POST GRADUATE DEPARTMENT OF AGRICULTURE

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

Programme Code: MENT

Programme Name: M.Sc. Ag. (Entomology)

(Semester I-II)

Examinations: 2023-24

Khalsa College Amritsar

PROGRAMME OBJECTIVES (PO)

PO- 1. Students will impart detailed knowledge of entomology and specific knowledge of its allied branches.

PO- 2. Students will learn how insects were originated and where they are arranged in kingdom Animalia

PO- 3. Students will have a deeper understanding of several aspects of biology of insects

PO- 4. Students will get detailed information regarding behaviour and management of insect pests.

PO- 5. Students will have working knowledge of statistical methods and will be able to design basic statistical analyses and evaluate basic statistical information.

Programme Specific Outcomes (PSOs):

PSO- 1. Students will be able to categories insects based on basic ecological, behavioural, developmental attributes and evolutionary history.

PSO- 2. Students will understand comparative morphology and anatomy of insects through dissection.

PSO- 3. Students will get to know about collection, preservation and identification of insects of different orders including pests and beneficial insects.

PSO- 4. Students will have hands-on training in preparation of artificial diets, rearing of insects and culturing of insect pathogens.

PSO- 5. Students will get acquainted with positive as well as negative impact of insects on agriculture, human health, and the environment.

PSO- 6. Students will have a deeper understanding of insect pest management strategies and will also learn about new advancements in pest management in fields and in warehouses.

PSO- 7. Students will get knowledge about population estimation of insect pests, losses caused by pests, crop modelling, designing and implementation of IPM.

PSO- 8. Students will check the efficacy of biocontrol agents and different groups of insecticides including botanicals and new promising compounds in laboratory as well as in the fields.

PSO- 9. Students will learn about estimation of insecticidal residues and their environmental implications.

PSO- 10. Students will acquire skill for designing of their experiments. They will also learn how to analyse statistical data and present results efficiently.

PSO- 11. Students will also learn about basics of plant pathology like epidemiology, detection, diagnosis and forecasting of plant diseases through survey, surveillance etc.

PSO- 12. Students will learn about quarantine restrictions imposed during import or export of agricultural produce and techniques for detection of pest infestations.

SEMESTER-I

Course Code	Course Title	Credit Hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
ENT-511	Insect Morphology	3 (2+1)	50+25+25	100	8-9
ENT-512	Insect Anatomy and Physiology	3 (2+1)	50+25+25	100	10-11
PPL-512	Principles of Plant Pathology	3 (2+1)	50+25+25	100	12-13
STAT-511	Statistical Methods for Applied/ Social Sciences	4 (3+1)	57+18+25	100	14-15
*PGS-511	Technical Writing & Communication Skills	1 (0+1)	100 (Pr)	100	16-17
*PGS-512	Library and Information Services	1 (0+1)	100 (Pr)	100	18
*ENT-599	Masters' Research	5 (0+5)	------	S/US	19
Total		**20 (13+7*)**			

* Non-credit course

Total Internal Assessment = 25% (House Test - 10%; Attendance - 10%; Conduct & Academic, Extra Curricular Activities - 5%).

SEMESTER-II

Course Codes	Course Title	Credit Hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
ENT-521	Insect Taxonomy	3 (1+2)	25+50+25	100	20-21
ENT-522	Toxicology of Insecticides	3 (2+1)	50+25+25	100	22-24
PPL-541	Diseases of Field and Medicinal Crops	3 (2+1)	50+25+25	100	25-26
STAT-521	Experimental Designs	3 (2+1)	50+25+25	100	27-28
*PGS-521	Agricultural Research, Research Ethics and Rural Development Programmes	1 (1+0)	100 (Th)	100	29-30
*ENT-599	Masters' Research	5 (0+5)	------	S/US	31
Total		**18(12+6*)**			

* Non-credit course

Total Internal Assessment = 25% (House Test - 10%; Attendance - 10%; Conduct & Academic, Extra Curricular Activities - 5%).

