# ANNAMALAI UNIVERSITY

**(Accredited with 'A+' Grade by NAAC)**

## FACULTY OF AGRICULTURE

**(Accredited by ICAR)**

## DEPARTMENT OF ENTOMOLOGY

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# Academic Regulations and Syllabi

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# DOCTOR OF PHILOSOPHY IN ENTOMOLOGY

## Under Choice based credit system (CBCS) with Outcome based Education

## 2022-2023 Onwards

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

**(*w.e.f. 2022-2023*)**

## 1. DEFINITIONS

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

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

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

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

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

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

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

1.8 **"Grade Point Average (GPA)"** means the quotient of the total credit points obtained by a student in various courses at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 scale and the GPA has to be corrected to two decimals.

1.9 **"Overall Grade Point Average (OGPA)"** means the quotient of cumulative credit points obtained by a student in all the courses taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

## 2. SYSTEM OF EDUCATION

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

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

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

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

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

2.2.4 If prior permission is not sought and obtained, it will be considered as a case of discontinuation and action will be taken to cancel the registration of such scholars.
2.2.5 The scholars should remit the yearly fees during the break of study also.

## 3. PROGRAMMES OFFERED

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

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

## 4. ELIGIBILITY FOR ADMISSION

Candidates seeking admission to Ph.D. programme should satisfy the following requirements.
4.1 Candidates with two-year master's degree programmes from universities recognized by Annamalai University are eligible to apply for Ph.D. programmes of the university (Table 1).
4.2 Candidates who have undergone the programme under conventional system should possess not less than a second-class Master's degree. The candidates under trimester system should possess a minimum OGPA of 3.00 out of 4.00. For those under semester system 7.00 out of 10.00 is required for various Doctoral programmes.

**Eligibility Criteria**

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

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

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

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

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

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

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

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

## 5. MODE OF SELECTION

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

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

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

5.4. The Departmental Research Committee (hereafter referred to as DRC) of concerned Department shall screen the applications as per the eligibility norms and shall conduct the written test and interview only for eligible candidates.

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

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

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

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

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

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

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

5.7. The DRC has the following functions

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

5.7.2 Facilitating research facilities in the Department.

5.7.3 Maintenance of research quality and quality of publications.

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

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

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

**6. ADMISSION**

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

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

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

## 7. TUITION FEES AND OTHER FEES

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

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

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

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

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

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

## 8. CREDIT GRADE POINT REQUIREMENTS

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

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

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

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

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

8.5. Requirements for Ph.D. programme shall also include successful completion of Non-Credit Compulsory Courses, thesis research in the major field of study and submission of thesis thereon.

## 9. ATTENDANCE REQUIREMENT

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

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

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

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

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

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

## 10. RESEARCH ADVISORY COMMITTEE

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

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

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

10.4 Research Supervisor

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

10.4.2 A teacher having Ph.D. with 5 years of service and PG teaching is eligible for teaching and guiding Ph. D. scholars. A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates.

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

10.5 Functions of the RAC:

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

10.5.2 Approve the topic of research and the synopsis.

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

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

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

10.6 The Research Advisory Committee will meet every semester

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

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

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

10.6.4 To approve the synopsis of the thesis.

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

10.7 Changes in RAC

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

10.8 Change of Research Supervisor

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

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

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

10.9 The tentative topic with broad outline of the research should be fixed within one year from the date of admission with the recommendations of the RAC. The topic of the thesis should be finalised in the final RAC meeting before submitting the synopsis.
10.10 Absence of Member during Qualifying / Final Viva-Voce Examination
Under extra-ordinary circumstances if the qualifying / final viva-voce examination to Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Director, DARE in advance.

## 11. EVALUATION OF STUDENT'S PERFORMANCE

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

## 12. EXAMINATIONS

12.1 There will be two examinations *viz.,* first test and final examination. Wherever the course has practical, there will be a final practical examination also.
12.2 The duration of first test will be of one and half an hour and final examinations in theory and practical will be conducted for three hours each.
12.2.1 The first test will be conducted by course teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Director, DARE through HOD within seven working days.
12.2.2 There will be final examination separately for theory and practical which will be conducted by the University. Each final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and another will be among the senior faculty of the Department).
The distribution of marks will be as indicated below:

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

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

**First Test (30 marks) (1.5 hours duration)**

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

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

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

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

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

12.3 Minimum Marks for Pass

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

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

12.4 Minimum GPA Requirement

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

a. Earn a Grade Point of 7.00 for a pass in each subject.

b. For purpose of continuing as a student in the university, a candidate is required to earn a Grade Point Average of not less than 7.00 at the end of each semester.

12.5 Re-Examination

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

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

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

12.6 Return of Valued Answer Papers

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

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

## 13. SEMINAR

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

13.1 Seminar Topic

13.1.1 The seminar topic should be only from the major field and should not be related to the area of thesis research. The seminar topics are to be assigned to the students by the Research Supervisor in consultation with HOD within three weeks after commencement of the semester.

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

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

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

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

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

## 14. QUALIFYING EXAMINATION

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

14.1 Minimum requirement for qualifying Viva-voce Examination

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

14.2 Selection of Examiner

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

14.3 Qualifying Viva-Voce Examination

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

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

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

Communication of Results of Qualifying Examination

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

14.5 Failure /Absence in Qualifying Examination

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

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

14.5.3 If a student fails in the re-examination, further re-examination will be considered on the recommendation of the RAC, HoD and Dean, Faculty of Agriculture. If the student fails in the qualifying examination, he/she is not permitted to register for further research credits in the next semester.

## 15. THESIS RESEARCH

15.1 Selection of Topic

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

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

15.2 Research Proposal

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

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

15.2.3 The distribution of research credit will be as follows:

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

15.3 Evaluation of Thesis Research

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

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

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

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

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

15.3.6 The minutes of the meeting of the Research Advisory Committee along with enclosures will be sent to the Director, DARE.

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

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

**SITUATION – I**

The student has completed the research credits as per the approved programme and awarded **SATISFACTORY** by the RAC. Under the said situation, the student can be permitted to register for fresh research credits in the subsequent semester. If the student is awarded

**UNSATISFACTORY**, he/she has to re-register the same block of research credits in the subsequent semester.

**SITUATION – II**

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

**SITUATION – III**

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

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

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

**SITUATION – IV**

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

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

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

## 16. SUBMISSION OF THESIS

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

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

16.3 The candidate shall be allowed to submit his/her thesis after the completion of stipulated period. A grace period of 90 days may be allowed to submit the thesis after the prescribed duration. If the thesis is not submitted even after the grace period, the student shall pay the tuition fee for the ensuing year.

16.4 If a student is not able to submit the thesis within the grace period, the student has to re-register for the credits in the forthcoming semester. The student who re-registers the credits after availing of the grace period will not be permitted to avail of grace period for the second time. The

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

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

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

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

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

16.9 Pre-submission Presentation

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

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

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

16.10 Submission of Synopsis

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

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

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

16.11 Guidelines for Preparation of Thesis

16.11.1 The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to university with the reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size.

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

16.11.3 The thesis shall be typed on both sides of the page in order to save paper and postage. The thesis shall contain a Certificate from the guide (Annexure) specifying that the thesis submitted is a

record of research work done by the candidate during the period of study under him/her and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship or similar title.

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

**17. VALUATION OF THE THESIS**

17.1 Panel of Examiners

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

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

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

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

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

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

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

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

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

17.2 Revision and Resubmission of Thesis

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

17.2.2 If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the

revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva–Voce examination will be conducted by the viva-voce board.

17.3 Re-registration and Submission of Thesis

The minimum of 80% attendance requirement for submitting the thesis after re-registration need not be insisted for those students who have fulfilled the minimum academic and residential requirement of three years.

17.4 Extension of Time

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

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

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

17.5.1 Number of Chances

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

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

## 18. DISCONTINUANCE AND READMISSION

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

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

18.3 In the case of field experiments or laboratory experiments in which continuity is essential for research and if a student temporarily discontinues in the middle without completing the experiments, then the entire experiment should be repeated, even if the discontinuation period does not exceed two semesters.

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

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## GENT 81 – Ph.D. in ENTOMOLOGY

## PROGRAMME OUTCOME

| | |
|---|---|
| **PO 1** | Scholars will gain advanced knowledge in prime frontiers of Entomology |
| **PO 2** | Scholars will acquire advanced and specialised skills in Entomology |
| **PO 3** | Scholars will learn appropriate methodology to handle instruments essential for carrying out cutting edge research |
| **PO 4** | Scholars will gain computing and analytical skills for research data processing |
| **PO 5** | Scholars will have a comprehensive understanding of methods and techniques applicable to their specific research, writing and presenting technical documents and will have capacity to philosophically interpret their research results |

## PO and CO Mapping Matrix

Correlation levels 1, 2 and 3 are as defined below:

1 - Low
2 - Moderate/ Medium
3 - Substantial /High

## SEMESTER WISE DISTRIBUTION OF CREDIT

| Semester | Major Course | Minor Course | Supporting Course | Seminar | Research | Total credit | Non credit Compulsory course |
|---|---|---|---|---|---|---|---|
| I | 6 | 4 | 2 | 1 | 2 | **15** | - |
| II | 6 | 2 | 3 | 1 | 10 | **22** | - |
| III | - | - | - | - | 16 | **16** | Research and Public Ethics |
| IV | - | - | - | - | 16 | **16** | **MOOC** |
| V | - | - | - | - | 16 | **16** | - |
| VI | - | - | - | - | 15 | **15** | - |
| **Total credit** | **12** | **6** | **5** | **2** | **75** | **100** | - |

| Course code | Course Title | Credit hour (Theory + Practical) |
|---|---|---|
| | **Major Courses (Any Four out of five major courses)** | |
| ENT 601 | Insect Phylogeny and Systematics | 3 (1+2) |
| ENT 602 | Insect Physiology and Nutrition | 3 (2+1) |
| ENT 603 | Insect Ecology and Diversity | 3 (2+1) |
| ENT 604 | Bio-inputs for Pest Management | 3 (2+1) |
| ENT 605 | Insect Toxicology and Residues | 3 (2+1) |
| | **Minor Course (Any Three out of five minor courses)** | |
| ENT 606 | Insect Behaviour | 2 (1+1) |
| ENT 607 | Plant Resistance to Insects | 2 (1+1) |
| ENT 608 | Acarology | 2 (1+1) |
| ENT 609 | Molecular Entomology | 2 (1+1) |
| ENT 610 | Integrated Pest Management | 2 (2+0) |
| | **Supporting Courses** | |
| COM 601 | Advances in Computing Applications | 2 (1+1) |
| STA 601 | Advances in Designs of Experiments | 3 (2+1) |
| | **Seminar** | |
| ENT 691 | Doctoral Seminar – I | 1 (0+1) |
| ENT 692 | Doctoral Seminar – II | 1 (0+1) |
| | **Research** | |
| ENT 694, 695, 696, 697,698, 699 | Doctoral Research | 75 (0+75) |
| | **Non credit compulsory courses** | |
| NGC 611 | Research and Public Ethics– **Contact hours: 2** | - |
| NGC 612 | **MOOC - Contact hours: 2** | - |

## ENT 601 Insect Phylogeny and Systematics (1+2)

**Course objective**

- To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects, International Code of Zoological Nomenclature and ethics and procedure for taxonomic publications.

