their elimination
19 Symptomatic diagnosis and other techniques to detect pest infestations
20 Symptomatic diagnosis and other techniques to detect pathogen infestations

21 VHT and other safer techniques of disinfestations /salvaging of infected material

Unit IV

22 WTO regulations; non-tariff barriers

23 Pest Risk Analysis (PRA)

24 Good laboratory practices for pesticide laboratories

25 Pesticide Industry

26 Sanitary and phytosanitary measures

27 Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity

28 Pest/disease and epidemic management

Unit V

29 International Agreements related to biosecurity and biosafety

30 Strategies for combating risks and costs associated with agro terrorism event

31 Mitigation planning, integrated approach for biosecurity

32 Biosafety, policies and regulatory mechanism

33 Cartagena Protocol on Biosafety and its implications

34 Issues related to release of genetically modified crops

LEARNING OUTCOME

- Students offering this course are expected to have a good knowledge of the rules and regulations of Plant Quarantine, WTO regulations, GAP, Sanitary and Phytosanitary measures.

SUGGESTED READING

1. Rajeev K and Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.
2. Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental), CRC Press.
3. Shukla, A. and Veda, O.P. 2007. *Introduction to Plant Quarantine*. Samay Prakashan, New Delhi.

SUGGESTED WEBSITES

1. http://www.plantquarantineindia.org
2. http://www.ippc,int/
3. http://www.fao,org
4. **http://www.plantquarantineindia.org/PQO** amendments.html
5. ttp://www.fao.org/biosecurity/

ENT 521 EDIBLE AND THERAPEUTIC INSECTS 2 1+1

AIM OF THE COURSE

To create awareness and acquaint students about the contribution that insects make to ecosystems, diets, food security and livelihoods in developed and developing countries.

THEORY

Unit I

Edible and therapeutic insects: the concept, definition, and importance. History and origin of insects as food, feed and medication; important insect species and insect products consumed.

Unit II

Edible insect ecology, conservation and management of edible insect resources; environmental opportunities of insect rearing

Unit III

Nutritional composition and role of insects in food security

Unit IV

Insect farming: the concept, definitions, and rearing techniques. Processing edible insects for food and feed

Unit V

Food safety and preservation, edible insects for livelihood security

PRACTICAL

Survey and identification of edible and therapeutic insect species; collection and preservation of edible and therapeutic insect specimens; rearing techniques of edible insect species; harvesting techniques of edible insects from natural environment; analysis of proximate elemental composition, antioxidant and anti-nutritional properties and microbial aspects of preservation.

LECTURE SCHEDULE

Unit I

1 Entomophagy-edible insects as a food source, concepts and definition
2 History and origin of insects as food
3 Different types edible insects and their nutritional value

Unit II

4 Dietary energy content of edible insects
5 Edible insects as feed and medication
6 Benefits of edible insects economically and environmentally

7 Therapeutic insects definition and concepts
8 Mid semester examination

Unit III

9 Edible insect ecology
10 Conservation and management of edible insect resources
11 Environmental opportunities of insect rearing

Unit IV

12 Nutritional composition of major edible insects
13 Utilization of edible insects & role of insects in food security
14 Insect farming: the concept, definitions

Unit V

15 Medicinal value of edible insects.
16 Food safety and preservation of edible insects
17 Edible insects for livelihood security

PRACTICAL SCHEDULE

1 Survey and identification of edible and therapeutic insect species
2 Edible insect density, diversity and abundance
3 Collection of edible and therapeutic insect specimens
4 Estimation of protein and amino acid content of some common edible insects
5 Fat and carbohydrate estimation of edible insects
6 Estimation of mineral composition of edible insects
7 Rearing techniques of edible insect species
8 Organoleptic analysis of edible insects
9 Harvesting techniques of edible insects
10 Different preservation techniques of edible and therapeutic insect specimens
11 Analysis of elemental composition of edible and therapeutic insect specimens
12 Antioxidant and anti-nutritional properties of edible insects
13 Processing edible insects for food and feed
14 Traditional and Innovative Technologies on edible insects processing
15 Microbiological analysis of edible insect
16 Microbial preservation of edible and therapeutic insects
17 **Final practical examination**

LEARNING OUTCOME

Students are expected to be aware of insects for edible and therapeutic use; their nutritional composition. Should know the techniques of farming and processing insects for human and animal consumption.