SEMESTER-III

Course Code	Course Title	Credit Hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
ENT-531	Post Harvest Entomology	2 (1+1)	38+37+25	100	32-33
ENT-532	Biological Control of Insect Pests and Weeds	3 (2+1)	50+25+25	100	34-35
ENT-533	Concepts of Integrated Pest Management	2 (2+0)	75+0+25	100	36-37
PPL-532 (Minor)	Techniques in Detection and Diagnosis of Plant Diseases	2 (0+2)	0+75+25	100	38-39
ENT-591	Credit seminar	1 (1+0)	100	100	40
*PGS-531	Intellectual Property & its Management in Agriculture	1 (1+0)	100 (Th)	100	41-42
*ENT-599	Masters' Research	10 (0+10)		(S/US)	43
TOTAL		**21(10+11*)**			

* Non-credit course

Total Internal Assessment = 25% (House Test - 10%; Attendance - 10%; Conduct & Academic, Extra Curricular Activities - 5%).

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SEMESTER-IV

Course Code	Course Title	Credit Hours	Marks	Total Marks	Page Number
			Theory + Practical + I. Assessment		
ENT-541	Insect Ecology	3 (2+1)	50+25+25	100	44-46
*PGS-541	Basic Concepts in Laboratory Techniques	1 (0+1)	100 (Pr)	100	47-48
*ENT-599	Masters' Research	10(0+10)	---------	S/US	49
Total		**14(3+11*)**			

* Non-credit course

Total Internal Assessment = 25% (House Test - 10%; Attendance - 10%; Conduct & Academic, Extra Curricular Activities - 5%).

SEMESTER-I

ENT-511 **Insect Morphology**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

1. To learn the external morphology of insects (i.e., to learn about the features of insects which help to distinguish one kind of insect from another).
2. To study specializations and adaptability of structures such as the mouthparts, antennae, legs, wings and pronotum
3. To understand how an insect life, functions, and reproduces.

Course Content:

Theory:

Section A

External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

Head- Origin, structure and modification; mouthparts, antennae, their types and functioning; tentorium and neck sclerites.

Section B

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; legs: structure and modifications.

Abdomen- Segmentation and appendages; genitalia and their modifications; embryonic and post-embryonic development.

Section C

Insect sense organs (mechano-, photo- and chemo- receptors); organogenensis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology.

Section D

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

Practical:

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

Suggested Reading

1. Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
2. Chu HF. 1992. How to Know Immature Insects. William Brown Publication, Iowa.
3. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
4. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
5. Gillott C. 1995. Entomology, 2nd Ed. Plenum Press, New York, London.
6. Gullan PJ and Cranston PS. 2000. The Insects, An Outline of Entomology, 2nd Ed. Blackwell Science, UK.
7. Peterson A. 1962. Larvae of Insects. Ohio University Press, Ohio.
8. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.
9. Snodgross RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.
10. Tembhore DB. 2000. Modern Entomology, Himalaya Publishing House, Mumbai.
11. Stehr FW. 1998. Immature Insects. Vols. I, II. Kendall Hunt Publication, Iowa.

Course Outcomes:

CO- 1. To get detailed information regarding evolution of insects, their segmentation and theories regarding segmentation of insect head.
CO- 2. Students will get to know about comparative morphological characteristics, sense organs and flight mechanisms of insects.
CO- 3. Students will get acquainted with history and importance of insect systematics, taxonomic categories and ethics in taxonomy.
CO- 4. They will learn important rules of zoological nomenclature, preparation of taxonomic keys and usage of these keys in identification of insects.

SEMESTER-I

ENT-512 **Insect Anatomy and Physiology**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

1. To study the different systems (digestive, circulatory, respiratory, reproductive, excretory, nervous, sensory, endocrine and exocrine) of insects
2. To learn the basic form and function of the insects
3. To study the physiological role of the various systems in insect survival
4. To study the role of physiology in the basic behaviour of insects

Course Content:

Theory:

Section A

Scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosysthesis of chitin; growth, hormonal control, metamorphosis and diapause;

Section B

Pheromone secretion, transmission, perception and reception; Physiology and mechanism of digestion, circulation and respiration in insects.

