GURU KASHI UNIVERSITY

M.Sc. Entomology

Session: 23-24

Department of Entomology

Graduate Outcomes of the programme

Estimate and evaluate methods of population estimation of insect pests in various agro ecosystems. Apply taxonomic keys in correct identification of insect's characterization and classify insect pests of economic importance. Create expertise in the identification, ecology, life history of insect pests and basic principles and strategies in the management of insect pests.

Program Learning Outcomes

1 Comprehend the principles and methodologies used in Entomology. Acquaint themselves about external morphology of the insect's body, *i.e.*, head, thorax and abdomen, their appendages and functions.

2 Familiarize the students with principles of insect pest management, including concept and philosophy of integrated pest management (IPM).

3 Train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomo-pathogenic microorganisms.

4 Impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology and adaptation of different system of insects according to habits and habitats of the insects.

5 Utilize the concepts of ecology and basic principles of distribution

6 Train students in sampling methodology, calculation of diversity indices, constructing life tables, and relating insect population fluctuations to biotic and abiotic factors.

7 Develop comprehension relevant to the basic concepts of toxicology, types of insecticides and their formulations, plant protection appliances and bioassay techniques.

8 Appraise the students of advanced techniques in handling of different bio agents, modern methods of biological control and scope in cropping system-based pest management in agro ecosystems.

Programme Structure							
Sr. No.	Course Code	Course Title	Type of Course	(Hours Per Week)			Total Credits
				L	T	P	
Semester I							
1	MEN101	Insect Morphology	Major	2	0	2	3
2	MEN102	Insect Ecology	Major	2	0	2	3
3	MEN100	Master Research	Thesis Research	NA	NA	NA	4NC
4	MPP301	Techniques for Detection and Diagnosis of Plant Diseases	Minor (CBCS)	2	0	2	3
5	MPP302	Integrated Disease Management	Minor (CBCS)				
6	MAR121	Agriculture statistics	Supporting	3	0	2	4
7	MAR125	Library and Information Services Lab	Common	0	0	4	2
	Total Credits						15+4NC
Semester II							
8	MEN201	Anatomy and Physiology of Insects	Major	2	0	2	3
9	MEN202	Insect Taxonomy	Major	2	0	2	3
10	MEN203	Biological Control of Insect Pests and Weeds	Major	2	0	2	3
11	MEN204	Host Plant Resistance	Major	1	0	2	2
12	MAR206	Fundamentals of Computer Applications	Supporting		-	4	2
13	MEN206	Seminar I	Major	0	0	2	2
14	MEN100	Master Research	Thesis Research	NA	NA	NA	5NC
	Total Credits						15+5NC
Semester III							
15	MEN301	Toxicology of Insecticides	Major	2	0	2	3
16	MEN302	Concepts of Integrated Pest	Major	2	0	2	3

		Management					
17	MAR203	Weed Management	Minor (CBCS)	2	0	2	3
18	MPP202	Molecular Approaches in Plant Protection	Minor (CBCS)				
19	MAR304	Technical writing and communication skills	Common		-	4	2
20	MEN100	Master Research	Thesis Research	NA	NA	NA	10NC
	Total Credits						11+10NC
Semester IV							
21	MEN401	Post Harvest Entomology	Major	1	0	2	2
22	MEN402	Apiculture	Major	2	0	2	3
	MEN403	Sericulture	Major				
24	MEN404	Insect Vectors of Plant Pathogens	Minor	1	0	2	2
25	MEN405	Principles of Acarology	Minor				
26	MAR402	Intellectual Property and its Management in Agriculture	Common	2	0	0	2
27	MEN100	Master Research	Thesis Research	NA	NA	NA	11NC
	Total Credits						9+11NC
	Grand total						50+30NC

- **CBCS- Choice Based Credit System**
- **NC- Non Credit**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]

Continuous Assessment 1: [10 Marks]
Continuous Assessment 2: [10 Marks]
Continuous Assessment 3: [05 Marks]

B. Mid Semester Test: [30 Marks]
C. End-Term Exam: [40 Marks]
D. Attendance: [5 Marks]

For the CAs the teacher shall take surprised test/term paper/quiz/assignments

Evaluation Criteria for practical Courses

- The syllabus of subject is divided into five experiments, each experiment marks is of 20 marks (10 lab performance, 5 viva, 5 lab record)- Total marks 100

Evaluation Criteria for Seminar

- It is of total Marks-100

Collection of review of literature - 20marks
Data Analysis -20 marks
Power Point Presentation - 20 marks
Presentation skills - 20 marks
Viva voce - 20 marks

Evaluation Criteria for Master Research

- The evaluation is Satisfactory or Unsatisfactory on the basis of the performance of the candidate.

