

## *Department of Agricultural Entomology*

### *Ph.D programme*

Course No.	Title of the course	Credits
<b>1<sup>st</sup> Semester</b>		
ENT-701	Advance Insect Ecology	2+0
ENT-702	Insect Behaviour	1+1
ENT-703	Advanced Insecticides Toxicology	2+1
ENT-704	Acarine Taxonomy	2+1
ENT-705	Advance Nematode Management	2+1
<b>2<sup>nd</sup> Semester</b>		
ENT-751	Advance Insect Systematic	2+1
ENT-752	Advance Insect Physiology	2+0
ENT-753	Advance Biological Control	1+1
ENT-754	Advanced Nematological Techniques	0+2
ENT-755	Advance Nematode Ecology	1+1
ENT-799	Seminar-I	1+0
<b>3<sup>rd</sup> Semester</b>		
ENT-801	Advanced Integrated Pest Management	1+0
ENT-802	Advance Nematode Taxonomy	1+1
ENT-803	Molecular Approaches in Entomological Research	1+1
ENT-849	Seminar-II	1+0
<b>4<sup>th</sup> Semester</b>		
	Nil	
<b>5<sup>th</sup> Semester</b>		
	Nil	
<b>6<sup>th</sup> Semester</b>		
ENT-999	Seminar-III	1+0

ENT-1000	Doctoral Research	0+45
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## ENT 701

## Advanced Insect Ecology

2+0

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

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tritrophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites.

Host seeking behaviour of parasitoids. Meaning of stress - plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

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

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

### Practical

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

## ENT 702

## Insect Behaviour

1+1

## **Theory**

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

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

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

Foraging - Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Behaviour in IPM-Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

## **Practical**

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees.

Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees / *Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

**ENT 703**

**Advanced Insecticide Toxicology**

**2+1**

## **Theory**

### **UNIT I**

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Biochemical and physiological target sites of insecticides in insects.

Developments in biorationals, biopesticides and newer molecules; their modes of action and structural - activity relationships; advances in metabolism of insecticides.

Joint action of insecticides; activation, synergism and potentiation.

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

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

### **Practical**

Sampling, extraction, clean-up and estimation of insecticide residues by various methods; calculations and interpretation of data; biochemical and biological techniques for detection of insecticide resistance in insects.

## **ENT 704**

### **Acarine Taxonomy**

**2+1**

### **Theory**

Introduction, classification in details, general morphology. Characteristics, discussion on phylogenetic relationship. Internal anatomy, systematics and taxonomy of phytophagous mites. Family Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae- key to sub-families, tribe, genera. Classification of Phytoseiid mites: Family: Phytoseiidae, Cheyletidae, Stigmaeidae, Tyedidae, Bdellidae, Ascidae.

### **Practical**

Collection techniques of mites, Preparation of temporary and permanent mounting media. Preservation and slide preparation; taxonomic study of different economically important mite families up to genera and species level.

## **ENT 705**

### **Advanced Nematode Management**

**2+1**

Concept of nematode management in relation to crop loss and economics; principles of nematode management; classical nematode management practices; methods of nematode management -.physical method (heat, steam, hot-water treatment, irradiation, etc.), cultural method (tillage, cropping system and pattern, soil solarization, summer ploughing, flooding, organicc amendmets, antagonistic and cover crops etc.), biological method (fungal, bacterial, and other bioagents with their uses), legislative method (quarantine, pest risk analysis, and other, disinfection methods), chemical method- nematicides (including biological origin) – types, doses, formulation and application technology, botanicals in nematode management (nematicidal principles in plant origin, phytochemicals, organic cakes, phototherapeutic substances,, biofumigation etc. and their utilization). Host resistance for nematode management (concept of host resistance, mechanisms of resistance, procedure and methods of screening resistant / tolerant varieties against important nematodes), molecular approaches of nematode management (RNAi technology, molecular transfer of nematode resistance gene(s) and other novel approaches) Integrated nematode management (INM)- procedures and practices; Evaluation and integration of nematode control methods, role of Nematology in IPM; Factors affecting nematode management and importance of biological, ecological and epidemiological information in nematode management.

### **Practical**

Calculation of dose of nematicides, application of nematicides, bioefficacy of nematicides (invitro and in-vivo), mortality observation and testing, methods.delivery of bioagents (fungal and bacterial) for nematode management, Probit analysis and

calculation of LD50 Experimentation and estimation of avoidable yield loss. Computation and handling field data using computer softwares like M-stat/SPSS, Excel sheet etc. for, nematode management efficacy.

**ENT 751**

**Advanced Insects Systematics**

**2 + 1**

### **Theory**

Detailed study of three schools of classification numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation - processes and evidences. Zoogeography.

Study of different views on the evolution of insects - alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications - small publications of species descriptions, revisionary works, monographs, checklists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

### **Practical**

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, construction of taxonomic keys for the selected group. Development of descriptions, photographing, writing diagrams, and preparation of specimens for "typee like" preservation. Submission of the collections made of the group.' Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms. Taxonomic study of important families up to genera / species level.

**ENT 752**

**Advanced Insects Physiology**

**2+0**

### **Objective**

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

### **Theory**

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin - protein interactions in various cuticles, types of sclerotization.

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

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of

sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

Endocrine system and insect hormones, physiology of insect growth and development – metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

**ENT 753                      Advanced Biological Control                      2+1**

**Theory**

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of biocontrol agents vis-a-vis target pest populations.

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

Colonization, techniques of release of natural enemies, recovery evaluation, conservation

and augmentation of natural enemies, survivorship analysis and ecological manipulation, large-scale production of biocontrol agents, bankable project preparation.

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

**Practical**

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

**ENT 754                      Advanced Nematological Techniques                      0+2**

**Practical**

Methods of nematode investigation and survey. Techniques of sampling, sample preservation; extraction of nematodes from soil - Baermann funnel, Cobb's decanting and

sieving, elutriation-and sugar centrifugal methods; extraction of cysts from soil; extraction of nematodes from plant material; estimation of population densities; staining plant material for nematodes; killing and fixing nematodes, clearing nematodes by Seinhorst's methods; preparation of temporary and permanent mounts; measurements, drawing, microphotography, special preparation of nematodes - perineal patterns, vulval cones, *enface* and body sections; collection of root exudates, preparation of exhibits of nematode diseased plant material, In vitro and in vivo culturing techniques of plant parasitic, bacteriophagous, mycophagous and omnivorous nematodes. Collection of plant root exudates and their bioassay; preservation of nematode and nematode infested plant parts; preparation of plant materials for exhibition. Principles and use of



**ENT 802****Advanced Nematode Taxonomy****1+1**

Principles and rules of nomenclature and classification; different systems of classification, Phylogenetic systematics, variations, description of new species, uses of keys for nematode identification. Non-conventional approaches of nematode identification- molecular, biochemical, immunodiagnostic, molecular characterization , and DNA finger-printing techniques. Development of computer-based nematode identification programmes.

**Practical**

Detailed studies of morphological structures and identification of plant parasitic nematodes up to species level. Preparation of compendia and keys. Micrometry and use of camera lucida for drawings, Identification of species / races of root-knot' and cyst nematodes. Uses of electrophoresis and rDNA - RFLP for diagnosis of nematode species.

**ENT 803****Molecular Approaches in Entomological Approaches****1****Theory**

Introduction to molecular biology; techniques used in molecular biology.

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

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

Insect gene transformation; biotechnology in relation to silkworms and honey bees. Introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies. DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

**Practical**

Isolationn of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

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