Section C

Physiology and mechanism of excretion, reproduction, secretion (exocrine and endocrine glands) and nerve impulse transmission in insects.

Section D

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

Practical:

• Latest analytical techniques for analysis of free amino acids of haemolymph;
• Determination of chitin in insect cuticle;
• Examination and count of insect haemocyte; preparation and evaluation of various diets;
• Consumption, utilization and digestion of natural and artificial diets.

Suggested Reading:

1. Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London.
2. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
3. Gullan PJ and Cranston PS. 2000. The Insects: An Outline of Entomology, 2nd Ed. Blackwell Science, UK.
4. Kerkut GA and Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.
5. Patnaik BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi.
6. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1.
7. Structure, Physiology and Development. Chapman and Hall, New York.
8. Simpson SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier), London, UK.
9. Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman and Hall, New York.

Course Outcomes:

CO- 1. Students will learn the importance and scope of insect anatomy and physiology.
CO- 2. They will get to know about basic structure and physiology of exoskeleton of insects.
CO- 3. They will analyse and integrate information pertaining to specific physiological system. They will learn to compare functioning of specific physiological systems in different insect orders.
CO- 4. Students will study embryonic and post-embryonic development of insects and role of nutrition in development of insects.

SEMESTER-I

PPL-512 **Principles of Plant Pathology**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives

The course aims to:

1 To impart knowledge to the students on history and importance of plant pathology

2 To impart knowledge on various principles involved in the plant diseases

Course Content:

Theory:

Section A

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

Section B

Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

Section C

Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

Section D

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

Practical:

• Basic plant pathological techniques;
• Isolation, inoculation and purification of plant pathogens and proving Koch's postulates;
• Techniques to study variability in different plant pathogens;
• Purification of enzymes, toxins and their bioassay;
• Estimation of growth regulators, phenols, phytoalexins in resistant and susceptible plants.

Suggested Reading

1. Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
2. Heitefuss R and Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
3. Mehrotra RS and Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
4. Singh RP. 2012. Plant Pathology 2nd edn. Kalyani Publishers, New Delhi.
5. Singh RS. 2017. Introduction to Principles of Plant Pathology. 5th edn. MedTech, New Delhi.
6. Singh DP and Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.
7. Upadhyay RK. and Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi.

Course Outcomes:

1. Thorough knowledge on principles, growth, reproduction, survival and dispersal of important plant pathogens and their symptomatology
2. Study of Biotic and abiotic causes of plant diseases and its management
3. Knowledge on different serological and molecular techniques for plant disease detection

SEMESTER-I

STAT-511 Statistical Methods for Applied/ Social Sciences

Time: 3 Hours **Maximum Marks: 100**

Theory: 57

Practical: 18

Internal assessment: 25

Credit hours: 4(3+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 9 marks (comprising of 9 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (12).

Course Objectives:

1. The aim of this course is to understand the basics of statistical methods and their applications in agriculture.
2. It helps the students in understanding, analyzing and interpreting the agricultural data.
3. It also helps in making appropriate decisions in agricultural research findings.

Course Content:

Theory

Section-A: Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Section-B: Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Section-C: Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

Section-D: Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test. Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data

Practical:

Exploratory data analysis, 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 Correlation and regression analysis, fitting of Linear and Quadratic Model.

• Non-parametric tests. ANOVA: One way, Two Way, SRS

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students will use scientific calculators to analyse the data.

Suggested Reading:

1. Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
2. Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
3. Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.
4. Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
5. Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.
6. Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.
7. Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.
8. Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed. John Wiley
9. http://freestatistics.altervista.org/en/learning.php.
10. http://www.statsoft.com/textbook/stathome.html.

Course Outcome:

CO 1: The course Statistical Methods enables the students to know basics of statistics, probability.

CO2: It enables them to know sampling methods, Sampling distributions and standard error.