Semester I

Course Title: Insect Morphology
Course Code: MEN101

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Collect insect fauna and their identification up to family level.
2 Classify and name of the insects
3 Study importance of common names and technical names of insects in agriculture
4 Understand and apply rules of zoological nomenclature for better understanding of phylogeny of insects

Course Contents (Theory)

Unit-I **8hours**

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.

Unit-II **8hours**

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.

Unit-III **7hours**

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

Unit-IV **7hours**

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.

Course Content (Practical)

30 hours

• 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

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.*
- *Gillott C. 1995. Entomology, 2nd Ed. Plenum Press, New York, London.*
- *Peterson A. 1962. Larvae of Insects. Ohio University Press, Ohio.*
- *Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.*
- *Tembhore DB. 2000. Modern Entomology, Himalaya Publishing House, Mumbai.*
- *Stehr FW. 1998. Immature Insects. Vols. I, II. Kendall Hunt Publication, Iowa.*

Course Title: Insect Ecology
Course Code: MEN102

L	T	P	Credits
2	0	2	3

Total Hours -60

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Impart knowledge on ecological significance of feeding guilds in phytophagous insects.
2 Explain about predators, parasites, parasitoids, and hyper parasitoids.
3 Develop a module for identification of different ways by which insects may defend themselves against predators and parasites.
4 Analyze the sampling techniques for population estimations.

Course Content

Unit-I **8hours**

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

Unit-II **9hours**

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.

Unit-III **7hours**

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.

Unit-IV **6 hours**

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w, Relation between the two and their association with Dyar's Lawand 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.

Course Content (Practical) **30 hours**

• 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

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning

Suggested Reading

- *Begon M, Townsend CR and Harper JL. 2006. Ecology: From Individuals to Ecosystems. 4th Ed. Blackwell Publishing, USA/ UK/ Australia.*
- *Chapman JL and Reiss MJ. 2006. Ecology: Principles and Applications. 2nd Ed. Cambridge Univ. Press, Cambridge.*
- *Fowler J, Cohen L and Jarvis P. 1998. Practical Statistics for Field Biology. 2nd Ed. John Wiley& Sons, Chichester, West Sussex PO19 8SQ, England.*
- *Gotelli NJ and Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, MA*

Course Title: Agriculture statistics
Course Code: MAR121

L	T	P	Credits
3	0	2	4

Total Hours-75

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Study about statistical principles apply in all the areas of experimental work
2 Understand the requirement at the national level and farm level for agriculture policy making,
3 Helps to develop decision making, agriculture development and estimates agriculture and national income
4 Study the importance of statistics in agriculture, helps to ascertain the volume of crop that needs to be produced based on output and demand of previous year

Course Content

Unit I **10hours**

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Hypothesis testing.

Unit II **15hours**

Concept of p-value. Tests of significance-t, F and chi-square (X^2); Data transformation and missing plot techniques.

Unit III **15hours**

Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs.

Unit IV **5hours**

Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Course Content (Practical)

30 Hours

- Correlation analysis. Regression analysis (exponential, power function, quadratic, multi-variate, selection of variables, validation of models, ANOVA and testing of hypothesis).
- Tests of significance (Z-test, t-test, F-test and Chi-square test). Analysis of variance.
- Completely randomized design.
- Randomized block and latin square designs.
- Missing plot and analysis of covariance.
- 24 and 33 simple and confounded experiments.
- Split plot designs. Factorial in split plot designs.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring

Suggested readings:

- Panse, V.G. and Sukhatme, P.V. 1954. *Statistical methods for agricultural workers. Pp. 361.*
- *Gupta, S.C. and Kapoor, V.K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.pp. 0.*
- *Snecdecor, G.W. and Cochran, W.G. 1989. Statistical Methods, 8th Edition. Wiley-Blackwell. Pp.524.*
- *Rangaswamy, R. 2016. Textbook of Agricultural Statistics. New Age International (P) Ltd. New Delhi. pp. 531.*

Course Title: Integrated Disease Management
Course Code: MPP302

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Understand the concept and tools of integrated disease management
2 Learn about the various components of integrated disease management, their limitations and implications
3 Study about the development of IDM for the control of diseases
4 Familiarize with the IDM adaptation in important crops, rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearl millet, Kharif pulses, vegetable and fruit crops

Course Content

Unit I **6hours**
Introduction, definition, concept and tools of disease management.

Unit II **9hours**
Components of integrated disease management, their limitations and implications.

Unit III **5hours**
Development of IDM and its adaptation in important crops, rice, wheat, cotton, sugarcane.

Unit IV **10hours**
Development of IDM and its adaptation in important crops chickpea, rapeseed mustard, pearl millet, Kharif pulses, vegetable and fruit crops.