SUGGESTED READING

1. Van Huis, A; Itterbeeck, J.K; Klunder, H; Mertens, E; Halloran, A; Muir, G and Vantomme. 2013. *Edible insects: future prospects for food and feed security*. Food

and Agricultural Organization of the United Nations, Rome.
2. Halloran, A; Flore, R; Vantomme, P and Roos, N. 2018. *Edible insects in sustainable food systems*.

SUGGESTED READING

1. https://doi.org/10.1186/s43014-019-0008-1**.**

ENT 522 MEDICAL AND VETERINARY ENTOMOLOGY 1+1

AIM OF THE COURSE

To study the major insect, mite, and tick vectors of disease to man and animals. Students will learn to identify and understand the life cycles, morphology, and behavior of mosquitoes, ticks, mites, lice, fleas, and other disease vectors.

THEORY

Unit I

Introduction to medical, veterinary and forensic entomology; Classification of Arthropod-borne diseases; Hematophagy, disease transmission and epidemiology; flies (Diptera) of medical and veterinary Importance; moth flies: Leishmaniasis and Bartonellosis; biting midges (Ceratapogonidae).

Unit II

Mosquito taxonomy, biology, and behavior; mosquito viruses: EEE, VEE, SLE, yellow fever, mosquito surveillance; malaria.

Unit III

Horse flies, deer flies: EIA, anaplasmosis; muscid flies; Myiasis (Muscoidea); myiasis and louse flies; black flies of medical and veterinary Importance; filariasis: mansonellosis, onchocerciasis

Unit IV

Lice of medical and veterinary importance; rickettsial diseases: epidemic typhus, etc.; mites: rickettsial pox; mites and acariasis: mange, scabies, chiggers; spiders and scorpions; fleas (Siphonaptera) of medical and veterinary importance; plague and murine typhus

Unit V

Ticks of medical and veterinary importance; lyme disease, rocky mountain spotted fever, tularemia; true bugs (Hemiptera): kissing bugs and bedbugs; chagas disease; tsetse flies; Lepidoptera and Hymenoptera of medical and veterinary importance.

PRACTICAL

Identification of arthropod Classes, Orders and Families of medical and veterinary importance; collection, segregation, curing insect and arachnid specimens, their preservation; management of insect and mite pests of medical and veterinary importance; study of some practical aspects in forensic entomology.

LECTURE SCHEDULE

Unit I

1 Introduction to medical, veterinary and forensic entomology; Classification of Arthropod-borne disease

2 Hematophagy, disease transmission and epidemiology of flies (Diptera) of medical and veterinary Importance

3 Moth flies: Leishmaniasis and Bartonellosis; biting midges (Ceratapogonidae) of medical and veterinary Importance

Unit II

4 Mosquito taxonomy, habitate, biology and behaviors

5 Mosquito transmitting viruses- EEE, VEE, SLE, yellow fever, mosquito surveillance; malaria diseases cycle, prevention of mosquito menace

6 Horse flies, deer flies, EIA, anaplasmosis of medical and veterinary importance

7 Muscid flies; Myiasis (Muscoidea); myiasis and louse flies; black flies of medical and veterinary Importance

8 **Mid semester examination**

Unit III

9 Filariasis, mansonellosis, onchocerciasis disease cycle, transmissions and prevention

10 Lice of medical and veterinary importance; rickettsial diseases: epidemic typhus, etc. of medical and veterinary importance

11 Mites, rickettsial pox, mites and acariasis, mange, scabies, chiggers of medical and veterinary importance

Unit IV

12 Spiders and scorpions; fleas (Siphonaptera) of medical and veterinary importance

13 Plague and murine typhus of medical and veterinary importance

14 Ticks lyme disease, rocky mountain spotted fever of medical and veterinary importance

Unit V

15 Tularemia; true bugs (Hemiptera): kissing bugs and bedbugs of medical and veterinary importance

16 Chagas disease- diseases cycle, transmissions, prevention and management; tsetse flies of medical and veterinary importance