CO3: In this course students are taught to find out the simple, partial and multiple relationship (correlation)between variables and the impact of several variables on dependent variables (Regression).

CO4: This course enables the students to do comparison of means having small no. of observations and large no. of observations, independency of attributes for only two attributes.

CO5: In this course students are taught to do comparison of several means of variables affected by various factors by Analysis of Variance technique. They are also taught to transform the data.

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students will use scientific calculators to analyse the data.

SEMESTER-I

***PGS 511 Technical Writing & Communication Skills**

Time: 3 hours **Maximum Marks: 100**
Practical: 100
Credit hours: 1(0+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. The question paper will consist of nine skill-oriented questions.
4. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5X8=40 Marks)
5. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4X15= 60 Marks)

Course objectives: To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing)

Course Content:

Practical:

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

Suggested Reading:

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
9. Richard WS. 1969. Technical Writing.
10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

Course outcomes: After the successful completion of this course students will be able to:

• Understand various stages of the writing process and apply them to technical and workplace writing tasks

• Integrate material collected from primary and secondary sources with their own ideas in research papers

SEMESTER -I

***PGS-512 Library and Information Services**

Time: 3 hours **Maximum Marks: 100**
Practical: 100
Credit hours: 1 (0+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. The question paper will consist of nine skill-oriented questions.
4. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5X8=40 Marks)

There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4X15= 60 Marks)

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

Course Contents:

Practical:

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

Course outcomes:

• Understand the definitions, descriptions, process explanations and other common forms of technical writing.
• Understand how to follow the stages of the writing process and apply them to technical and workplace writing tasks
• Synthesize and integrate material collected from primary and secondary sources with their own ideas while writing research papers.

SEMESTER-I

***ENT-599** ***Masters' Research**

S/US

Credits hours: 5(0+5)

SEMESTER-II

ENT-521 **Insect Taxonomy**

Time: 3 Hours **Maximum Marks: 100**

Theory: 25

Practical: 50

Internal assessment: 25

Credit hours: 3(1+2)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

The course aims to:

1. Identify hexapods to order and the majority of common insects to family by sight.
2. Identify adult insects to order and family using dichotomous keys.
3. Collect insects and field data in different habitats using a variety of techniques.
4. Curate insect specimens properly, including labelling, pinning, point mounting, and preserving in ethanol.
5. Describe the taxonomic process: how species are described, named, and classified.
6. Explain how key innovations in the life history of insects led to their incredible diversity.
7. Interpret phylogenetic trees depicting the evolutionary relationships among insects.

Course Contents:

Theory:

Section A

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism. Brief evolutionary history of insects- introduction to phylogeny of insects and Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained.

Section B

International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses. Process of speciation and interbreeding allopatric species. Molecular systemnatics, DNA barcoding, karyological and biochemical approaches in taxonomy. Insect labeling protocols and procedures.

Section C

Distinguishing characters, general biology, habits and habitats of insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.

Section D

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

Practical:

• Study of Orders of insects and their identification using taxonomic keys;

• Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera;

• Field visits to collect insects of different orders.

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

Course Outcomes:

CO- 1. Students will know about the history and importance of insect classification.

CO- 2. To get knowledge about phylogeny of insects and classification of superclass Hexapoda.

CO- 3. Students will learn about distinguishing morphological characters, habits and habitats of insects belonging to economically important families of different orders of class Insecta.

SEMESTER-II

ENT-522 **Toxicology of Insecticides**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

The course aims to:

1. Outline the history of insecticides
2. Recognize the major classes of insecticide and understand their mode of action
3. List and describe processes involved in toxic dynamics of insecticides
4. Become aware of the limitations of insecticide use such as resistance and environmental contamination
5. Develop a basic understanding on performing insect bioassay

Course Contents:

Theory:

Section A

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India; Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

Section B

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

Section C

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

Section D

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

Practical:

• Insecticide formulations and mixtures;
• Laboratory and field evaluation of bio-efficacy of insecticides;
• Bioassay techniques;
• Probit analysis;
• Evaluation of insecticide toxicity;
• Toxicity to beneficial insects;
• Pesticide appliances;
• Working out doses and concentrations of pesticides;
• Procedures of residue analysis.

