

**DEPARTMENT OF ENTOMOLOGY  
SASRD, NAGALAND UNIVERSITY  
MEDZIPHEMA CAMPUS.**

<b>Sl. No.</b>	<b>Course No</b>	<b>Course title</b>	<b>Credit hrs.</b>
1.	ENT - 601	Advanced insect systematics	1+2
2.	ENT – 602	Immature stages of insects	1+1
3.	ENT - 603	Advanced insect physiology	2+0
4.	ENT - 604	Advanced insect ecology	1+1
5.	ENT - 605	Insect behaviour	1+1
6.	ENT - 606	Recent trends in biological control	1+1
7.	ENT - 607	Advanced insecticide toxicology	2+1
8.	ENT- 608	Advanced host plant resistance	1+1
9.	ENT - 609	Advanced acarology	1+1
10.	E NT - 610	Agricultural ornithology	1+1
11.	**ENT – 611	Molecular approaches in entomological research	1+1
12.	**ENT - 612	Advanced integrated pest management	2+0
13.	#ENT - 613/ PL PATH 606	Plant biosecurity and biosafety	2+0
14.	ENT – 691	Course seminar	0+1
15.	ENT – 692	Synopsis seminar	Non credit
16.	ENT – 693	Pre-submission thesis seminar	0+1
17.	ENT - 699	Research (thesis)	0+45
	<i>**Compulsory for ph.d programme; #Cross-listed with plant pathology.</i>		

**Theory****UNIT- I**

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.

**UNIT- II**

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

**UNIT- III**

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

**UNIT - IV**

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, check lists, 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 “type like” preservation. Submission of the collections made of the group. Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms. Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms.

**Theory****UNIT- I**

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

**UNIT- II**

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**

Types of immature stages; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

**Theory****UNIT- I**

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

**UNIT- II**

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

**UNIT- III**

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

**UNIT- IV**

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

**Theory****UNIT- I**

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.

**UNIT- II**

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, tri-trophic 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.

**UNIT - III**

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

**UNIT- IV**

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 - 605**

**INSECT BEHAVIOUR**

**1+1**

### **Theory**

#### **UNIT- I**

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.

#### **UNIT- II**

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

#### **UNIT- III**

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

#### **UNIT- IV**

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 - 606**

**RECENT TRENDS IN BIOLOGICAL CONTROL**

**1+1**

### **Theory**

#### **UNIT- I**

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-à-vis* target pest populations.

## **UNIT- II**

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

## **UNIT III**

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.

## **UNIT- IV**

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 - 607**

**ADVANCED INSECTICIDE TOXICOLOGY**

**2+1**

### **Theory**

#### **UNIT- I**

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

#### **UNIT -II**

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

#### **UNIT- III**

Joint action of insecticides; activation, synergism and potentiation.

#### **UNIT- IV**

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

#### **UNIT- V**

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; 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- 608**

**ADVANCED HOST PLANT RESISTANCE**

**1+1**

**Theory**

**UNIT- I**

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

**UNIT- II**

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

**UNIT- III**

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

**UNIT- IV**

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

**Practical**

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

**ENT - 609**

**ADVANCED ACAROLOGY**

**1+1**

**Theory**

**UNIT- I**

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

**UNIT- II**

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

**UNIT- III**

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

**UNIT- IV**

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

### **Practical**

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

**ENT - 610**

**AGRICULTURAL ORNITHOLOGY**

**1+1**

### **Theory**

#### **UNIT- I**

Status of agricultural ornithology in India, groups of birds associated with agro-ecosystems. Habitat associations of birds in both wet and dry agricultural systems. Association of birds with different cultivation practices and crop stages, their seasonality and succession. Pestiferous and beneficial birds associated with different crops, their general biology and ecology. Food and feeding habits of birds in crop fields.

#### **UNIT- II**

Nature of damage caused by birds in different crops. Foraging ecology of birds in agricultural fields. Birds affecting stored grains in houses and godowns. Beneficial role of birds in agriculture and attracting them to field. Use of bird excreta in agriculture. Management of bird pests in agriculture: physical, cultural, ecological and chemical methods.

### **Practical**

Study of different groups of birds associated with agriculture, their morphology and field identification. Field visits to different agroecosystems. Study of bird associations with different crop stages. Study of nesting and roosting habits of birds in agricultural habitats. Study of the feeding habits, nature and types of damage caused by birds in selected crops. Visits to godowns. Analysis and study of the use of bird excreta in agriculture at a bird sanctuary. Field visits to paddy growing command areas to study birds in crop fields. Assignments on assessing bird damage, estimation of populations *etc.*

**ENT – 611**

**MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH**

**1+1**

### **Theory**

#### **UNIT- I**

Introduction to molecular biology; techniques used in molecular biology.

#### **UNIT- II**

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

#### **UNIT -III**

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

#### **UNIT- IV**

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

#### **UNIT- V**

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

#### **Practical**

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

**ENT - 612**

**ADVANCED INTEGRATED PEST MANAGEMENT**

**2+0**

#### **Theory**

##### **UNIT- I**

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

##### **UNIT- II**

Case histories of national and international programmes, their implementation, adoption and criticisms, global trade and risk of invasive pests.

##### **UNIT- III**

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' realtime situations.

##### **UNIT- IV**

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

**ENT - 613/ PL PATH 606**

**PLANT BIOSECURITY AND BIOSAFETY**

**2+0**

#### **Theory**

##### **UNIT -I**

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

##### **UNIT -II**

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

##### **UNIT- III**

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.