**Theory**

**Unit I**

Schools of classification - numerical, evolutionary and cladistic, methodologies employed. Development of phenograms, cladograms. Molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography.

**Unit II**

Different views on the evolution of insects - alternative phylogenies of insects, Kukalova Peck and Kristensen. Fossil insects. Evolution of insect diversity over geological times.

**Unit III**

International Code of Zoological Nomenclature, appendices to ICZN, scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures.

**Unit IV**

Concept of phylocode and alternative naming systems. Taxonomic publications, publications of species descriptions, works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases.

**Unit V**

Molecular taxonomy, barcoding species and the progress made in molecular systematics. Current trends in Insect Phylogeny and Systematics

**Practical**

Collection, curation and study of taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, and construction of taxonomic keys for the selected group; Development of descriptions, photographing, writing diagrams, and preparation of specimens for “type like” preservation, Submission of the collections made of the group; Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms; Rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

**Theory Lecture Schedule**

1. Schools of classification - numerical, evolutionary and cladistic, methodologies employed
2. Development of phenograms and cladograms
3. Molecular approaches for the classification of organisms
4. Methods in identification of homology
5. Species concepts, speciation processes and evidences
6. Zoogeography
7. Different views on the evolution of insects - alternative phylogenies of insects, Kukalova Peck and Kristensen
8. Fossil insects & Evolution of insect diversity over geological times
9. **First Test**
10. International Code of Zoological Nomenclature, appendices to ICZN, scientific ethics

11. Nomenclature and documentation protocols and procedures
12. Report preparation on new species
13. Deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures
14. Concept of phylocode and alternative naming systems
15. Taxonomic publications – small publications of species descriptions
16. Works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases.
17. Molecular taxonomy, barcoding species and molecular systematic, Current trends in Insect Phylogeny and Systematics

**Practical Schedule**

1. Collection of insects from rice ecosystem
2. Curation of collected insects
3. Collection of insects from pulse ecosystem
4. Curation of collected insects
5. Collection of insects from cotton ecosystem
6. Curation of collected insects
7. Collection of insects from sugarcane ecosystem
8. Curation of collected insects
9. Collection of insects from vegetable ecosystem
10. Curation of collected insects
11. Collection of insects from orchard ecosystem
12. Curation of collected insects
13. Collection of insects from weeds
14. Curation of collected insects
15. Collection of insects from grassland ecosystem
16. Curation of collected insects
17. Collection of insects from forest ecosystem
18. Curation of collected insects
19. Collection of insects from aquatic ecosystem
20. Curation of collected insects
21. Study of taxon of insects
22. Literature search
23. Compilation of a checklist
24. Study of characters
25. Development of character table
26. Construction of taxonomic keys for the selected group
27. Development of descriptions
28. Photographing and Writing diagrams
29. Preparation of specimens for “type like” preservation
30. Submission of the collections made of the group
31. Multivariate analysis techniques for clustering specimens into different taxa
32. Development of phenograms
33. Rooting and character polarization for developing cladograms
34. Use of computer programmes to develop cladograms

**Course Outcome**

**CO 1:** Gaining of advanced knowledge on different schools of classification
**CO 2:** Skills in construction of taxonomic keys
**CO 3:** Expertise in handling molecular tools in taxonomy methods
**CO 4:** Knowledge on evolution of insects and ICZN
**CO 5:** Skills in computing and analysis and taxonomic publications

**CO – PO Mapping Matrix**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **-** | **-** | **-** | **1** |
| **CO 2** | **-** | **3** | **3** | **3** | **1** |
| **CO 3** | **1** | **3** | **3** | **3** | **1** |
| **CO 4** | **1** | **1** | **-** | **2** | **1** |
| **CO 5** | **-** | **3** | **1** | **3** | **1** |

**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. Dakeshott J and Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag, Berlin.
3. Freeman S and Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.
4. Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.
5. Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.
6. Mayr E and Ashlock PD. 1991. *Principles of Systematic Zoology*. 2nd Ed. McGraw Hill, New York.
7. Mayr E.1969. *Principles of Systematic Zoology*. McGraw-Hill, New York.
8. Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic and Professional, London.
9. Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co., London.
10. Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.


## ENT 602 Insect Physiology and Nutrition (2+1)

**Course objective**

- To impart knowledge on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones, etc.

**Theory**

**Unit I**

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in cuticle, hardening of cuticle.

**Unit II**

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

**Unit III**

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

**Unit IV**

Endocrine system and insect hormones, physiology of insect growth and development, metamorphosis, polymorphism and diapause.

**Unit V**

Insect behaviour in IPM**-** Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management. Current trends in Insect Physiology and Nutrition

**Practical**

Preparation of synthetic diets for different groups of insects; Rearing of insects on synthetic, semi-synthetic and natural diets; Determination of co-efficient of utilization; Qualitative and quantitative profile of bio-molecules; practicing analytical techniques for analysis of free amino acids of haemolymph; Zymogram analyses of amylase; Determination of chitin in insect cuticle; Examination and count of insect haemocytes.

**Theory Lecture Schedule**

1. Physiology of insect cuticle
2. Biochemistry of insect cuticle
3. Moulting process
4. Biosynthesis of chitin
5. Chitin-protein interactions in cuticle
6. Hardening of cuticle
7. Digestive enzymes
8. Digestive physiology in phytophagous insects
9. Digestive physiology in wood boring insects
10. Digestive physiology in wool feeding insects
11. Efficiency of digestion
12. Efficiency of absorption
13. Role of endosymbionts in insect nutrition
14. Nutritional effects on growth and development

15. Physiology of excretion
16. Osmoregulation and water conservation mechanisms
17. **First Test**
18. Detailed physiology of nervous system
19. Transmission of nerve impulses
20. Neurotransmitters and modulators
21. Receptor potentials in different types of sensilla
22. Pheromones in insect life
23. Semiochemicals in insect life
24. Toxins and defense mechanisms
25. Endocrine system
26. Insect hormones
27. Physiology of metamorphosis
28. Polymorphism
29. Diapauses
30. Insect behaviour in IPM
31. Concept of super-normal stimuli
32. Behavioural manipulation as potential tool in pest management
33. Use of semiochemicals
34. Auditory stimuli and visual signals in pest management. Current trends in Insect Physiology and Nutrition

**Practical Schedule**

1. Requirements for insect culture
2. Preparation of synthetic diets for different groups of insects I
3. Preparation of synthetic diets for different groups of insects II
4. Preparation of synthetic diets for different groups of insects III
5. Rearing of insects on synthetic diet
6. Rearing of insects on semi-synthetic diet
7. Rearing of insects on natural diets I
8. Rearing of insects on natural diets II
9. Rearing of insects on natural diets III
10. Culturing disease free insect culture
11. Determination of co-efficient of utilization
12. Qualitative and quantitative profile of bio-molecules
13. Analysis of free amino acids of haemolymph
14. Estimation of free amino acids of haemolymph
15. Zymogram analyses of amylase
16. Determination of chitin in insect cuticle
17. Examination and count of insect haemocytes

**Course Outcome**

**CO 1:** Gaining expertise on anatomy and physiology of various systems in insects
**CO 2:** Skills in dissecting various systems in insects
**CO 3:** Analysis of essential nutrients and minerals in insects
**CO 4:** Skills in rearing of insects on artificial and natural diets and analysing their growth parameters
**CO 5:** Understanding application aspects of insect physiology in pest management

**CO – PO Mapping Matrix**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **3** | **3** | **2** | **3** |
| **CO 2** | **1** | **3** | **3** | **1** | **2** |
| **CO 3** | **-** | **-** | **3** | **3** | **1** |
| **CO 4** | **1** | **3** | **3** | **3** | **3** |
| **CO 5** | **1** | **-** | **-** | **3** | **3** |

**Suggested Reading**


1. Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford and IBH, New Delhi.
2. Bernays EA and Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman and Hall, London.
3. Kerkut GA and Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. IXIII. Pergamon Press, Oxford, New York.
4. Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Association for Advancement of Entomology, Trivandrum, Kerala.
5. Rockstein, M. 1978. *Biochemistry of Insects*, Academic Press.
6. Simpson, SJ. 2007. *Advances in Insect Physiology*, Vol. 33, Academic Press (Elsevier), London, UK.


## ENT 603 Insect Ecology and Diversity (2+1)

**Course objective**

- To impart advanced knowledge on distribution and abundance of insects, evolution of ecological characteristics, insect-plant interactions and biodiversity and conservation.

**Theory**

**Unit I**

Characterization of distribution of insects - Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stableage distribution, Population projections. Predator-Prey Models - Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

**Unit II**

Insect Plant Interactions. Fig-fig wasp mutualism and a quantitative view of types of associations. Role of insects in the environment. Adaptations to terrestrial

habitats. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism.

**Unit III**

Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Meaning of stress-plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses. Host seeking behavior of parasitoids.

**Unit IV**

Biodiversity and Conservation - RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

**Unit V**

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies – timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies. Current trends in Insect Ecology and Diversity.

**Practical**

Methods of data collection under field conditions; Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc.; Calculation of sample sizes by different methods; Fitting Poisson and Negative Binomial distributions and working out the data transformation methods; Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies – Calculation of changes under selection, Demonstration of genetic drift; Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/ *Goniozus*/ Female Bruchids, etc.; A test of reproductive effort and fitness; Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution; Exercises in development of Algorithms for crop modelling

**Theory Lecture Schedule**

1. Characterization of distribution of insects - Indices of Dispersion, Taylor's Power law.
2. Island Biogeography.
3. Population dynamics- Life tables, Leslie Matrix, Stableage distribution, Population projections.
4. Predator-Prey Models - Lotka-Volterra and Nicholson-Bailey Model.
5. Crop Modeling- an introduction.
6. Insect Plant Interactions - Fig-fig wasp mutualism and a quantitative view of types of associations.