Course Content (Practical)

30 hours

- Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM.
- Demonstration of IDM in certain crops as project work.

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Sharma, R.C. and Sharma, J.N.2018. Integrated Plant Disease Management, Scientific Publisher, Jodhpur .pp. 362.*
- *Nagarajan,S. 2013. Dynamics of Plant Diseases, Allied Publishers, New Delhi, India. pp. 120.*
- *Mehrotra, R.S. 2011.Plant Pathology, McGraw Hill Education, New York, United States. pp. 910.*
- *Gupta, V.K. and Sharma, R.C. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur. pp. 319.*

Course Title: Techniques for Detection and Diagnosis of Plant Diseases
Course Code: MPP301

L	T	P	Credits
2	0	2	3

Total Credits-60

Learning Outcomes:

Study the isolation of pathogens using selective media, pure culture techniques. Also, the methods to prove Koch's postulates with biotroph and necrotroph pathogens in Lab.

1) Learn about the preservation of plant pathogens and disease specimens.
2) Understand the use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.
3) Get Familiar with the use of microscopic techniques and staining methods, chromatography, phase contrast and electron microscopy, spectrophotometer, ultracentrifuge and electrophoretic apparatus.
4) Demonstrate the serological and molecular techniques for detection of plant pathogens.

Course Contents

UNIT I **9hours**

Weed biology, ecology and crop-weed competition including allelopathy. Scope and principles of weed management and control/weed classification, biology, ecology and allopath, crop weed indices. History and development of herbicide.

UNIT II **7hours**

Classification and selectivity of herbicides based on chemical, physiological application and selectivity. Mode and mechanism of action of important herbicides. Herbicide structure- activity relationship and factors affecting the efficiency of herbicides.

UNIT III **6hours**

Herbicide formulations and mixtures. Weed control through bio-herbicides, myco-herbicides and allelo-chemicals. Degradation of herbicides in soil and plants. Herbicide resistance in weeds and crops herbicide rotations.

UNIT IV **8hours**

Weed management in major crops and cropping systems. Management of parasitic weeds and special weed problems. Weed shifts in cropping systems. Aquatic and perennial weed control. Integrated weed management. Cost: benefit analysis of weed management.

Course Content (Practical) **30 hours**

- Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.
- Preservation of plant pathogens and disease specimens, use of centrifuge, pH meter, micrometer, haemocytometer, camera lucida.
- Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of manuscripts

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings

- *Meena, A. K., Godara, S. L. and Meena, P . N. 2020. Detection and Diagnosis of Plant Diseases. Scientific Publishers, Jodhpur, Rajasthan. pp. 124.*
- *Boonham, N., Tomlinson, J. and Mumford, R. 2016. Molecular Methods in Plant Disease Diagnostics, Principles and Protocols. CABI Publishing. New Delhi. pp. 212.*
- *Kumar, P. Tiwari, A.K., Kamle, M. Abbas, Z. Singh, P. 2019. Plant Pathogens, Detection and Management for Sustainable Agriculture. Apple Academic Press, Florida, USA. pp.362.*

Course Title: Library and Information services
Course Code: MAR125

L	T	P	Credits
0	0	4	2

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1 Identify library services and availability of resources in order to develop a realistic overall plan for research
2 Use general information resources to increase familiarity with the topic and disciplinary vocabulary
3 Learn about the research topic, question or thesis to achieve a manageable focus appropriate to the assignment criteria, available resources, and evidence needed to support thesis
4 Identify keywords, synonyms and related terms in order to flexibly Effective search

Course Content

- Introduction to Library and its services; five laws of library science; type of documents;
- Classification and cataloguing; organization of documents;
- Sources of information primary, secondary and tertiary;
- Current awareness and SDI services; tracing information from reference sources;
- Library survey; preparation of bibliography; use of Online Public Access Catalogue;
- Use of CD-ROM databases and other computerized library services, CeRA,
- J-Gate; use of Internet including search engines and its resources; e-resources.

Suggested readings:

1. *Gita, S. 2012. Library and Information Services. LAP Lambert Academic Publishing.USA. pp. 76.*
2. *Kishore, A. 2021. A Conceptual approach to library and information science A complete self study guide.2nd edition. AKB Publication. Jaipur. pp. 250*

Course Title: Master Research
Course Code: MEN100

L	T	P	Credits
NA	NA	NA	5 NC

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments

Semester II

Course Title: Anatomy and Physiology of Insects
Course Code: MEN201

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Identify different layers of insect's exoskeleton and their functioning.
2 Describe the male and female reproductive systems of insects and identification the internal and external structures associated with each sex.
3 Possess knowledge about the major parts of an insect's head capsule, including sclerites, sutures, and appendages.
4 Understand the structure and functioning of insect mouthparts and their evolution.