Suggested Reading

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

Course Outcomes:

CO- 1. Students will get to know about importance, scope and basic principle of insecticide toxicology and its relationships with other disciplines.
CO- 2. To learn about the structure and mode of action of different groups of insecticides including botanicals and new promising compounds
CO- 3. Students will learn the mechanisms of resistance development in insects against insecticides and how we can manage the problem of insecticide resistance.

CO- 4. To be able to evaluate toxicity of insecticides and to understand the factors affecting toxicity of insecticides. They will also learn about Insecticide Act 1968, safe handling of insecticides and treatment in case of insecticide poisoning.
CO- 5. Students will get acquainted with different methods of estimation of insecticide residues. They will also study the significance and environmental implications of insecticides residues.

SEMESTER-II

PPL-541 **Diseases of Field and Medicinal Crops**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

1. Students acquire knowledge on plant disease diagnosis and devising management strategies against them.
2. Students gain hands-on training on isolation and identification of plant pathogens.
3. Instill confidence in students for setting up agri-clinics and other agri-enterprises farmer

Course Contents:

Theory:

Section A: Diseases of Cereal crops- Rice, wheat, barley, pearl millet, sorghum and maize. Diseases of Pulse crops- Gram, urdbean, mungbean, lentil, pigeonpea, soybean and cowpea.

Section B: Diseases of Oilseed crops- Rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor. Diseases of Cash crops- Cotton, sugarcane.

Section C: Diseases of Fodder legume crops- Berseem, oats, guar, lucerne.

Section D: Medicinal crops- Plantago, liquorice, mulathi, rosagrass, sacred basil, mentha, ashwagandha, Aloe vera.

Practical:

• Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops;

• Collection and dry preservation of diseased specimens of important crops.

Suggested Reading

1. Joshi LM, Singh DV and Srivastava KD. 1984. Problems and Progress of Wheat Pathology in South Asia. Malhotra Publ. House, New Delhi.
2. Rangaswami G. 1999. Diseases of Crop Plants in India. 4th Ed. Prentice Hall of India, New Delhi.
3. Ricanel C, Egan BT, Gillaspie Jr AG and Hughes CG. 1989. Diseases of Sugarcane, Major Diseases. Academic Press, New York.
4. Singh RS. 2017. Plant Diseases. 10th Ed. Medtech, New Delhi.
5. Singh US, Mukhopadhyay AN, Kumar J and Chaube HS. 1992. Plant Diseases of Internatiobnal Importance. Vol. I. Diseases of Cereals and Pulses. Prentice Hall, Englewood Cliffs, New Jersey.

Course Outcomes:

CO1: Students acquire knowledge on plant disease diagnosis and devising management strategies against them.

CO2: Students gain hands-on training on isolation and identification of plant pathogens.

CO3: Instill confidence in students for setting up agri-clinics and other agri-enterprises farmer.

SEMESTER-II

STAT-521 **Experimental Designs**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives:

The aim of this course is to understand the basics of statistical methods and their applications in agriculture. It helps the students in understanding, analyzing, and interpreting the agricultural data. It also helps in making appropriate decisions in agricultural research findings.

Course Contents:

Theory:

Section A: Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

Section B: Uniformity trials, size and shape of plots and blocks, Analysis of variance, completely randomized design, randomized block design and Latin square design.

Section C: Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Section D: Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical:

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

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students are allowed to use scientific calculators to analysis is the data.

Note: Students are allowed to use scientific calculator in University examinations; statistical tables will be provided to students in examinations. No rigorous mathematical proofs are expected from students; stress will be on application only.

Suggested Reading:

1. Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
2. Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
3. Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.
4. Federer WT. 1985. Experimental Designs. MacMillan.
5. Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
6. Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
7. Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley.
8. www.drs.icar.gov.in.