7. Role of insects in the environment.
8. Adaptations to terrestrial habitats.
9. Evolution of insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects.
10. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity-role of plants.
11. Herbivory, pollination, predation, parasitism.
12. Modes of insect-plant interaction, tri-trophic interactions.
13. Evolution of herbivory, monophagy vs polyphagy.
14. Role of plant secondary metabolites.
15. Meaning of stress- plant stress and herbivory.
16. Consequences of herbivory to plant fitness and response to stress.
17. **First Test**
18. Constitutive and induced plant defenses.
19. Host seeking behavior of parasitoids.
20. Biodiversity and Conservation - RET species, Ecological Indicators.
21. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic
22. Phenotypic frequencies, Fitness under selection
23. Rates of Evolution under selection.
24. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem
25. Patch departure rules, central place foraging
26. Mean-variance relationship and foraging by pollinators.
27. Nutritional Ecology.
28. Reproductive ecology- Sexual selection, Mating systems,
29. Reproductive strategies –timing, egg number, reproductive effort,
30. Sibling rivalry and parent-offspring conflict.
31. Agro- Ecosystems
32. Natural Ecosystems
33. Pest Control as applied ecology- case study I
34. Pest Control as applied ecology- case study II, Current trends in Insect Ecology and Diversity

**Practical Schedule**

1. Methods of data collection under field conditions
2. Assessment of distribution parameters- Taylor's power law
3. Iwao's patchiness index
4. Index of Dispersion
5. Calculation of sample sizes by different methods
6. Fitting Poisson and Negative Binomial distributions
7. Working out the data transformation methods
8. Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies
9. Calculation of changes under selection
10. Demonstration of genetic drift
11. Assessment of Patch Departure rules.
12. Assessment of Resource size by female fruit flies
13. Assessment of Resource size by female *Goniozus*

14. Assessment of Resource size by female Bruchids
15. A test of reproductive effort and fitness
16. Construction of Life tables - application of Leslie Matrix – population projections
17. Stable age distribution and exercises in development of Algorithms for crop modelling

**Course Outcome**

**CO 1:** Advanced knowledge on insect ecology
**CO 2:** Expertise on methodology in assessing insect distribution parameters
**CO 3:** Knowledge on insect-plant interactions
**CO 4:** Skills in assessing insect abundance
**CO 5:** Proficiency in constructing insect life tables

**CO – PO Mapping Matrix**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | 1 |
| **CO 2** | 1 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 3 | - | 3 | 3 |
| **CO 4** | 3 | 3 | - | 3 | 3 |
| **CO 5** | 3 | 3 | - | 3 | 3 |

**Suggested Reading**


1. Barbosa P and Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions*. Wiley, London.
2. Elizabeth BA and Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects.* Chapman and Hall, New York.
3. Freeman S and Herron JC.1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.
4. Gotelli NJ and Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates,
5. Sunderland, MA. Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA, USA.
6. Krebs C. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co., New York.
7. Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.
8. Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton University Press, Princeton.
9. Real LA and Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, USA.
10. Southwood TRE and Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Wiley Blackwell, London.


**ENT 604 Bio-inputs for Pest Management (2+1)**

**Course Objective**

- To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-

based pest management in agro-ecosystems. They should be able to guide entrepreneurs for establishing a viable mass production unit/ insectary.

**Theory**

**Unit I**

Scope of classical biological control and augmentative bio-control; introduction and

handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of bio-agents *vis-à-vis* target pest populations.

**Unit II**

Bio-inputs: mass production of bio-pesticides, mass culturing techniques of bioagents, insectary facilities and equipments, basic standards of insectary, viable mass -production unit, designs, precautions, good insectary practices.

**Unit III**

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations

**Unit IV**

Large-scale production of bio-control agents, bankable project preparation.

**Unit V**

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in bio-control agents for introgressing and for progeny selections, breeding techniques of bio-control agents. Current trends in Bio-inputs for Pest Management

**Practical**

Mass rearing and release of some commonly occurring indigenous natural enemies; Assessment of role of natural enemies in reducing pest populations; Testing side effects of pesticides on natural enemies; Effect of semio-chemicals on natural enemies, breeding of various bio-control agents, performance of efficiency analyses on target pests; Project document preparation for establishing a viable mass-production unit/insectary; Observation of feeding behavior acts of predatory bugs/ beetles.

**Theory Lecture Schedule**

1. Scope of classical biological control
2. Augmentative bio-control
3. Handling of natural enemies
4. Nutrition of entomophagous insects
5. Nutrition of host insects
6. Dynamics of bio-agents
7. Target pest populations
8. Bio-inputs: mass production of bio-pesticides
9. Insectary facilities and equipments
10. Basic standards of insectary
11. Mass culturing techniques of bioagents I

12. Mass culturing techniques of bioagents II
13. Mass culturing techniques of bioagents III
14. Mass culturing techniques of bioagents IV
15. Mass culturing techniques of bioagents V
16. Mass culturing techniques of bioagents VI
17. **First Test**
18. Viable mass-production unit – Designs
19. Viable mass-production unit –Precautions
20. Viable mass-production unit - good insectary practices
21. Mid Semester Examination
22. Colonization, techniques of release of natural enemies
23. Recovery evaluation
24. Conservation of natural enemies
25. Augmentation of natural enemies
26. Survivorship analysis
27. Ecological manipulations
28. Large-scale production of bio-control agents
29. Bankable project preparation
30. Scope of genetically engineered microbes
31. Parasitoids in biological control
32. Genetics of ideal traits in bio-control agents for introgressing
33. Genetics of ideal traits in bio-control agents for progeny selections
34. Breeding techniques of bio-control agents, Current trends in Bio-inputs for Pest Management

**Practical Schedule**

1. Mass rearing commonly occurring indigenous natural enemies I
2. Mass rearing commonly occurring indigenous natural enemies II
3. Mass rearing commonly occurring indigenous natural enemies III
4. Mass rearing commonly occurring indigenous natural enemies IV
5. Mass rearing commonly occurring indigenous natural enemies V
6. Release of reared natural enemies
7. Application of bio preparations
8. Assessment of role of natural enemies in reducing pest populations in cotton
9. Assessment of role of natural enemies in reducing pest populations in rice
10. Testing side effects of pesticides on natural enemies
11. Effect of semio-chemicals on natural enemies
12. Breeding of various bio-control agents
13. Performance of efficiency analyses on target pests I
14. Performance of efficiency analyses on target pests II
15. Project document preparation for establishing a viable mass-production unit/insectary
16. Observation of feeding behavior acts of predatory bugs
17. Observation of feeding behavior acts of beetles

**Course Outcome**

**CO 1:** Gaining advanced knowledge in biocontrol of pests
**CO 2:** Skills in handling of different bioagents
**CO 3:** Expertise on adoption of modern methods of biological control
**CO 4:** Proficiency in assessment of efficiency of biocontrol agents
**CO 5:** Expertise in computing effect of biocontrol agents in different crop ecosystems

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Burges HD and Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.
2. Coppel HC and James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.
3. De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman and Hall, London.
4. Dhaliwal, GS and Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publishers, New Delhi.
5. Gerson H and Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman and Hall, New York.
6. Huffakar CB and Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

## ENT 605 Insecticide Toxicology and Residues (2+1)

**Course Objective**

- To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

**Theory**

**Unit I**

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Modes of action of newer insecticide molecules; developments in bio-rational approaches; SPLAT; RNAi technology for pest management.

**Unit II**

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.

**Unit III**

Joint action of insecticides; activation, synergism and potentiation.

**Unit IV**

Problems associated with pesticide use in agriculture: pesticide resistance; resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

**Unit V**

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; bound and conjugated residues, effect on soil fertility; insecticide laws and standards, and good agricultural practices.

**Practical**

Residue sampling, extraction, clean-up and estimation of insecticide residues by various methods; Calculations and interpretation of data; Biochemical and biological techniques for detection of insecticide resistance in insects; Preparation of EC formulation using neem oil. Current trends in Insecticide Toxicology and Residues.

**Theory Lecture Schedule**

1. Penetration and distribution of insecticides in insect systems
2. Insecticide selectivity
3. Factors affecting toxicity of insecticides
4. Modes of action of newer insecticide molecules I
5. Modes of action of newer insecticide molecules II
6. Modes of action of newer insecticide molecules III
7. Developments in bio-rational approaches
8. SPLAT and RNAi technology for pest management
9. Biochemical and physiological target sites of insecticides in insects
10. Developments in biorationals

11. Developments in bio pesticides
12. Developments in newer molecules
13. Modes of action and structural – activity relationships
14. Advances in metabolism of insecticides
15. Joint action of insecticides
16. Activation in insecticides and synergism in insecticides
**17. First Test**
18. Potentiation in insecticides
19. Problems associated with pesticide use in agriculture
20. Pesticide resistance
21. Resistance mechanisms
22. Resistant management strategies
23. Pest resurgence and outbreaks
24. Persistence of Insecticides
25. Pollution by insecticides
26. Health hazards and other side effects
27. Estimation of insecticidal residues-sampling
28. Estimation of insecticidal residues-extraction
29. Estimation of insecticidal residues- clean-up
30. Estimation by various methods
31. Maximum residue limits (MRLs) and their fixation
32. Bound and conjugated residues - effect on soil fertility
33. Insecticide laws and standards
34. Good agricultural practices, Current trends in Insecticide Toxicology and Residues

**Practical Schedule**

1. Dissection of Nervous system – Grasshopper
2. Dissection of Nervous system – Beetles
3. Dissection of Nervous system – housefly
4. Residue sampling
5. Residue extraction
6. Residue clean-up
7. Estimation of insecticide residues by Calorimetry
8. Estimation of insecticide residues by GC/HPLC
9. Calculations and interpretation of data
10. Biochemical methods to detect insecticide resistance in insects
11. Biological techniques to detect insecticide resistance in insects
12. Different types of pesticides
13. Formulation types
14. Application techniques of formulations
15. Formulation aids
16. Preparation of EC formulation using neem oil
17. Joint action of insecticides

**Course Outcome**

**CO 1:** Advanced knowledge in latest developments in insecticide toxicology
**CO 2:** Skills in bioassay of insecticides and handling plant protection appliances
**CO 3:** Proficiency in analytical techniques to identify the biochemical and physiological target sites of insecticides
**CO 4:** Practical skills in detecting insecticide resistance development and in residue estimation
**CO 5:** Proficiency in insecticide resistance and residue management

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.
2. Dhaliwal GS and Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publishers, New Delhi.
3. Hayes WJ and Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.
4. Ishaaya I and Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ.House, New Delhi.
5. Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.
6. O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.
7. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.
8. Prakash A and Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.


## ENT 606 Insect Behaviour (1+1)

**Course Objective**

- To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behavior in insects.

**Theory**

**Unit I**

Defining Behaviour**-** Concept of umwelt, instinct, fixed action patterns, imprinting, complex behavior, inducted behavior, learnt behavior and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behavior- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behavior and behavioural polymorphism.

**Unit II**

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

**Unit III**

Reproductive behavior- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behavior- kinselection, parental manipulation and mutualism; Self organization and insect behavior.

**Unit IV**

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behavior, pollination behavior, co-evolution of plants and insect pollinators.

**Unit V**

Behaviour in IPM**-** Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management. Current trends in Insect Behaviour.

**Practical**

Quantitative methods in sampling behavior; Training bees to artificial feeders; Sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honeybee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees; Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

**Theory Lecture Schedule**

1. Defining Behaviour
2. Concept of umwelt, instinct, fixed action patterns, imprinting, complex behavior, inducted behavior, learnt behavior and motivation.
3. History of Ethology- development of behaviorism and ethology
4. Contribution of Darwin, Frisch, Tinbergen and Lorenz
5. Studying behavior- Proximate and Ultimate approaches, behavioural traits under natural selection
6. Genetic control of behavior and behavioural polymorphism
7. Orientation- Forms of primary and secondary orientation including taxes and kinesis
8. Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication
9. **First Test**

10. Use of signals in defense, mimicry, polyphenism; evolution of signals, Reproductive behavior- mate finding, courtship, territoriality,
11. Parental care, parental investment, sexual selection and evolution of sex ratios
12. Social behavior- kinselection, parental manipulation and mutualism, Self organization and insect behavior
13. Foraging- Role of different signals in host searching (plant and insects) and host acceptance
14. Ovipositional behavior, pollination behavior
15. Co-evolution of plants and insect pollinators
16. Behaviour in IPM**-** Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management
17. Use of semiochemicals, auditory stimuli and visual signals in pest management. Current trends in Insect Behaviour.