Course Contents

Unit-I **18hours**

Scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosysthesis of chitin

Unit-II **8hours**

Growth, hormonal control, metamorphosisand diapause; pheromone secretion, transmission, perception and reception.

Unit-III **8hours**

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

Unit-IV **6hours**

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.

Course Content (Practical) 30 hours

• Determination of chitin in insect cuticle;
• Examination and count of insect haemocytes; preparation and evaluation of various diets;
• Consumption, utilization and digestion of natural and artificial diets.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London.*
- *Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publishers, NewDelhi.*
- *Gullan PJ and Cranston PS. 2000. The Insects: An Outline of Entomology, 2nd Ed. Blackwell Science, UK.*
- *Patnaik BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi.*

Course Title: Insect Taxonomy
Course Code: MEN202

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to:
1. To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same.
2. To introduce the students to the classification of insects up to the level of families
3. Hands-on experience in identifying the families of insects with an emphasis on the practical aspects.

4. Ability to properly collect, preserve and label insect specimens

Course Content

Unit I **9 hours**

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

Unit-II **7 hours**

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

Unit-III **8 hours**

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.

Unit-IV **6 hours**

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.

Course Content (Practical) **30 hours**

• 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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca.*
- *Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi.*
- *Gullan PJ and Cranston PS. 2010. The Insects: An outline of Entomology. 4th Ed. Wiley-Blackwell Publications, West Sussex, UK.*

- *Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw Hill, New Delhi.*
- *Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.*

Course Title: Biological Control of Insect Pests And Weeds

Course Code: MEN203

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Appraise the students about potential of useful insects in agricultural pest management
2 Acquaint with economic importance of different categories of insects
3 Evaluate efficacy of various bio pest control agents
4 Do mass production of natural enemies of pest insects

Course Content

Unit-I **9hours**

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

Unit-II **7 hours**

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.

Unit-III **8hours**

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

Unit-IV **6hours**

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.

Course Content (Practical) 30 hours

• 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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Burges, H.D. and Hussey, N.W. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.*
- *De Bach, P. 1964. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.*
- *Dhaliwal, G.S. and Arora, R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.*
- *Gerson, H. and Smiley, R.L. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman & Hall, New York*

Course Title: Host Plant Resistance
Course Code: MEN204

L	T	P	Credits
1	0	2	2

Total Hours-45

Learning Outcomes:

1 Apart knowledge on the sources of resistant plants to insect pest.
2 Learn about various factors affecting plant resistance to insects.
3 Apply various techniques of plant resistance to insect pest
4 Acquaint with the breeding techniques for insect resistance in crops.

Course Content

Unit-I **4hours**
History and importance of resistance; principles, classification, components, types and mechanisms of resistance. Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit-II **4hours**
Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance – acquired and induced systemic resistance.

Unit-III **4hours**
Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Unit-IV **3hours**
Factors affecting plant resistance including biotypes and measures to combat them. Role of biotechnology in plant resistance to insects.

Course Content (Practical) **30 hours**

• Screening techniques for measuring resistance

• Measurement of plant characters and working out their correlations with plant resistance
• Testing of resistance in important crops
• Bioassay of plant extracts of susceptible/ resistant varieties
• Demonstration of antibiosis, tolerance and antixenosis

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Dhaliwal, G.S. and Singh, R. (Eds). 2004. Host Plant Resistance to Insects – Concepts and Applications. Panima Publ., New Delhi.*
- *Maxwell, F.G. and Jennings, P.R. (Eds). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons, New York.*
- *Smith, C.M. 2005. Plant Resistance to Arthropods – Molecular and Conventional Approaches. Springer, Berlin.*

Course Title: Fundamentals of Computer Applications Lab
Course Code: MAR206

L	T	P	Credits
0	0	4	2

Total Hours-60

Learning Outcomes: On successful completion of this course, the students will able to**:**

1 Learn and understand about basics of MS-Word, Excel, preparation of Graphs
2 Read, understand, and interpret material on technology. They will have an appreciation for some of the ideas, issues, and problems involved in writing about technology and in workplace writing.
3 Understand the operating systems, peripheral devices, networking, multimedia and internet
4 Familiarize with basic sources and methods of research and documentation on topics in technology, including on-line research.