Course Outcome:

CO- 1. The course Experimental Design for Research Workers enables students to learn about the formation of Experimental units, plots and blocks, random implementation of considered factors on experimental units, and the procurement of samples representing the whole experimental population.

CO-2. The context of this course enables students to analyze agricultural experimental data such as to identify the factors effectively different in their effects. Study of different layout of designs enable students to analyze data generated from various layouts of factors applied.

CO-3. Also the topics taught to students in last section enable them to represent their results derived from research in technical and expressive way.

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students are allowed to use scientific calculators to analysis is the data.

Note: Students are allowed to use scientific calculator in University examinations; statistical tables will be provided to students in examinations. No rigorous mathematical proofs are expected from students; stress will be on application only.

SEMESTER-II

***PGS-521 Agricultural Research, Research Ethics and Rural Development Programmes**

Time: 3 Hours **Maximum Marks: 100**
Theory: 100
Credit hours: 1(1+0)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 20 marks (comprising of 10 short answer type questions of 2 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (20).

Course objective: the main objective of the course is to enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Course Contents:

Theory:

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

Section B: International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agriculture research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility. Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

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

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

Suggested Readings:

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

Course Outcomes: After successful completion of this course students are expected: • To be familiar with the national and international institutions involved in research and about various research ethics and the problems faced by researchers. • To be acquainted with the various rural development programmes and the problems being faced in the implementation of the policies designed for rural development.

SEMESTER-II

***ENT-599** ***Masters' Research**

S/US
Credits hours: 5(0+5)

SEMESTER-III

ENT-531 **Post Harvest Entomology**

Time: 3 Hours **Maximum Marks: 100**

Theory: 38

Practical: 37

Internal assessment: 25

Credit hours: 2(1+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course objective:

To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

Course Contents:

Theory:

Section A

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

Section B

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

Section C

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

Section D

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/ sanitation, disinfestations of stores/ receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and

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

Practical:

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

Suggested Readings:

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

Course Outcomes:

Upon successful completion of this course, students should be able to:
1. Explain the principles of post-harvest technology.
2. Illustrate the physiological and biochemical changes occurring during various stages of fruits and vegetables development and production.
3. Indicate the importance and the significance of proper post-harvest handling to maintain the quality of fruits and vegetables.
4. Analyse various aspects of quality control and evaluation.

SEMESTER-III

ENT-532 Biological Control of Insect Pests and Weeds

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal Assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

Course Objectives

1. To study the concept, history and scope, ecological basis of biological control, natural enemies: predators, parasitoids and insect pathogens (mode of action, application, epizootics), advantages and disadvantages, characteristics of bio-control agents
2. To learn about procedure of biological control: introduction; enhancement of bio control agents (introduction, conservation, mass culture, augmentation, release, monitoring and importation); rearing techniques of bio-control agents and their host insects; role of biological control in IPM

Course Contents:

Theory:

Section A

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

Section B

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa, etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

Section C

Mass production of quality bio-control agents- techniques, formulations, economics, field release/ application and evaluation. Development of insectaries, their maintenance.

Section D

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical:

• Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers;

• Visits to bio-control laboratories to learn rearing and mass production of egg, egg- larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds;

• Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Suggested Reading:

1. Burges HD and Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.
2. De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman and Hall, New York.
3. Dhaliwal GS and Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publishers, New Delhi.
4. Gerson H and Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman and Hall, New York.
5. Huffaker CB and Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.
6. Ignacimuthu SS and Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.
7. Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.
8. Van Driesche and Bellows TS. Jr. 1996. *Biological Control*. Chapman and Hall, New York.

Course Outcomes:

CO- 1. Students will learn about various biocontrol agents used to prevent the attack of pests to promote eco-friendly control methods.

CO- 2. They will learn the mass multiplication techniques of biocontrol agents through hands-on training and can earn good money from industrial production of biocontrol agents.

CO- 3. To check the field efficacy of various formulations of biocontrol agents.

CO- 4. To understand the trends and future possibilities of biological control and study the role of biotechnology and semio chemicals in biological control.