**Practical Schedule**

1. Quantitative methods in sampling behavior
2. Training bees to artificial feeders
3. Sensory adaptation and habituation in a fly
4. Sensory adaptation and habituation in a butterfly
5. Physical cues used in host selection of phytophagous insect
6. Chemical and odour cues in host selection in DBM
7. Chemical and odour cues in host selection in gram pod borer
8. Colour discrimination in honeybee
9. Colour discrimination in butterfly model
10. Learning in bees
11. Memory in bees
12. Role of self-organization by honeybees
13. Resource tracking by honeybees
14. Evaluation of different types of traps against fruit flies I
15. Evaluation of different types of traps against fruit flies II
16. Use of honey bees to understand behavioural polymorphism with respect to learning
17. Use of *Helicoverpa armigera* and response to pheromone mixtures

**Course Outcome**

**CO 1:** Gaining advanced knowledge on insect behaviour
**CO 2:** Skills in quantitative methods in estimating insect behaviour
**CO 3:** Proficiency in estimating influence of chemical and odour cues from hosts on insects
**CO 4:** Advanced skills in erecting insect traps and understanding insect behaviour
**CO 5:** Computational skills to analyse insect response to pheromones

**CO – PO Mapping Matrix**

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

| | | | | | |
|---|---|---|---|---|---|
| **CO 4** | **1** | **3** | **3** | **3** | **3** |
| **CO 5** | **1** | **2** | **1** | **3** | **3** |

**Suggested Reading**


1. Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford and IBH, New Delhi.
2. Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ., Jodhpur.
3. Bernays EA and Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman and Hall, London.
4. Brown LB. 1999. *The Experimental Analysis of Insect Behaviour*. Springer, Berlin.
5. Krebs JR and Davies NB. 1993. *An Introduction to Behavioural Ecology*. 3rd Ed. Chapman and Hall, London.
6. Manning A and Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.
7. Mathews RW and Mathews JR. 1978. *Insect Behaviour.* A Wiley-InterScience Publ. John Wiley and Sons, New York.


## ENT 607 Plant Resistance to Insects (1+1)

**Course Objective**

- To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

**Theory**

**Unit I**

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species – gene pool; insect sources – behaviour in relation to host plant factors.

**Unit II**

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenoloxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

**Unit III**

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker aided selection in resistance breeding.

**Unit IV**

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance

**Unit V**

Conventional, contemporary and novel methods of resistance breeding of crop plants; breakdown of resistance in crop varieties. Current trends in Plant Resistance to Insects.

**Practical**

Understanding mechanisms of resistance for orientation, feeding, oviposition, etc., allelochemical bases of insect resistance; Macroculturing of test insects like aphids, leaf/ plant hoppers, mites and stored grain pests; Field screening- microplot techniques, infester row technique, spreader row technique and plant nurseries; Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

**Theory Lecture Schedule**

1. Importance of plant resistance, historical perspective, desirable morphological,
2. Anatomical and biochemical adaptations of resistance; assembly of plant species – gene pool
3. Insect sources – behaviour in relation to host plant factors
4. Physical and chemical environment conferring resistance in plants
5. Role of trypsin inhibitors and protease inhibitors in plant resistance
6. Biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenoloxidase pathways, salicylic acid pathways;
7. Effects of induced resistance and exogenous application of elicitors
8. Biotechnological approaches in host plant resistance
9. **First Test**
10. Genetic manipulation of secondary plant substances
11. Incorporation of resistant gene in crop varieties
12. Marker aided selection in resistance breeding.
13. Estimation of plant resistance based on plant damage- screening and damage rating
14. Evaluation based on insect responses
15. Techniques and determination of categories of plant resistance
16. Conventional, contemporary and novel methods of resistance breeding of crop plants
17. Breakdown of resistance in crop varieties. Current trends in Plant Resistance to Insects.

**Practical Schedule**

1. Understanding mechanisms of resistance for orientation
2. Understanding mechanisms of resistance for Feeding
3. Understanding mechanisms of resistance for Oviposition
4. Allelochemical bases of insect resistance
5. Macroculturing of test insects - aphids
6. Macroculturing of test insects - leaf/ plant hoppers
7. Macroculturing of test insects - mites
8. Macroculturing of test insects - stored grain pests
9. Field screening
10. Microplot techniques
11. Infester row technique
12. Spreader row technique

13. Plant nurseries
14. Determination of antixenosis index
15. Determination of Antibiosis index
16. Determination of Tolerance index
17. Determination of Plant resistance index.

**Course Outcome**

**CO 1:** Obtaining advanced knowledge on insect resistance in crop plants
**CO 2:** Skills in macroculturing of test insects
**CO 3:** Proficiency in estimating mechanisms of resistance
**CO 4:** Skills in estimating biophysical and biochemical factors of resistance
**CO 5:** Analytical skills in determination of various indices of plant resistance to pests

**CO – PO Mapping Matrix**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **1** | **1** | **3** | **3** |
| **CO 2** | **3** | **3** | **3** | **3** | **3** |
| **CO 3** | **1** | **3** | **3** | **3** | **3** |
| **CO 4** | **1** | **3** | **3** | **3** | **3** |
| **CO 5** | **1** | **3** | **3** | **3** | **3** |

**Suggested Reading**


1. Panda N. 1979. *Principles of Host Plant Resistance to Insects*. Allenheld, Osum and Co., NewYork.
2. Rosenthal GA and Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites*. Vol. I, II. Academic Press, New York.
3. Sadasivam S and Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests*. Marcel Dekker, New York.
4. Smith CM, Khan ZR and Pathak MD. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida.

## ENT 608 Acarology (1+1)

**Course Objective**

- To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

**Theory**

**Unit I**

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India.

**Unit II**

Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

**Unit III**

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

**Unit IV**

Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

**Unit V**

Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization. Current trends in acarology.

**Practical**

Identification of commonly occurring mites up to species, preparation of keys for identification; Collection of specific groups of mites and preparing their identification keys; Rearing phytoseiid mites and studying their role in suppression of spider mites; Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens, etc.

**Theory Lecture Schedule**

1. Comparative morphology of Acari
2. phylogeny of higher categories in mites
3. knowledge of commonly occurring orders and families of Acari in India
4. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae
5. Diagnostic characteristics of commonly occurring species from families Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae
6. Diagnostic characteristics of commonly occurring species from families Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae

7. Diagnostic characteristics of commonly occurring species from families Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae
8. Soil mites in India
9. **First Test**
10. Management of economical important species of mites in agriculture
11. Management of economical important species of mites in veterinary and public health
12. Storage acarology
13. Mites as vectors of plant pathogens
14. Mode of action, structure-activity relationships of different groups of acaricides
15. Resistance and Resurgence of mites
16. Predatory mites - mass production and utilization in managing mite pests
17. Acaropathogenic fungi- identification, isolation and utilization. Current trends in acarology.

**Practical schedule**

1. Identification of commonly occurring mites
2. Preparation of keys for identification commonly occurring mites
3. Preparation of keys for identification commonly occurring mites
4. Preparation of keys for identification commonly occurring mites
5. Collection of specific groups of mites
6. Preparation of keys for identification specific groups of mites
7. Preparation of keys for identification specific groups of mites
8. Preparation of keys for identification specific groups of mites
9. Slide preparation
10. Rearing of phytoseiid mites
11. Rearing of phytoseiid mites
12. Rearing of phytoseiid mites
13. Role of phytoseiid mites in suppression of spider mites
14. Groups of acaricides
15. Management of mite pests of crops using acaricides
16. Phytoseiid predators
17. Fungal pathogens

**Course Outcome**

**CO 1:** Gaining advanced knowledge on morphology mites
**CO 2:** Skills in preparation of taxonomic keys for mites
**CO 3:** Skills in rearing of mites
**CO 4:** Proficiency in estimating efficiency of predatory mites
**CO 5:** Analytical skills in determination of efficacy of acaricides

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Evans GO.1992. *Principles of Acarology.* CABI, London.
2. Gerson H and Smiley RL. 1990. *Acarine Bio-control Agents- An Illustrated Key and Manual*. Chapman and Hall, New York.
3. Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.
4. Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.
5. Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.


## ENT 609 Molecular Entomology (1+1)

**Course Objective**

- To familiarize the students with DNA recombinant technology, marker genes, transgenic plants, and biotechnological advances in entomology

**Theory**

**Unit I**

Introduction to molecular biology; techniques used in molecular biology.

**Unit II**

DNA and RNA analysis in insects - transcription and translocation mechanisms. DNA recombinant technology, identification of genes/ nucleotide sequences form characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

**Unit III**

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Transgenic plants for pest resistance and diseases.

**Unit IV**

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy
and phylogeny. Genetic improvement of tolerance of natural enemies.

**Unit V**

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops. Current trends in Molecular Entomology.

**Practical**

Isolation of DNA/ RNA; Purity determinations, purification of total DNA from animal tissues; Base pair estimation; Agarose gel electrophoresis; Quantitative enzyme profile of alimentary canal; Restriction mapping of DNA; Demonstration of PCR, RFLP and RAPD techniques.

**Theory lecture Schedule**

1. Introduction to molecular biology and Techniques used in molecular biology
2. DNA and RNA analysis in insects and Transcription and translocation mechanisms
3. DNA recombinant technology, identification of genes/ nucleotide sequences form characters of interest
4. Genetic improvement of natural enemies
5. Cell lines, genetic engineering in baculoviruses
6. *Bt* and entomopathogenic fungi
7. Genes of interest in entomological research - marker genes for sex identification
8. Neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI, lectins and proteases
9. **First test**
10. Transgenic plants for pest resistance and diseases
11. Insect gene transformation, biotechnology in relation to silkworms and honey bees
12. Introduction of lectin genes for pest suppression
13. DNA finger printing for taxonomy and phylogeny
14. Genetic improvement of tolerance of natural enemies
15. DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis;
16. Sf transgenic technology and implications; molecular biology of baculoviruses;
17. Insecticide resistance -Resistance management strategies in transgenic crops. Current trends in Molecular Entomology.