Course Content (Practical) 30 hours

- Ms-word: creating a document, saving and editing, use of options from tool bars, format, insert and tools (spelling and grammar)
- Alignment of text, creating a table, merging cells, column and row width.
- Ms-excel: entering expressions through the formula tool bar and use of inbuilt functions, sum, average, max, min.
- Creating graphs and saving with and without data in Ms-excel.
- Ms-access: creating database, structuring with different types of fields.
- Ms-power point: preparation of slides on power point.
- Internet Browsing: browsing a web page and creating of E-Mail ID. Agri. net (ARIS).

Suggested Readings:

- *Salaria, R.S. 2017. Computer Fundamentals. Daryaganj, New Delhi. pp. 486.*
- *Manish, S. and Bhatt, A. 2016. Computers in Agriculture: Fundamentals and Applications. New India Publishing Agency. New Delhi. pp. 190.*
- *Manjunath, B.E. 2010.Computer Basics. Vasan Publications, Bengaluru, Karnataka. pp. 356*

Course Title: Seminar I
Course Code: MEN206

L	T	P	Credits
0	0	2	2

Learning Outcomes: On successful completion of this course, the students will able to:

1 Show competence in identifying relevant information, defining and explaining topics under discussion
2 Present the classical and innovative work related to entomology subject.
3 Reach across diverse disciplines to apply theories, methods and knowledge bases from multiple fields to a single question or problem
4 Judge when to speak and how much to say, speak clearly and audibly in a manner appropriate to the subject

Course Content

Seminar topic will be suggested by faculty

Course Title: Master Research
Course Code: MEN100

L	T	P	Credits
NA	NA	NA	5NC

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments

Semester III

Course Title: Toxicology of Insecticide
Course Code: MEN301

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Recognize the major classes of insecticide and understand their mode of action
2 Demonstrate the various processes involved in toxic dynamics of insecticides
3 Get awareness regarding the limitations of insecticide use such as resistance and environmental contamination
4 Develop a basic understanding on performing insect bioassays

Course Content

Unit-I **6 hours**

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Unit-II **10hours**

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, tertiaryamines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

Unit-III **8hours**

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and

phytotoxicity. bioassay definition, objectives, criteria, factors, problems and solutions.

Unit-IV **6hours**

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis.

Course Content (Practical) **30 hours**

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

Transaction Mode

Learning Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative

Suggested readings

- *Gupta, H.C.L.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.*
- *Ishaaya, I. and Degheele, (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.*
- *Matsumura, F. 1985. Toxicology of Insecticides. Plenum Press, New York.*
- *Prakash, A. and Rao, J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.*

Course Title: Concepts of Integrated Pest Management
Course Code: MEN302

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

1 Acquire knowledge about losses due to insect pests in crops and stored grains.
2 Learn about the components of IPM
3 Disseminate knowledge about surveillance, forecasting and issuing of pest alerts.
4 Analyze merits and constraints of IPM vis-à-vis chemical control measures.

Course Content

Unit I **10hours**

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.

Unit-II **10hours**

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

Unit-III **5hours**

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.

Unit-IV **5hours**

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.

Course Content (Practical) **30 hours**

- Characterization of agro-ecosystems.
- Sampling methods and factors affecting sampling.
- Population estimation methods.
- Crop loss assessments, potential losses, avoidable and unavoidable losses.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Atwal, A.S., Dhaliwal, G.S. and David, B.V. 2001. Elements of Economic Entomology. Popular Book Depot, Chennai.*
- *Dhaliwal, G.S., Singh, R. and Chhillar, B.S. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi. .*
- *Dunston, A.P. 2007. The Insects: Beneficial and Harmful Aspects. Kalyani Publishers, New Delhi*
- *Evans, J.W. 2005. Insect Pests and their Control. Asiatic Publ., New Delhi.*

Course Title: Weed Management
Course Code: MAR203

L	T	P	Credits
2	0	2	3

Total Credits-60

Learning Outcomes:

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

1 Identify the weed and its four stages of development.
2 Understand the difference between annual, biennial and perennial weeds.
3 Give examples of cultural weed controls.
4 Know the advantages and disadvantages of the various methods of herbicides applications.

Course Contents

UNIT I **9hours**

Weed biology, ecology and crop-weed competition including allelopathy. Scope and principles of weed management and control/weed classification, biology, ecology and allopath, crop weed indices. History and development of herbicide.

UNIT II **7hours**

Classification and selectivity of herbicides based on chemical, physiological application and selectivity. Mode and mechanism of action of important herbicides. Herbicide structure- activity relationship and factors affecting the efficiency of herbicides.

UNIT III **6hours**

Herbicide formulations and mixtures. Weed control through bio-herbicides, myco-herbicides and allelo-chemicals. Degradation of herbicides in soil and plants. Herbicide resistance in weeds and crops herbicide rotations.