SEMESTER-III

ENT-533 Concepts of Integrated Pest Management

Time: 3 Hours **Maximum Marks: 100**

Theory: 75

Internal Assessment: 25

Credit hours: 2(2+0)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 15 marks (comprising of 10 short answer type questions of 1.5 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (15).

Course Objectives

1. Be able to analyse pest problems, determine if management is necessary, and make appropriate recommendations using IPM techniques.
2. Be familiar with different methods of pest management - their benefits and limitations.
3. Understand the value of beneficial insects.

Course Contents:

Theory:

Section A

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

Section B

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

Section C

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost- benefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

Section D

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system.

Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world

Suggested Reading

1. Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi.
2. Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
3. Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.
4. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
5. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi.
6. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

Course Outcomes:

CO- 1. Students will get knowledge about origin, history, concept, philosophy and ecological principles of IPM.

CO- 2. They will be able to assess crop losses, economic thresholds and cost benefit ratios.

CO- 3. They will be acquainted with different sampling techniques and insect-pest population estimation methods.

CO- 4. Students will learn about designing and implementation of IPM programmes for different crops and constraints in IPM implementation.

SEMESTER-III

PPL-532 Techniques for Detection and Diagnosis of Plant Diseases

Time: 3 Hours **Maximum Marks: 100**

Practical: 75

Internal assessment: 25

Credit hours: 2(0+2)

Course Objectives

The course aims to:

1. To impart knowledge to the students about detection and diagnosis of various plant pathogens, their isolation, preservation
2. To impart knowledge on various plant pathological lab techniques

Course Contents:

Practical:

- Detection of plant pathogens 1. Based on visual symptoms, 2. Biochemical test 3. Using microscopic techniques, 4. Cultural studies; (use of selective media to isolate pathogens). 5. Biological assays (indicator hosts, differential hosts) 6. Serological assays 7. Nucleic acid based techniques (Non-PCR–LAMP, Later flow microarray and PCR based- multiplex, nested, qPCR, immune capture PCR, etc.)
- Phenotypic and genotypic tests for identification of plant pathogens
- Molecular identification (16S rDNA and 16s-23S rDNA intergenic spacer region sequences-prokaryotic organisms; and eukaryotic organism by ITS region) and whole genome sequencing;
- Volatile compounds profiling by using GC-MS and LC-MS;
- FAME analysis, Fluorescence in-situ Hybridization (FISH), Flow Cytometry, Phage display technique, biosensors for detection of plant pathogens;
- Genotypic tools such as genome/ specific gene sequence homology comparison by BLAST (NCBI and EMBL) and electron microscopy techniques of plant virus detection and diagnosis.

Suggested Reading:

1. Baudoin ABAM, Hooper GR, Mathre DE and Carroll RB. 1990. Laboratory Exercises in Plant Pathology: An Instructional Kit. Scientific Publ., Jodhpur.
2. Dhingra OD and Sinclair JB. 1986. Basic Plant Pathology Methods. CRC Press, London, Tokyo.
3. Fox RTV. 1993. Principles of Diagnostic Techniques in Plant Pathology, CABI Wallington.
4. Forster D and Taylor SC. 1998. Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology. Humana Press, Totowa, New Jersey.
5. Mathews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Boca Raton, Tokyo.
6. Matthews REF. 1993. Diagnosis of Plant Virus Diseases. CRC Press, Florida.
7. Noordam D. 1973. Identification of Plant Viruses, Methods and Experiments. Cent. Agic. Pub. Doc. Wageningen.
8. Pathak VN. 1984. Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi.

9. Trigiano RN, Windham MT and Windham AS. 2004. Plant Pathology-Concepts and Laboratory Exercises. CRC Press, Florida.Chakravarti BP. 2005. Methods of Bacterial Plant Pathology. Agrotech, Udaipur.

Course Outcomes:

CO1: Thorough knowledge about Proving Koch postulates with biotrophs and necrotroph pathogens.
CO3: To study about Principles, constriction and working of different microscopic techniques and staining methods.
CO4: To demonstrate evaluation of fungicides and bactericides against different diseases.