**Practical Schedule**

1. Isolation of DNA
2. Isolation of DNA
3. Isolation of RNA
4. Isolation of RNA
5. Purity determinations
6. Purification of total DNA from animal tissues
7. Purification of total DNA from animal tissues
8. Base pair estimation
9. Agarose gel electrophoresis
10. Agarose gel electrophoresis
11. Quantitative enzyme profile of alimentary canal
12. Restriction mapping of DNA
13. Restriction mapping of DNA
14. Demonstration of PCR

15. Demonstration of RFLP
16. Demonstration of RAPD techniques
17. Demonstration of RAPD techniques

**Course Outcome**

**CO 1:** Obtaining advanced knowledge on molecular entomology
**CO 2:** Skills in isolation of DNA and RNA
**CO 3:** Proficiency in electrophoresis techniques
**CO 4:** Skills in other molecular techniques
**CO 5:** Computational skills in estimating the impact of transgenic crops on insects and natural enemies

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Bhattacharya TK, Kumar P and Sharma A. 2007. *Animal Biotechnology*. 1st Ed., KalyaniPublication, New Delhi.
2. Hagedon HH, Hilderbrand JG, Kidwell MG and Law JH. 1990. *Molecular Insect Science.* PlenumPress, New York.
3. Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.
4. Oakeshott J and Whitten MA. 1994. *Molecular Approaches to Fundamental and AppliedEntomology*. Springer Verlag.
5. Rechcigl JE and Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.*Lewis Publ., North Carolina.
6. Roy U and Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publishers,New Delhi.
7. Singh BD. 2008. *Biotechnology* (*Expanding Horizons*). Kalyani Publishers, New Delhi.
8. Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publishers, New Delhi.

## ENT 610 Integrated Pest Management (2+0)

**Course Objective**

- To acquaint the students with recent concepts of integrated pest management; surveillance and data base management; successful national and international case histories of integrated pest management, non-conventional tools in pest management.

**Theory**

**Unit I**

Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

**Unit II**

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

**Unit III**

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies;

**Unit IV**

Scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

**Unit V**

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management. Current trends in IPM

**Theory Lecture Schedule**

1. Principles of sampling
2. Principles of surveillance
3. Database management
4. Computer programming
5. Simulation techniques
6. System analysis and modeling
7. Case histories of national programmes - implementation
8. Case histories of international programmes - implementation
9. Case histories of national programmes – adoption and criticism
10. Case histories of international programmes -adoption and criticism
11. Case histories of international programmes -adoption and criticism
12. Global trade
13. Risk of invasive pests
14. Updating knowledge on insect outbreaks
15. Insect outbreak management.
16. Genetic engineering
17. **First Test**
18. New technologies- limitations in IPM programmes

19. Deployment of benevolent alien genes for pest management- case studies
20. Deployment of benevolent alien genes for pest management- case studies
21. Deployment of benevolent alien genes for pest management- case studies
22. Scope of bio-intensive programmes
23. Limitations of bio-intensive programmes
24. Ecological based IPM programmes
25. Application of IPM to farmers' real time situation
26. Challenges of IPM
27. Need for IPM
28. Future outlook of IPM
29. Dynamism of IPM under changing cropping systems and climate
30. Insect pest management under protected cultivation - vegetables
31. Insect pest management under protected cultivation – Cut flowers
32. Pesticide resistance
33. Pesticide residue
34. Strategies for pesticide resistance management, current trends in IPM

**Course Outcome**

**CO 1:** Gaining knowledge on recent concepts of integrated pest management
**CO 2:** Proficiency in insect pest surveillance and data base management
**CO 3:** Understanding the implementation of IPM programmes
**CO 4:** Analysing the scope and limitations of bio-intensive IPM programmes
**CO 5:** Knowledge on non-conventional tools in pest management

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Dhaliwal GS and Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publishers, New Delhi.
2. Dhaliwal GS, Singh R and Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publishers, New Delhi.
3. Flint MC and Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.
4. Koul O and Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.
5. Koul O, Dhaliwal GS and Curperus GW. 2004. *Integrated Pest Management – Potential, Constraints and Challenges.* CABI, London.
6. Maredia KM, Dakouo D and Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.

7. Metcalf RL and Luckman WH. 1982. *Introduction to Insect Pest Management.* John Wiley and Sons, New York.
8. Norris RF, Caswell-Chen EP and Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.
9. Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.
10. Subramanyam B and Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

## COM 601 ADVANCES IN COMPUTING APPLICATIONS (1+1)

**Course Objective**

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

**Theory**

**Unit I Introduction to Latex:**

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

**Unit II Packages and Classes in Latex:**

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

**Unit III MS Access:**

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

**Unit IV Introduction to Python:**

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

**Unit V Using Databases in Python:**

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

**Theory Lecture Schedule**

1. Introduction to Latex.
2. Document Structure.
3. Classes.
4. Typesetting Text.
5. Inserting Equations
6. Packages and Mathematical Symbols.
7. List of figure.

8. List of Tables.
9. **First Test**
10. Bibliography and References.
11. MS Access Concepts of Database, Creating Database.
12. DBMS in Agriculture.
13. Introduction to Python.
14. Built-in Data types.
15. Strings.
16. Python Console.
17. Database in Python.

**Practical Schedule**

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

**Course Outcome**

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

**CO-PO Mapping Matrix**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 1 | 1 | 2 |
| **CO 2** | 3 | 3 | 2 | 1 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | 3 |
| **CO 4** | 3 | 3 | 2 | 3 | 3 |
| **CO 5** | 3 | 3 | 2 | 3 | 3 |

**Suggested Reading**


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


**E-Resources**

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

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

**Course Objective**

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

**Theory**

**Unit–I: Sampling Techniques**

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

**Unit–II: Statistical Methods**

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

**Unit–III: Correlation and Regression Analysis**

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

**Unit–IV: Experimental Designs**

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

**Unit–V: Factorial Experiments**

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

**Practical**

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

**Theory Lecture Schedule**

1. Classification, tabulation and graphical representation of data.
2. Descriptive statistics.
3. Theory of probability. Random variable and mathematical expectation.
4. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial.
5. Normal distributions and their applications.
6. Concept of sampling distribution: t, chi-square and F distributions.

7. Tests of significance based on normal, t, chi-square and F distributions.
8. Correlation, Rank correlation, Correlation ratio.
9. Intra-class correlation. Test of significance of correlation coefficient.
10. Coefficient of determination.
11. Path analysis.
12. Regression analysis.
13. Partial and multiple correlation and regression.
14. Estimation of parameters. Predicted values and residuals.
15. Introduction to multivariate analytical tools.
16. Test of hypothesis on means, Multivariate analysis of variance and covariance.
17. **First Test**
18. Cluster analysis, Classification by linear discriminant function.
19. Canonical correlations, Principal components.
20. Factor analysis, multi- dimensional scaling and Correspondence Analysis.
21. Hierarchical clustering.
22. Principal component analysis.
23. Need for design of experiments, characteristics of a good design.
24. Basic principles of designs - randomization, replication and local control.
25. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom.
26. Completely randomized design, randomized block design and Latin square design.
27. Factorial experiments: Layout and analysis of factorial experiments.
28. Complete block design – split – plot design.
29. Strip-plot design: split split –plot design.
30. Resolvable block designs and their applications.
31. Randomization procedure, analysis and interpretation of results.
32. Analysis of covariance. Missing plot technique and its application to RBD, LSD.
33. Factorial experiments (symmetrical as well as asymmetrical).
34. Factorial experiments with control treatment. Groups of experiments. Transformation of data.

**PRACTICAL SCHEDULE**

1. Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests.
2. Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval.
3. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution.
4. Correlation and regression analysis.
5. Fitting of orthogonal polynomial regression.
6. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests.
7. Analysis of data obtained from CRD, RBD, LSD.
8. Analysis of Covariance.
9. Analysis of factorial experiments without and with confounding, Analysis with

missing data.

10. Split plot and strip plot designs. Groups of experiments, Transformation of data.
11. Exercises on various Non-parametric tests.
12. Random sampling, Use of random number tables, Simple random sampling, Determination of sample size.
13. Exercises on Inverse sampling, Stratified sampling.
14. Cluster sampling and Systematic sampling.
15. Estimation using Ratio and regression estimators.
16. Estimation using Multistage design and Double sampling.
17. Practical Examination.

**Course Outcome**

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

**CO – PO Mapping Matrix**

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

**Suggested Reading**


1. Agarwal, B. L. 2003, Basic Statistics, New Age International. New Delhi.
2. Anderson, T.W. 1958. *An Introduction to Multivariate Statistical Analysis.* John Wiley, New Delhi.
3. Bansil, P.C. 2002. *Agrl. Statistics*. CBS Publishers. New Delhi.
4. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. 1994. *Time Series Analysis: Forecasting and Control*. Pearson Education, Delhi.
5. Campbell, R.A. 1974. *Statistics for Biologists.* Cambridge University Press. New York.
6. Cochran, W.G. and Cox, G.M. 1957. *Experimental Design.* John Wiley and Sons Inc. New York.
7. Das, M. N. and Giri, N.C. 1986. *Design and Analysis of Experiments.* New Age International. New Delhi

8. Federer, W.T. 2002. *Statistical Design and Analysis of Intercropping Experiments.* Springer-Verlag. New York
9. Gomez and Gomez. 1984. *Statistical procedure for Agrl. Research.* Wiley-interscience. New York
10. Gupta, S.P. 2004, Statistical Methods, S. Chand and Sons. New Delhi. Singh R and Mangat N.S. 1996. *Elements of Survey Sampling*. Kluwer Academic Publishers.

*******

# ANNEXURES

**Annexure - 1**

ANNAMALAI UNIVERSITY
DIRECTORATE OF ACADEMIC RESEARCH
(DARE)
Annamalainagar – 608002

## REQUEST FOR EXTENSION OF TIME

| | | |
|---|---|---|
| Name of the Scholar | : | |
| Roll No. | : | |
| Programme | : | Ph.D. |
| Department | | |
| Faculty | : | |
| Mobile No. | : | |
| Email id | : | |
| Date of Registration of the Programme | : | |
| Supervisor Name & Address | : | |

| | | |
|---|---|---|
| Reason for Extension of time | : | |
| Synopsis Submitted | : | Submitted/ Not submitted |
| Extension of time | : | 1 year / months* from … to ….. |

Signature of the Scholar

Signature of the Head of the Department
(Name with Seal)

Signature of the Supervisor
(Name with Seal)

Signature of the Dean
(Name with Seal)

**ANNAMALAI UNIVERSITY**
**Annamalainagar – 608002**
**Department:**

## MINUTES OF THE FIRST RESEARCH ADVISORY COMMITTEE MEETING

The Research Advisory Committee Meeting of the Ph.D. Scholar, Mr./Ms.---------- (Roll No.----------) was held on----------at--------in the Department of ----------.