17 Lepidoptera and Hymenoptera of medical and veterinary importance

PRACTICAL SCHEDULE

1 Identification of arthropod Classes of medical and veterinary Importance
2 Method of collection, segregation, curing insect and arachnid specimens of medical and veterinary Importance
3 Characters of order Diptera of medical and veterinary Importance and their management
4 Mosquitoes- characters, identification, diseases transmission and prevention of mosquito breeding
5 Malaria, dengue disease cycle, transmissions, prevention and their management
6 Filariasis, mansonellosis, onchocerciasis disease cycle, transmissions, prevention and their management
7 Lice of medical and veterinary importance; rickettsial diseases: epidemic typhus, etc
8 Mites- identification, characters, of mites of medical and veterinary importance and their management
9 Characters of Spiders and scorpions of medical and veterinary Importance and their management
10 Ticks lyme disease, rocky mountain spotted fever of medical and veterinary importance and their management
11 Characters of order Siphonaptera of medical and veterinary importance and their management
12 Characters of order Hemiptera, identifications of bugs related of medical and veterinary importance. kissing bugs and bed bugs and their management
13 Characters of order Lepidoptera of medical and veterinary importance and their management
14 Characters of order Hymenoptera of medical and veterinary importance and their management
15 Practical aspects of forensic entomology
16 Visit to forensic laboratory
17 **Final practical examination**

LEARNING OUTCOME

Students are expected to identify the arthropods of medical and veterinary importance; identify the diseases transmitted by these arthropod vectors and suggest management options.

SUGGESTED READING

1. Gary Mullen Lance Durden 2018. *Medical and Veterinary Entomology*, 3rd Edition, Academic Press.
2. Gullan. P. J. and Cranston, P. S. 2010. *The Insects: An Outline of Entomology*. 4th Edition, Wiley-Blackwell, West Sussex, UK & New Jersey, US.

3. David, B. V. and Ramamurthy, V. V. 2011. *Elements of Economic Entomology*, 6th Edition, Namrutha Publications, Chennai.

SUGGESTED WEBSITES:

1. https://medent.usyd.edu.au/fact/mosquitoes.htm
2. https://www.nationalgeographic.org/media/bloodthirsty/
3. https://wiki.bugwood.org/Preservation
4. https://www.onhealth.com/content/1/bug_bites_stings_pictures
5. https://www.healthline.com/health/bug-bites#pictures-of-different-bites-and-stings

ENT 523 FOREST ENTOMOLOGY 2 1+1

AIM OF THE COURSE

Objective to promote a more global theoretical understanding of pest population dynamics and the causes of forest insect outbreaks: covering pests of both natural forests and plantations, the diversity of tropical forest insects, their ecological functions, the concept of pests and the incidence of pests in natural forests, plantations and stored timber.

THEORY

Unit I

Introduction to forestry in the tropics, tropical forests: characteristics and types of tropical forests, management of tropical forests and the problems in their management; plantation forestry: beginnings, expansion and current status.

Unit II

History of tropical forest entomology, diversity of forest insects: structural and functional diversity – the feeding guilds, concept of pests, ecology of insects in forest environment, concept and functioning of ecosystem, role of insects in ecosystem processes of tropical forests: insects as primary consumers, secondary and tertiary consumers, as decomposers, as food, pollinators and other ecological interactions.

Unit III

Insect pests in natural forests, general pest incidence, pest outbreaks: Lepidoptera, Coleoptera, Hemiptera, and Hymenoptera; insect pests in plantations, nursery pests, sapling pests, pests of older plantations and their impact; insect pests of stored timber, categories of wood destroying insects and their damage: termites and beetles.

Unit IV

Population dynamics, characteristics of population growth, factors affection population growth, principles governing population dynamics, types and causes of forest

insect outbreaks; general issues in forest entomology: enemies' hypothesis, resource concentration hypothesis, pest evolution hypothesis; pest problems in plantations of indigenous *vs* exotic species; pest problems in monocultures *vs* mixed plantations.