SEMESTER-III

***ENT-591** **CREDIT SEMINAR**

Maximum Marks: 100

Theory:100

Credits hours: 1(1+0)

SEMESTER-III

***PGS-531 Intellectual Property & its management in Agriculture**

Time: 3 Hours **Maximum Marks: 100**
Theory: 100
Credit hours: 1(1+0)

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 20 marks (comprising of 10 short answer type questions) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A,B,C,D) and the candidate will attempt 4 questions (one from each section). All questions will carry equal 20 marks.

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

Course Contents:

Theory:

Section A: Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Section B: Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection;

Section C: Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity;

Section D: International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings:

1. Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

Course outcomes:

After the successful completion of this course students will be able to:

• Use different tools of IPR for their rights.

• They will be able to guide the innovative farmers regarding various IPR tools and their use for protection of their rights.

SEMESTER-III

***ENT-599** ***Masters' Research**

S/US
Credits hours: 10(0+10)

SEMESTER-IV

ENT-541 **Insect Ecology**

Time: 3 Hours **Maximum Marks: 100**

Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions, out of which first question of 10 marks (comprising of 10 short answer type questions of 1 mark each) covering the whole syllabus will be compulsory.
4. Of the remaining 8 questions, two questions will be asked from each section (A, B, C, D) and the candidates will attempt 4 question (one from each section). All questions will carry equal marks (10).

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

Course Contents:

Theory:

Section A

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

Section B

Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) – aestivation, hibernation.

Section C

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions – The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

Section D

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology. Climate change and insect pest/ natural enemy population; ecological engineering.

Practical:

• Types of distributions of organisms;

• Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution;

• Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit;

• Fitting Holling's Disc equation;

• Assessment of prey-predator densities from natural systems and understanding the correlation between the two;

• Assessing and describing niche of some insects of a single guild;

• Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms;

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

• Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

Suggested Reading

1. Burges HD and Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.
2. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, New York.
3. Dhaliwal GS and Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publishers, New Delhi.
4. Gerson H and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York.
5. Huffaker CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
6. Ignacimuthu SS and Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi.
7. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.
8. Van Driesche and Bellows TS. Jr. 1996. Biological Control. Chapman and Hall, New York.

Course Outcomes:

It would help in different aspects of interactions of insects with different abiotic factors of ecosystem like temperature, relative humidity, light, air and water currents, influence of biotic

Factors like intraspecific Interactions – Competition, Sex relations, Reproduction, Parental care, Cooperation, aggregation, colonial and social life and interspecific interactions like competition, Commensalism, Symbiosis, Parasitism – host interactions, Predators-prey interaction. The concept of population dynamics, different modes for sampling, population Growth, Causes of Population Fluctuations, Host plant insect interactions, Biochemical adaptation against environmental stress – Hibernation, Aestivation, Dormancy, Quiescence, Diapause, Polymorphism and Swarming in different insects

SEMESTER-IV

***PGS-541 Basic Concepts in Laboratory Techniques**

Time: 3 Hours **Maximum Marks: 100**
Practical: 100
Credit hours: 1(0+1)

Instructions for the Paper Setters:

1. The question paper will consist of nine skill-oriented questions.

2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5×8=40 Marks)

3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4×15= 60 Marks)

Course Objectives: To acquaint the students about the basics of commonly used techniques in laboratory. It will also help the students to safely use the Laboratory tools and equipments which will avoid various laboratory accidents.

Course contents:

Practical:

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps,viscometerthermometer,magneticstirrer,microvens,incubators,sandbath,waterbath,oilbath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings:

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

Course outcomes:

After completion of this course students are expected to:

• Handling the laboratory chemicals and equipment safely.

• Use the laboratory resources precisely.

• Can guide farmers regarding preparation of doses of various agro chemicals in the field.

SEMESTER-IV

***ENT-599** ***Masters' Research**

S/US
Credits hours: 10(0+10)