The following members were present.

| | |
|---|---|
| 1 | Supervisor & Convener |
| 2. | Head of the Department |
| 3. | Member |
| 4. | Member |
| 5. | Member |

Mr./Ms.---------- presented an overview of the proposed research work. The Research Advisory Committee approved the research topic as "..... ....."..... The Committee has recommended the scholar to undertake the following course work examinations based on the qualification of the candidate and the proposed research area.

| Course Code | Course Title | Credits | Major/Minor/Supportive course |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

Number of course works as applicable to the scholars

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Supervisor**
(Signature with Name, Date and Seal)

**Signature of Head of the Department**
(Name with Seal)

**Annexure - 2**

Date :
Place:

**ANNAMALAI UNIVERSITY**

**ANNAMALAINAGAR – 608002**

**DEPARTMENT:**

## MINUTES OF THE RESEARCH ADVISORY COMMITTEE MEETING FOR CONFIRMATION OF PROVISIONAL REGISTRATION

The Research Advisory Committee Meeting of the Ph.D. Scholar, ---------- (Roll. No. ----------) was held on ---------at --------a.m./p.m. in the Department of ------. The following members were present:

1. (Supervisor & Convener)
2. Head of the Department
3. (Member)
4. (Member)
5. (Member)

Mr./Ms. ---------- has successfully completed the following course work examinations recommended by the Research Advisory Committee. He/She has obtained the following grades in the course work.

| Sl. No | Course Code | Course Title | Credits | Category | Grade / Marks |
|---|---|---|---|---|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |
| 6. | | | | | |
| 7. | | | | | |
| 8. | | | | | |
| | | | | **GPA** | |

**CoE signed result sheet of the course work duly attested by the Supervisor with seal should be enclosed along with this.**

The scholar completed the first seminar presentation on_____to the faculty members and research scholars. The attendees list is enclosed herewith. The committee also evaluated the research work carried out by the scholar and satisfied/not satisfied with the performance of the scholar. Hence, the Committee

recommends/does not recommend the confirmation of provisional registration of the scholar, and permits/does not permit the scholar to proceed with his/her research work.

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

Date:

Place:

* Strike off whichever is not applicable

**DEPARTMENT OF _____**

**ANNAMALAI UNIVERSITY**

**ANNAMALAINAGAR – 608002**

## CHECKLIST FOR THE CONFIRMATION OF Ph.D. REGISTRATION

| | | |
|---|---|---|
| 1. | Research Advisory Committee meeting **Minutes and Research Performance Assessment** signed by all the RAC members | **YES/NO** |
| 2. | No. of Courses attended .....(not applicable for M.Phil. scholars) | **YES/NO** |
| 3. | Photocopy of mark sheets of the course works signed by COE attested by the Supervisor | **YES/NO** |
| 4. | Original copy of the certificate for the seminar presentation | **YES/NO** |
| 5. | Attendance particulars for the seminar presentation | **YES/NO** |
| 6. | Comprehensive examination result mentioned in the RAC minutes | **YES/NO** |
| 7. | Approval of Research Advisory Committee members for change of course work/ course code/course title | **YES/NO** |
| 8. | Faculty for confirmation is same as that of Provisional Registration | **YES/NO** |

**Checked and found Correct**

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Annexure – 5**

**DEPARTMENT OF _____**
**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR – 608002**

## Research Progress Report

(To be submitted every semester from date of Registration)

| | | | |
|---|---|---|---|
| 1. | Name and Roll No. of the Scholar | : | |
| 2. | Programme | : | Ph.D. |
| 3. | Title of research work | : | |
| 4. | Date of previous RAC meeting | : | |
| 5. | Brief report of the research work carried out between previous and present RAC meetings. Mention the objectives completed: | | |
| 6. | List research paper published/accepted for publication/communicated forpublication / patents (National /International) filed / approved: | | |
| 7. | National / International Conference/Symposia attended (Give details such asName of the Conference, venue, title, period): | | |
| 8. | Overall assessment and comments about the progress of the research scholar: | | |

| | |
|---|---|
| **Member**<br>(Signature with Name and Date) | **Member**<br>(Signature with Name and Date) |
| **Member**<br>(Signature with Name and Date) | **Supervisor**<br>(Signature with Name, Date and Seal) |

**Head of the Department**
(Signature with Name, Date and Seal)

**Note:** Research Performance Assessment restricted to maximum 2 pages should besubmitted along with the minutes of RAC meeting duly signed by RAC members.

**Annexure – 5**

## PROFORMA FOR REGISTRATION OF RESEARCH CREDITS

(**To be given during first week of semester**)

## PART A: PROGRAMME

Semester: Year: Date of registration:

1. Name of the student and
2. Enrolment number:/Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Program of work for this semester (list out the Items of research work to be undertaken during the semester):

Approval of advisory committee

| Advisory Committee | Name | Signature |
|---|---|---|
| 1. Supervisor | | |
| 2. Member | | |
| 3. Member | | |
| 4. Member | | |

Professor and Head

*Approval may be accorded within 10 days of registration*

**Annexure – 5**

## PROFORMA FOR EVALUATION OF RESEARCH CREDITS

## PART B EVALUATION

(**Evaluation to be done before the closure of Semester**)

Date of Commencement semester: Date of closure of semester:

Date of evaluation:

1. Name of the student
2. Enrolment number: Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Whether the research work has been carried out as per the approved program:
6. If there is deviation specify the reasons :
7. Performance of the candidate : SATISFACTORY /NOT SATISFACTORY

**Approval of the advisory committee**

| Advisory Committee | Name | Signature |
|---|---|---|
| 1. Supervisor | | |
| 2. Member | | |
| 3. Member | | |
| 4. Member | | |

Professor and Head

**Annexure - 6**

**ANNAMALAI UNIVERSITY**

**ANNAMALAINAGAR – 608002**

**DEPARTMENT:**

## MINUTES OF THE RESEARCH ADVISORY COMMITTEE MEETING FOR SUBMISSION OF SYNOPSIS

The Research Advisory Committee Meeting of the Ph.D. Scholar, Mr./Ms. _____(Roll No._____) was heldon _____at a.m./p.m. in the Department of_____. The following members were present.

1. (Supervisor & Convener)
2. Head of the Department
3. (Member)
4. (Member)
5. [Member]

The Research Advisory Committee critically reviewed the research work entitled "……....." carried out by

Mr./Ms.---------- and the contents of the draft Synopsis. The scholar completed the pre-synopsis presentation on…… to the faculty members and research scholars. The attendees list is enclosed herewith. The scholar has ..... publications in the journals (NAAS/SCI/UGC listed) from his/her research work.

The scholar has the following publications in the listed journals.

1.(Accepted/Published)

2.(Accepted/Published)

It is also certified that the Paper/Papers mentioned above are withinthe scope of the Journal and the paper/papers is/are relevant to the Ph.D. work carried out by the scholar.

The Committee is satisfied with the research performance of the scholar, the quality and quantum of research work and approves the Synopsis submission. The Committee also recommends the panel of Indian and Foreign Examiners for the evaluation of the Thesis.

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Member**
(Signature with Name and Date)

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Annexure - 7**

# ANNAMALAI UNIVERSITY
## ANNAMALAINAGAR – 608002
## DEPARTMENT:

## CERTIFICATE FOR SUBMISSION OF SYNOPSIS AFTER COMPLETION OF MINIMUM DURATION

| | | | | |
|---|---|---|---|---|
| 1. | Name of the Research Scholar | : | | |
| 2. | Roll No. | : | | |
| 3. | Date of Provisional Registration& Confirmation | : | | |
| 4. | Faculty & Department | : | | |
| 5. | Date of RAC meeting for synopsis submission | : | | |
| 6. | Break of study availed (if any) mention theperiod | : | | |
| 7. | Duration of research period from the date of submission of synopsis excluding the break of study period | : | Year | Month |
| 8. | Synopsis submitted within the minimum duration | : | Yes / No | |
| 9. | If Yes, whether the scholar has two publicationsas per the Annamalai University norms | : | Yes / No | |

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Annexure - 8**

# ANNAMALAI UNIVERSITY
## ANNAMALAINAGAR – 608002
## DEPARTMENT:

List of attendees for the Pre-Synopsis seminar Presentation of **Mr/Ms. ----------, Department of ----------,** held on --------- at ------. in the ----------, Annamalai University, Annamalainagar – 608 002.

| Sl.No. | Name | Designation & Address | Signature |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

**Member**

(Signature with Name and Date)

**Member**

(Signature with Name and Date)

**Member**

(Signature with Name and Date)

**Supervisor**

(Signature with Name and Date)

**Head of the Department**

(Signature with Name, Date and Seal)

**Annexure - 9**

# DIRECTORATE OF ACADEMIC RESEARCH(DARE)

# ANNAMALAI UNIVERSITY

# ANNAMALAINAGAR – 608002

## PROFORMA FOR SUBMISSION OF SYNOPSIS

I. Registration Details:

| | | | |
|---|---|---|---|
| Name of the Scholar:<br>Contact No.:<br>Email ID: | | Roll No.: | |
| Name of the Supervisor:<br>Contact No.:<br>Email ID: | | | |
| Month and Year of Registration | | Period of break of study granted, if any | |
| Date of Confirmation | | Date of Completion of minimum period | |
| Faculty and Department as per the Provisional Registration Order | | | |
| Date of completion of maximum period | | Extension of period approved (mention date) | upto: |
| Date of Research Advisory Committee meeting for approval of Synopsis | | Date of submission of Synopsis | |

II. Semester Fee Payment Details:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Month and Year | | | | | | | | |
| Amount Paid | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

III. Course Work Details:

| Course Code | Course Title | Credits | Category | Grade/Marks |
|---|---|---|---|---|
| | | | | |
| | | | | |
| **CGPA** | | | | |
| **Comprehensive Examination** | | | | Pass/Fail |

IV. Progress Report:

| Period | Jan-Jun | Jul-Dec | Jan-Jun | Jul-Dec | Jan-Jun | Jul-Dec | Jan-Jun | Jul-Dec |
|---|---|---|---|---|---|---|---|---|
| Date of Submission | | | | | | | | |
| | | | | | | | | |

:

V. Proof for the Seminar Presentations (attach the Circular copies) :

VI. Publication Details:

| **Journal** | **Published** |
|---|---|
| National | |
| International | |

Enclose photo copy of the papers published.

VII. Details of Synopsis Fee:

| **Amount (Rs.)** | **D.D. No.** | **D.D. Date** | **Name of the Bank** | **Branch** |
|---|---|---|---|---|
| | | | | |

**VIII.** Whether Synopsis submitted within the maximum duration: **YES/NO**

If No, copy of the Extension order should be enclosed:

Certify that the information furnished above is true and correct to the best of myknowledge.