Unit V

Management of tropical forest insect pests, historical development and present status of tropical forest pest management, overview of pest management options: *preventive measures*, *remedial measures*; unique features of forest pest management; constraints to forest pest management in the tropics; guidelines for the practice of forest pest management in the tropics. Insect pests in plantations: Location-specific case studies.

PRACTICAL

Collection, identification and preservation of important insect pest specimens of forest plants and some damage material; detection of insect infestation and assessment of losses due to insect pests; habitat management for vertebrate and insects pests; fire control methods and devices. Familiarization with the meteorological and plant protection equipment, application of pesticides and bio-control agents in the management of insect pests in nurseries and plantations.

LECTURE SCHEDULE

Unit I

1 Introduction to tropical forests, characteristics and types of tropical forests, management of tropical forests and the problems in their management

2 Plantation forestry: beginnings, expansion and current status

3 History of tropical forest entomology, diversity of forest insects: structural and functional diversity – the feeding guilds, concept of pests and concept and functioning of ecosystem

Unit II

4 Ecology of insects in forest environment, role of insects in ecosystem processes of tropical forests: insects as primary consumers, secondary and tertiary consumers, as decomposers, as food, pollinators and other ecological interaction

5 Insect pests in natural forests

6 General pest incidence, pest outbreaks: Lepidoptera and Coleoptera

7 General pest incidence, pest outbreaks: Hemiptera and Hymenoptera

8 **Mid semester examination**

Unit III

9 Insect pests in plantations, nursery pests, sapling pests, pests of older plantations and their impact

10 Pests of stored timber, categories of wood destroying insects and their damage: termites and beetles

11 Insect pests in plantations: Location-specific case studies

Unit IV

12 Population dynamics, characteristics of population growth, factors affection population growth, principles governing population dynamics

13 Types and causes of forest insect outbreaks, general issues in forest entomology: enemies' hypothesis, resource concentration hypothesis, pest evolution hypothesis

14 Pest problems in plantations of indigenous vs exotic species; pest problems in

Unit V monocultures vs mixed plantations

15 Historical development and present status of tropical forest pest management, overview of pest management options

16 Preventive measures, remedial measures, unique features of forest pest management

17 Constraints to forest pest management in the tropics; guidelines for the practice of forest pest management in the tropics

PRACTICAL SCHEDULE

1 Collection, identification and preservation of important insect pest specimens of forest plants: Lepidoptera and Coleoptera

2 Collection, identification and preservation of important insect pest specimens of forest plants: Hymenoptera and Hemiptera

3 Collection, identification and preservation of important insect pest specimens of stored timbers.

4 Collection, identification and preservation of important insect pest specimens of monoculture and mixed plantations

5 Collection, identification and preservation of natural enemies in forest ecosystem

6 Detection of insect infestation and assessment of losses due to insect pests

7 Habitat management for vertebrate pests

8 Habitat management for insects pests

9 Fire control methods and devices

10 Role of termites in decomposition of leaf litters in forest ecosystem

11 Symbiotic relationship of forest pests with other organisms of forest ecosystem

12 Familiarization with the meteorological and plant protection equipment

13 Application of pesticides in the management of insect pests in nurseries

14 Application of pesticides in the management of insect pests in plantations

15 Bio-control agents in the management of insect pests in nurseries

16 Bio-control agents in the management of insect pests in plantations

17 **Final practical examination**

LEARNING OUTCOME

Students are expected to acquire knowledge of insect pests of forest nurseries, forests and plantations, their nature of damage, life history traits and effective management. Likewise, students are expected to have a thorough knowledge of pestiferous insects of stored timber, hide and other forest produce.

SUGGESTED READING

1. Nair, K. S. S. 2007 *Tropical Forest Insect Pests: Ecology, Impact, and Management*, Cambridge University Press, Edinburgh/ New York.
2. Jha, L. K. and Sen Sarna P. K. 1994. *Forest Entomology*. Ashish Publishing House, Delhi.
3. Stebbings, E. P. 1977. *Indian Forest Insects*. JK Jain Brothers.

SUGGESTED WEBSITES

1. https://www.ncforestservice.gov/forest_health/FHH_Entomology.pdf
2. http://webhome.auburn.edu