UNIT IV **8hours**

Weed management in major crops and cropping systems. Management of parasitic weeds and special weed problems. Weed shifts in cropping systems. Aquatic and perennial weed control. Integrated weed management. Cost: benefit analysis of weed management.

Course Content (Practical) 30 hours

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

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings

- Smith, A.E. 1995. *Handbook of weed management systems*. CRC press publishers, US
- Jana, B.L. 2015. *A Text Book Of Weed Management (Weeds And Their Control Methods*). Pointer Publishers. Delhi.
- Das, T. K. 2008. *Weed Science: Basic and Applications*. Jain brothers, New Delhi
- Gupta, O.P. 1998. *Weed Management: Principles and Practices*. Agrobios publications. New Delhi

Course Title: Molecular Approaches in Plant Protection
Course Code: MPP202

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Understand the basic concepts and principles to study host pathogen relationship
2 Learn about the recognition system and signal transduction of pathogens
3 Acquire basic knowledge about induction of defense responses-pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, programmed cell death, viral induced gene silencing
4 Study the importance of biotechnology in disease management

Course Content

Unit I **9hours**

Recent concepts of molecular biology and techniques used in plant protection. Genes of interest in plant protection. Identification, characterization and isolation of novel genes involved in pest resistance.

Unit II **8hours**

Molecular basis of host plant-insect and pathogen interactions. PR-proteins and G-proteins. Molecular characterization of biodiversity-insects and pathogens.

Unit III **7hours**

Molecular biology of baculoviruses. Molecular mechanisms of genetically engineered plants for pest resistance and pesticide resistance.

Unit IV **6hours**

Improvement of biocontrol agents and useful insects using molecular techniques. Bio-safety related issues.

Course Content (Practical) 30 hours

- Molecular characterization of pest populations.
- Detection of biotypes/races.
- Establishment of phylogenetic relationships/dendrograms.
- Detection of Cry-gene and estimation of cry-toxin; characterization of capsid proteins of insect viruses.
- Detection of disease induced biochemical changes at molecular level.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- Marshall, G. 1994. *Molecular Biology in Crop Protection*. Springer, Netherlands. pp. 283.
- Nagarajan, S. 2013. *Dynamics of Plant Diseases.* Allied Publishers, New Delhi, India. pp. 120.
- Mehrotra, R.S. 2011. *Plant Pathology.* McGraw Hill Education, New York, United States. pp. 910.

Course Title: Technical writing and communication skills	**L**	**T**	**P**	**Credits**
Course Code: MAR304	0	0	4	2

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Understand and know how to follow the stages of the writing process (prewriting/writing/rewriting) and

2 Apply them to technical and workplace writing tasks

3 Produce a set of documents related to technology and writing in the workplace and will have improved their ability to write clearly and accurately

4 Understand the basic components of definitions, descriptions, process explanations, and other common forms of technical writing

Course Content

Unit I **15 hours**

Various forms of scientific writings: theses, technical papers, review, manuals etc., various parts of thesis and research communications: title page, authorship contents page, preface.

Unit II **15 hours**

Introduction, review of literature, material and methods, experimental results and discussion;

Unit III **15 hours**

Writing of abstracts, summaries, citations etc.

Unit IV **15 hours**

Commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; paginations, numbering of tables and illustrations; writing of numbers and dates in scientific write-ups; editing and proof reading; writing a review article, access methods.

Suggested readings:

- *Day, R.A. and Gastel, B. 2011. How to Write and Publish a Scientific Paper, 7th Edition. Greenwood Press, United States. pp. 300.*

- *Laplante, P.A. 2011. Technical Writing: A Practical Guide for Engineers and Scientists.CRC Press, London. pp. 250.*
- *Greenlaw, R. 2012. Technical Writing, Presentational Skills and Online Communication: Professional Tools and Insights. Idea Group, U.S. pp. 247.*

Course Title: Master Research
Course Code: MEN100

L	T	P	Credits
NA	NA	NA	9NC

Learning Outcomes:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.

Semester IV

Course Title: Post Harvest Entomology
Course Code: MEN401

L	T	P	Credits
1	0	2	2

Total Hours-45

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1 Study extent of losses in stored grains and their products.
2 Diagnose various types of pest(insects and non-insects) problems in stored conditions
3 Disseminate preventive and curative measures of pest management in stored grains.
4 Study the importance of sanitation and other non-chemical methods of pest control

Course Content

Unit-I **4hours**

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

Unit-II **4 hours**

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

Unit-III **4hours**

Ecology of insect pests of stored commodities/ grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains

and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

Unit-IV **3 hours**

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.