**Signature of the Research Scholar**

**Signature of the Supervisor**

(Name with Seal)

**Signature of the Head of the Department**

(Name and Seal)

(for Office use only) Checked and Accepted

**Annexure - 10**

# DIRECTORATE OF ACADEMIC RESEARCH(DARE)
# ANNAMALAI UNIVERSITY
# ANNAMALAINAGAR – 608002

## CHECKLIST WHILE SUBMITTING Ph.D. SYNOPSIS

| | | |
|---|---|---|
| 1. | Proforma for submission of Synopsis | **YES/NO** |
| 2. | Whether change of Supervisor is approveda.) if yes, attach a copy of the letter<br>b.) Whether the scholar has completed a minimum of one year with the new Supervisor | **YES/NO** |
| 3. | One copy of the Synopsis with soft copy as per Annamalai University Regulations | **YES/NO** |
| 4. | Original Minutes of the Research Advisory Committee signed by all themembers | **YES/NO** |
| 5. | Panel of Examiners (both Indian and Foreign) **with complete and correct postal address** including Phone No, Mobile No, Fax No and correct Official E-mail ID (**typed only**) in a closed cover | **YES/NO** |
| 6. | Recent publications list of all Foreign and Indian examiners in the last 5years in a closed cover | **YES/NO** |
| 7. | The panel of Foreign Examiners should not be of Indian origin | **YES/NO** |
| 8. | Photocopy of the Provisional Registration Confirmation order | **YES/NO** |
| 9. | Photocopies of UG and PG Degree Certificates attested by HOD | **YES/NO** |
| 10. | Synopsis fee of Rs._____may be paid in the University Cash Counter / Bank. | **YES/NO** |
| 11. | Photo copy of the Journal publications | **YES/NO** |
| 12. | Photo Copy of the fee challan for all the years till the submission of Synopsis | **YES/NO** |
| 13. | Certificate for submission of synopsis after the completion of minimumduration | **YES/NO** |
| 14. | a.) Whether the Synopsis is submitted within the maximum durationb.) If No, enclosed copy of the Extension order | **YES/NO** |
| 15. | Photo Copy of the circular for the pre-synopsis presentation | **YES/NO** |
| 16. | Attendance particulars for the pre-synopsis presentation (Applicable to all scholars irrespective of year of registration) | **YES/NO** |
| 17. | Report from "URKUND" Software attached for all Published / accepted Papers listed in Synopsis | **YES/NO** |

**Checked and found Correct**
**Signature of the Supervisor**

**Signature of the**
**Head of the Department**

**Annexure - 11**

# PANEL OF INDIAN EXAMINERS FOR Ph.D. THESIS EVALUATION

Name and Roll No. of the Scholar :

Programme : Ph.D.

Title of the Thesis :

Faculty& Dept. as per PG Qualification :

Name of the Supervisor :

| Sl. No. | Name with full postal address with pin code | Area of specialization |
|---|---|---|
| | **PANEL OF INDIAN EXAMINERS**<br>**(Preferably from IITs, NITs, Universities and Government Institutions)**<br>**(Not less than Associate Professor)** | |
| 1. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br><br><br>No. of Publications: |
| 2. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br><br><br>No. of Publications: |
| 3. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br><br><br>No. of Publications: |
| 4. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br><br><br>No. of Publications: |
| 5. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br><br><br>No. of Publications: |

**Note:** For each expert, the list of publications in reputed Journals indexed with Scopus/Web of Science/Thomson Reuters/ISI with impact factor during the last five years to be enclosed.

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Dean**
(Signature with Name, Date and Seal)

**Annexure - 12**

# PANEL OF FOREIGN EXAMINERS FOR Ph.D. THESIS EVALUATION

Name and Roll No. of the Scholar :

Programme : Ph.D.

Title of the Thesis :

Faculty& Dept. as per PG Qualification :

Name of the Supervisor :

| Sl. No. | Name with full postal address with zip code | Area of specialization |
|---|---|---|
| | **PANEL OF FOREIGN EXAMINERS** | |
| 1. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br>No. of Publications: |
| 2. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br>No. of Publications: |
| 3. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br>No. of Publications: |
| 4. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br>No. of Publications: |
| 5. | Name :<br>Designation :<br>Department :<br>Address :<br>Mobile : Official E-mail: | **Area of specialization**<br><br>No. of Publications: |

**Note:** For each expert, the list of publications in reputed Journals indexed with Scopus/Web of Science/Thomson Reuters/ISI with impact factor during the last five years to be enclosed.

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Dean**
(Signature with Name, Date and Seal)

**Annexure - 13**

# PROFORMA FOR SUBMISSION OF Ph.D. THESIS

## I. Registration Details:

| | | | |
|---|---|---|---|
| Name of the Scholar:<br>Contact No:<br>Email ID: | | Roll No: | |
| Name of the Supervisor:<br>Contact No :<br>Email ID : | | | |
| Month and Year of Registration | | Period of break of study granted, if any | |
| Date of confirmation | | Date of completion of minimum period | |
| Date of completion of Maximum period | | Extension of period approved (mention date) | upto: |
| Date of RAC meeting for Approval of synopsis | | Date of submission of thesis | |

**II.** Extension of time for thesis submission beyond **3 months** after the submission of synopsis (if any):

Late fee details:

| Amount (Rs.) | D.D. No. | D.D. Date | Name of the bank | Branch |
|---|---|---|---|---|
| | | | | |

**III. Whether No Dues Certificate is enclosed:**

Certified that the information furnished above is true and correct to the best of my knowledge.

**Signature of the Scholar**

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

---

(For Office use only) Checked and Accepted

**Annexure - 14**

**DIRECTORATE OF ACADEMIC RESEARCH(DARE)**
**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR – 608002**

## CHECK LIST WHILE SUBMITTING Ph.D. THESIS

| | | |
|---|---|---|
| 1. | Five Copies of the Thesis (with soft copy of the Thesis in PDF format with each copy) prepared as per the guidelines of Annamalai University | **YES/NO** |
| 2. | (a) Whether the thesis is submitted within the maximum duration | **YES/NO** |
| | (b) if no, enclose copy of the extension order | **YES/NO** |
| 3. | Whether the thesis is submitted within three months from the synopsis meeting | **YES/NO** |
| 4. | Proforma for submission of thesis | **YES/NO** |
| 5. | No dues certificate (original) | **YES/NO** |
| 6. | Checked for language and grammar | **YES/NO** |
| 7. | Report from "URKUND" software attached | **YES/NO** |
| | | |

**Synopsis and Thesis titles are the same.**

**Checked and found correct**

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

Annexure - 15

**DIRECTORATE OF ACADEMIC RESEARCH(DARE)**
**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR – 608002**

# NO DUES CERTIFICATE

**(To be submitted along with Thesis to**

**the Director, DARE, Annamalai University, Annamalainagar)**

Name of the Scholar :
Programme : Ph.D.
Roll No :
Department and Faculty :
Month & Year of Submission of Thesis :

| Sl. No. | Details | No Dues Certificate | Signature (Name with Seal) |
|---|---|---|---|
| 1. | University Library | | |
| 2. | Department Library | | |
| 3. | D1- Section | | |
| 4. | Department of the Supervisor and Scholar | | |
| 5. | Department Store | | |
| 6. | Hostel Office | | |
| **7.** | **Project Section (G/CRD)** | | |
| **8.** | **Scholarship Section (H)** | | |
| 9. | Director, DARE **(For Office use Only)** | | |

*** Strike off whichever is not applicable**

**Declaration**

I hereby declare that in the event of any due from me found at a later date, I shallpay the same to the Institution.

**Signature of the Scholar**

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**DEPARTMENT OF _____**
**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR – 608002**

## MINUTES OF THE RESEARCH ADVISORY COMMITTEE MEETING FOR RESUBMISSION OF THESIS

The Research Advisory Committee Meeting of the Ph.D. Scholar, Mr./Ms._____(Roll No._____) was held on_____at_____ a.m./p.m. in the Department. of_____
The following members were present:

1. (Supervisor & Convener)
2. Head of the Department
3. (Member)
4. (Member)
5. [Member]

The Comments given by the examiners have been reviewed by the Research Advisory Committee, and the committee certifies that the corrections were carried outby the scholar as suggested by the examiner(s).

He/She is permitted to resubmit the thesis.

Title of the Thesis “ ”.

**Member**
(Research Advisory Committee)

**Member**
(Research Advisory Committee)

**Member**
(Research Advisory Committee)

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

**Annexure - 17**

**DEPARTMENT OF _____**

**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR – 608002**

# CIRCULAR

## Ph.D. Public Viva-Voce Examination

| | |
|---|---|
| Name of the Scholar | : |
| Roll Number | : |
| Faculty & Department | : |
| Title of the Thesis | : |
| Date and Time of Viva-voce Examination | : |
| Venue | : |
| Name and address of the Supervisor | : |
| Name and address of the Indian Examiner | : |

**All are cordially invited**

**Supervisor**
(Signature with Name, Date and Seal)

**Head of the Department**
(Signature with Name, Date and Seal)

Copy to:

1. The Controller of Examinations.
2. The Deans of Faculties.
3. The Heads of Departments with request to display in the Department NoticeBoard.
4. The Director, Directorate of Academic Research (DARE).
5. The Director, Academic Affairs.
6. The Director, Directorate Research and Development (DRD).
7. The University Librarian.
8. The Heads of Departments of other Universities/Colleges/IIT/NIT/IIM withrequest to display in their Department Notice Board.
9. P.S to Vice-Chancellor.
10. P.A to Registrar.

# GUIDELINES FOR THE PREPARATION OF SYNOPSIS AND THESIS

**Appendix – I**

## GUIDELINES FOR THE PREPARATION OF SYNOPSIS

Synopsis should outline the research problem, the methodology it and the summary and conclusion of the findings. The size of the Synopsis should not exceed 15 pages of typed matter reckoned from the first page to the last page including the list of references and list of publications of the scholar. The sequence in which the synopsis should be arranged is as follows with references and list of publications in separate pages.

1) Cover page and title page (as shown in the Annexure I)
2) Text divided into suitable headings (numbered consecutively)
3) References (not more than 12)
4) List of publications (those published/accepted for publications. Mention the impact factor of the journal- only Web of science or Scopus impact factor)

Standard A4 size (297 mm x 210 mm) bond paper may be used for preparing the synopsis. The synopsis should have the following page margins:

| | | |
|---|---|---|
| Top edge | : | 30 to 35 mm |
| Bottom edge | : | 25 to 30 mm |
| Left side | : | 35 to 40 mm |
| Right side | : | 20 to 25 mm |

The synopsis should be prepared using good quality white paper preferably not lower than 80 GSM. One and half line spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 13. One or two tables/figures may be included at appropriate places in the text of the synopsis and they should conform to the margin specification. All page numbers (Arabic numbers) should be typed without punctuation on the upper right hand corner 20 mm from top with the last digit in line with the right hand margin. Synopsis should be soft bound with black calico cloth and using flexible cover of thick white art paper. The cover should be printed in black letters and the text for printing should be identical to what has been prescribed for the title page. The references such as journals, books, E-books, conference proceedings, patents, etc should be typed following the International standard.

**Appendix – II**

## GUIDELINES FOR THE PREPARATION OF THESIS

The scholars are expected to read the guidelines carefully, and meticulously follow them in the preparation of the thesis. Non-compliance with any of these instructions may lead to the rejection of the thesis submitted.

### 1. GENERAL

This Manual is intended to provide general guidelines to the research scholars in the preparation of the thesis. In general, the thesis shall report, in an organized and scholarly fashion, an account of original research work of the research scholar leading to the discovery of new facts or techniques or correlation of facts already known (analytical, experimental hardware oriented, etc.). Thesis shall demonstrate quality as to make a definite contribution to the advancement of knowledge and the research scholar's ability to undertake sustained research and present the findings in an appropriate manner with actual accomplishments of the work.

### 2. SIZE OF THE THESIS

The size of the thesis shall be normally between 100 and 300 pages of typed matter reckoned from the title page to the last page of thesis including the reference section.

### 3. ARRANGEMENT OF THE CONTENTS OF THE THESIS

The sequence in which the thesis material should be arranged and bound as follows:

1) Cover page and Title page (as shown in Annexure I)
2) Certificate (as shown in Annexure II)
3) Declaration by the Scholar (Annexure III)
4) Abstract
5) Acknowledgement (one page only)
6) Table of contents (Annexure IV)
7) List of Tables (Annexure V)
8) List of Figures (Annexure VI)
9) List of Abbreviations and Symbols (Annexure VII)
10) Chapters
11) Appendices (if applicable)
12) References
13) List of Publications

The Tables and Figures should be included subsequently after referring to them in the text of the thesis. The thesis starting from chapters should be printed on both sides.

## 4. QUALITY OF PAPER AND MARGIN SPECIFICATIONS

The thesis should be prepared using good quality white paper preferably not lower than 80 GSM. Standard A4 size bond paper may be used for preparing the thesis. The dimensions of the final bound thesis (5 copies) should be 290 mm x 205 mm.

The following page margins should be followed while preparing the thesis:

| | | |
|---|---|---|
| Top edge | : | 30 to 35 mm |
| Bottom edge | : | 25 to 30 mm |
| Left side | : | 35 to 40 mm |
| Right side | : | 20 to 25 mm |

The Tables and figures should also conform to the margin specifications. Large size figures should be photographically or otherwise reduced to the appropriate size.

## 5. MANUSCRIPT PREPARATION

While preparing the thesis manuscript, attention should be paid to ensure that all textual matter is typewritten in the same format to the extent possible. Hence, some of the information required for the final typing of the thesis is presented in this section. The headings of all items from 2 to 12 listed in section 3 should be typed in upper case letters without punctuation and centered 50 mm below the top of the page. The text should start 4 spaces below the heading. The page numbering from 1 to 8 should be done using lower case Roman numerals and the pages from 9 to 12 should be numbered using Arabic numerals.

### 1.1 Cover Page and title Page

A specimen copy of the cover page and title page for the thesis is given in Annexure II.

### 1.2 Certificate

The certificate shall be typed in double line spacing using font style Times New Roman and Font size 12 as per the format shown in Annexure III. The certificate shall be signed by the Supervisor and shall be followed by the supervisor's name academic designation, department and full address of the institution where the supervisor has guided the scholar. Signature of the co-supervisor with details should be included wherever applicable.

### 1.3 Abstract

Abstract should be an essay type of description not exceeding four pages outlining the research problem, methodology used and summary of the findings. This shall be typed in one and a half line spacing using Font style Times New Roman and Font size 12.

### 1.4 Acknowledgement

It should be very brief and restricted to one page only when typed in one and a half line spacing. The scholar's signature shall be affixed at the bottom right end above the scholar's name typed in capitals.

### 1.5 Table of contents

The title page, certificate and acknowledgement will not find a place among the items listed in the Table of Contents, but the page numbers of which are in lower case Roman letters. One and a half line spacing should be adopted for typing the matter under this head. A specimen copy of the table of contents for the thesis is given in Annexure IV.

### 1.6 List of Tables

The list should use exactly the same captions as they are written above the tables in the text. One and a half line spacing should be used for typing under this heading.

### 1.7 List of Figures

The list should use exactly the same captions as they appear below the figures in the text. One and a half line spacing should be used for typing under this heading.

### 1.8 List of symbols and abbreviations

One and a half line spacing shall be used for typing the matter under this heading. Standard symbols, abbreviations, etc., shall be used.

### 1.9 Chapters

The chapters may be broadly classified into three parts: (i) introduction,

(ii) the main theme of the thesis and (iii) results, discussion, summary and conclusion. The main chapters may be divided into several sections, divisions and sub-divisions. Each chapter should be given appropriate title. Titles and figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.

### 1.10 Appendices

Appendices are provided to give supplementary information, which if included in the main text may serve as a distraction and spoil the central theme of the thesis. Appendices shall be numbered using Arabic numerals, e.g. Appendix 1, Appendix 2, etc. Tables and references in appendices should be numbered and referred at appropriate places just as in the case of chapters. Appendices shall carry the title of the work reported and the same title shall be included in the table of contents.

### 1.11 List of References

Any works of other researchers, if used either directly or indirectly, the origin of the material thus referred to should be indicated at appropriate places in the thesis. Such references in the form of research articles, monographs, books, review articles, patents and proceedings shall be cited in the thesis following the international standard. A citation should be placed wherever appropriate, preferably at the end of a sentence. All the citations shall be in the same font as the main text. The list of references should be typed 4 spaces below the heading

“REFERENCES” in single line spacing using Font style Times New Roman and Font size 13.

### 1.12 List of Publications

The list of publications (those already published/accepted for publication in journals and papers presented in conferences/symposia) made by the research scholar during the period of research shall be reported in the table of contents.

### 1.13 Tables and Figures

Table means tabulated data in the body of the thesis as well as in the appendices. Others such as charts, graphs, maps, photographs and diagrams may be designated as figures. The table or figure including caption should be accommodated within the prescribed margin limits and should appear on the following page where their first reference is made. All tables and figures should be typed on the same quality paper used for the preparation of the text of the thesis. Two or more small tables or figures may be grouped and typed in a single page, if necessary. Wherever possible, the photograph(s) shall be reproduced on a full sheet of photographic paper or standard A4 size paper.

## 2. TYPING INSTRUCTIONS

**2.1 General:** The impressions on the typed/printed copies should be black in colour. One and a half line spacing should be used for typing the general text. The general text shall be typed in Font style Times New Roman and Font size

13. Long tables, long quotations, foot notes, multiline captions and references should be typed in single line spacing.

**2.2 Chapters:** The format for typing headings, division headings and sub-division headings are as follows

| | | |
|---|---|---|
| Chapter heading | | CHAPTER 1<br>INTRODUCTIO<br>N |
| Division heading | | 1.1 OUTLINE OF THESIS |
| Sub-division heading | | 1.1.1 Literature Review<br>1.1.1.1 Romanian views on archaeology |

The word CHAPTER without punctuation should be centered 50 mm down from the top of the page. Two spaces below, the title of the chapter should be typed centrally in capital letters. The text should commence 4 spaces below this title, the first letter of the text starting 20 mm inside from the left hand margin. The division and sub-division captions along with their numbering should be left justified. The typed material directly below division or sub-division heading should commence 2 spaces below it and should start typing 20 mm from the left hand margin. Within division or sub-division paragraphs are permitted and they should also commence 3 spaces below the last line of the preceding paragraph, with offset from the left hand margin by 20 mm.

## 3. NUMBERING INSTRUCTIONS

### 3.1 Page Numbering

All page numbers (whether it be in Roman or Arabic numbers) should be typed without punctuation on the upper right hand corner 20 mm from the top with the last digit in line with the right hand margin. The preliminary pages such as title page, acknowledgement, table of contents, etc. should be numbered in lower case Roman numerals. Pages of the main text starting with Chapter 1 should be consecutively numbered using Arabic numerals till the end of the thesis.

### 3.2 Numbering of Chapters, divisions and Sub-Divisions

The numbering of chapters, divisions and sub-divisions should be done using Arabic numerals only and further decimal notation should be used for numbering the divisions and sub-divisions within a chapter. For example sub- division 2 under division 4 belonging to chapter 3 should be numbered as

3.2.4. The caption for the sub-division should immediately follow the number assigned to it. Appendices, if any, should also be numbered in an identical manner starting with appendix 1.

### 3.3 Numbering of tables and figures

Tables and figures appearing anywhere in the thesis should have appropriate numbers. For example, if a Figure in Chapter 4 happens to be fifth, then assign 4.5 to that figure. Similar rules apply for tables. For example, if a tablein chapter 3 happens to be second, then assign 3.2 to that table. If Figures or Tables appear in Appendices, then Table 3 in Appendix 1 will be designated as Table A1.3. Similarly for Figures.

### 3.4 Numbering of Equations

Equations appearing in each chapter or appendix should be numbered serially, the numbering should commence afresh for each chapter or appendix. Thus for example, an equation appearing in chapter 3, if it happens to be the fourth equation in that chapter should be numbered as (3.4) thus:

$$y' + a(t)\, y = b(t) \qquad (3.4)$$

While referring to this equation in the body of the thesis it should be referred to as equation (3.4).

## 4. BINDING SPECIFICATIONS

Thesis side pinning/stitching, covered with wrapper printed on 300 GSM white art card and outer side gloss laminated, adhesive binding. The cover should be printed in black letters and the text for printing should be identical to what has been prescribed for the title page.

**Appendix – III**

**A typical Specimen of Cover page and Title Page**

<Font style Times New Roman>

# XXXXXXXXXXXXX

<Font Size 18><1.5 line spacing>

**A THESIS** <Font Size14>

***Submitted by*** <Font Size 14><Italic>

**XXXXXXX** <Font Size 16>

***in partial fulfillment of the requirements for the award of the degree of***

*<Font Size 14><Italic><1.5 line spacing>*

**DOCTOR OF PHILOSOPHY** <Font size 16>


**DEPARTMENT OF ----------**

## ANNAMALAI UNIVERSITY

**ANNAMALAINAGAR 608 002** <Font Size 16><1.5 line spacing>

**.....2021** <Font Size 14>

**Appendix – IV**

# XXXXXXXXXXX

**A THESIS**

***Submitted by***

**XXXXXXX**

***in partial fulfillment of the requirements for the award of the degree of***

**DOCTOR OF PHILOSOPHY**

**DEPARTMENT OF ----------**

**ANNAMALAI UNIVERSITY**
**ANNAMALAINAGAR 608 002**

**APRIL 2021**

Appendix – V

# ANNAMALAI UNIVERSITY

**Dr.----------**

Professor

Department of ----------

Annamalainagar 608 002

Tamil Nadu, INDIA

Mobile :

E-mail:

## CERTIFICATE

This is to certify that the thesis entitled "----------" is a bonafide record of research work done by **Mr/Ms. ---------- (Roll No. ----------),** Research Scholar, Department of ----------, Annamalai University, Annamalainagar, under my guidance during the period **----------,** and that this thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title to this candidate or anyother candidate.

This is also to certify that the thesis represents the independentwork of the candidate.

Place :

Date :

( ----------)

Research Supervisor

**Appendix – VI**

# DECLARATION

I, **----------,** Research Scholar in the Department of ----------, declare that the work embodied in this Ph.D. thesis entitled "----------" is the result of my own bonafide work carried out with my personal effort and submitted by me under the supervision of **Dr. ----------,** Professor, Department of ----------, Annamalai University, Annamalainagar. The contents of this thesis have not formed the basis for the award of any Degree/Diploma/ Fellowship/Titles in this University or any other University or similar Institutions of higher learning.

I declare that I have faithfully acknowledged and given credit and referred to the researchers wherever their works have been cited in the body of the thesis. I further declare that I have not willfully copied others' data/work/results, etc. reported in the journals, magazines, books, reports, dissertations, theses, Internet, etc. and claimed as my own work.

Place:

Date: Signature of the Research Scholar

Roll No.:

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**Annexure – VII**

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