Course Content (Practical) **30 hours**

• 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

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Hall DW. 1970. Handling and Storage of Food Grains in Tropical and Subtropical Areas. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.*
- *Jayas DV, White NDG and Muir WE. 1995. Stored Grain Ecosystem. Marcel Dekker, New York.*
- *Khader V. 2004. Textbook on Food Storage and Preservation. Kalyani Publishers, New Delhi.*

Course Title: Apiculture
Course Code: MEN402

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to:

1. Adopt and implement the Apiculture
2. Learn about Industrial use of bees and other insects producers of honey, wax and lac products
3. Understand the role of different insects (honey bees, bumble bees, wasps, flies and beetles) as pollinators of crops
4. The course will be useful for providing self-employment to the learner

Course Content

Unit-I **8hours**

Historical development of apiculture at global level and in India; Classification of bees; global distribution of genus Apis and races; Morphology and anatomy of honey bee; Honey bee biology, ecology, adaptations; Honey bee behaviour – nest founding, comb construction, brood care, defense, other in-house and foraging activities; Bee pheromones; Honey bee communication.

Unit-II **6hours**

Commercial beekeeping as an enterprise; Design and use of bee hives; Apicultural equipment; Seasonal bee husbandry; Honey bee nutrition and artificial diets; Absconding, swarming, drifting – causes and management; Curbing drone rearing; Laying worker menace – causes, signs and management.

Unit-III **8hours**

Bee genetics; Principles and procedures of bee breeding; Screening of honey bee colonies; Techniques in mass queen bee rearing; Mating nuclei and their establishment; Selective mating; Queen bee management; Bee packages. Honey – composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification –potential and profitability; Production/ collection of bee

pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling; Apitherapy; Value addition of hive products; Development of apiculture project.

Unit-IV **8hours**

Ectoparasitic and endoparasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics; Wax moths, wasps and ants – biology, ecology, nature and symptoms of damage, management tactics; Predatory birds, their damage potential and management tactics; Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees. Non-Apis pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops.

Course Content (Practical) **30 hours**

• Morphological characteristics of honey bee
•Mouthparts; digestive, respiratory and reproductive adaptations in different castes of honey bees
• Recording of colony performance
• Seasonal bee husbandry practices
• Swarming, queen lessness, swarming, laying workers menaces, etc. and their remedies
• Innovative techniques in mass queen bee rearing; selection and breeding of honeybees
• Production technologies for various hive products
• Bee enemies and diseases and their management
• Recording pollination efficiency
• Application of various models for determining pollination requirement of crop

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings

- *Abrol DP and Sharma D. 2009. Honey Bee Mites and Their Management. Kalyani Publishers, New Delhi, India.*

- *Abrol DP. 2009. Honey bee Diseases and Their Management. Kalyani Publishers, New Delhi, India.*
- *Abrol DP. 2010. Beekeeping: A Compressive Guide to Bees and Beekeeping. Scientific Publishers, India.*

Course Title: Sericulture
Course Code: MEN403

L	T	P	Credits
2	0	2	3

Total Hours-60

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1. Start entrepreneurship of Sericulture
2. Learn rearing of silk worms for production of silk
3. Acquire knowledge about latest techniques of rearing in Apiculture**.**
4. Get hands-on training on Mulberry nursery management,
Silkworm rearing and Silk reeling

Course Content

Unit I **8hours**

History of Sericulture, importance, organizations involved in sericulture activities, silkworm types, distribution, area and silk production.
Mulberry species, ecological requirements, cultivation, improved varieties, propagation methods, sapling production, planting and pruning techniques; pest and diseases, management strategies; intercropping, water and weed management. Food plants of eri silkworm, castor cultivation, intercultural operations, nutrient and water management; method of harvest; host plants of Tasar, nursery and cultivation, selection of seed, soaking and heap making, pruning techniques. Food plants of Muga silkworm, Som and Soalu propagation methods; nursery techniques; intercultural operations and weed management.

Unit II **8hours**

Silkworm origin – classification based on voltinism, moultinism, geographical distribution and genetic nature – pure races –multivoltine and bivoltine races –cross breeds – bivoltine hybrids –Races and hybrids of mulberry, eri, tasar and muga silkworm- Morphology and biology of silkworm, sex limited characters anatomy of digestive and excretory systems of larva; structure and function of silkglands.

Unit III **8hours**

Rearing house, types, disinfection, room and bed disinfectants; egg incubation methods, Chawki rearing, feeding, cleaning and spacing; rearing of late age worms, feeding, cleaning, spacing and moulting care; mountages,

cocoon harvesting and marketing; pests and diseases of silkworms and their management.

Unit IV **6hours**

Post cocoon technology, stifling, cocoon cooking, brushing, reeling, re-reeling, bleaching, degumming, dyeing, printing and weaving, different reeling machines; value addition in sericulture; economics of sericulture.

Course Content (Practical) **30 hours**

- Morphology of mulberry plants
- Identification of popular mulberry genotypes
- Nursery bed and main field preparation
- Planting methods
- Identification of nutrient deficiency symptoms
- Identification of weeds
- Pruning and harvesting methods
- Identification of pests and diseases of mulberry– Terminalia arjuna, Terminalia tomentosa, Som and Soalu- Nursery and pruning techniques – Intercultural operations
- Morphology of silkworm – Identification of races – Dissection of mouth parts and silk glands – Disinfection techniques – rearing facilities – silkworm rearing –feeding, cleaning and spacing – Identification of pests and diseases of mulberry silkworm – hyperparasitoids and mass multiplication techniques – silkworm egg production technology –Tasar, Eri and muga silkworms – rearing methods–pests and diseases of non-mulberry silkworms Visit to grainage, cocoon market and silk reeling centre – Economics of silkworm rearing.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Dandin SB and K Giridhar. 2014. Hand book of Sericulture Technologies. Central Silk Board, Bangalore, 4p.*
- *Govindaiah G, VP, Sharma DD, Rajadurai S and Nishita V Naik. 2005. A text book on mulberrycrop protection. Central Silk Board, Bangalore.450 p*

Course Title: Insect Vectors of Plant Pathogens
Course Code: MEN404

L	T	P	Credits
1	0	2	2

Total Hours-45

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1 Learn typical features of insect vectors of plant pathogens
2 Understand significance of insect vectors vis-à-vis other pest insects of plants
3 Check potential of insect vectors in spreading crop diseases
4 Analyze the feasibility of implementing integrated disease management programs (IDMP) in agricultural crops

Course Content

Unit-I **4 hours**

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

Unit-II **4hours**

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

Unit-III **4 hours**

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips. Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

Unit-IV **3 hours**

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Course Content (Practical) **30 hours**

• Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes

• Culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies
• Vector rearing and maintenance
• Estimating vector transmission efficiency, studying vector-virus host interaction

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Basu AN. 1995. Bemisiatabaci (Gennadius) – Crop Pest and Principal Whitefly Vector of Plant Viruses. Oxford and IBH, New Delhi.*
- *Harris KF and Maramarosh K. (Eds.). 1980. Vectors of Plant Pathogens. Academic Press, London.*
- *Maramorosch K and Harris KF. (Eds.). 1979. Leafhopper Vectors and Plant Disease Agents. Academic Press, London.*

Course Title: Principles of Acarology
Course Code: MEN405

L	T	P	Credits
1	0	2	2

Total Hours-45

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1. To acquaint the students with external morphology of different groups of mites
2. Train in identification of commonly occurring families of plant associated mites
3. Provide information about important mite pests of crops
4. Provide information about their management

Course Content

Unit-I **4 hours**

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Soil arthropods and their classification, habitats and their identification.

Unit-II **4 hours**

Introduction to morphology and biology of mites and ticks. Broad classification major orders and important families of Acari including diagnostic characteristics.

Unit-III **4 hours**

Estimation of populations; sampling and extraction methods for soil arthropods. Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees.

Unit-IV **3 hours**

Management of mites using acaricides, phytoseiid predators, fungal pathogens, etc. Culturing of phytophagous, parasitic and predatory mites. Mode of action of acaricides, resistance of mites and ticks to acaricides, its management.

Course Content (Practical) 30 hours

• Collection of mites from plants, soil and animals
• Extraction of mites from soil, plants and stored products
• Preparation of mounting media and slide mounts
• External morphology of mites
• Identification of mites up to family level using key

Suggested readings:

- *Anderson JM and Ingram JSI. 1993. Tropical Soil Biology and Fertility: A Handbook of Methods. CABI, London.*
- *Chhillar BS, Gulati R and Bhatnagar P. 2007. Agricultural Acarology. Daya Publ. House, New Delhi.*
- *Dindal DL. 1990. Soil Biology Guide. A Wiley-InterScience Publ., John Wiley and Sons, New York.*
- *Gerson U and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, NewYork.*

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Course Title: Intellectual Property and its management in Agriculture
Course Code: MAR402

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes:

1. To equip students and stakeholders

2. Knowledge of Intellectual Property Rights (IPR) related protection systems,

3. Significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

4. Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Course Content

Unit-I **8 hours**

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.

Unit-II **8 hours**

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.

Unit-III **5 hours**

Protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.

Unit-IV **7 hours**

National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and

Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested readings:

- *Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.*
- *Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.*
- *Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies*

Course Title: Master Research
Course Code: MEN100

L	T	P	Credits
NA	NA	NA	11NC

Learning Outcomes:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.