## Masters Degree Programme

## M.Sc. (Ag.) 1st Semester

### ENT 501 Insect Morphology 1+1

### Theory:

Principles, utility and relevance. Insect body wall: structure, cuticular outgrowths, colouration and special integumentary structures in insects. Chaetotaxy and its significance in insect identification. Body tagmata, sclerites and segmentation.

Head – origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.

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; movement of legs.

Abdomen - segmentation and appendages; Genitalia and their modifications.

Morphology of immature stages of insects; types of metamorphosis. Insect sense organs (mechano-, photo- and chemo-receptors).

### Practical

Study of insect segmentation, various tegmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs of insects. Identification of different types of larva and pupa. Studies on larval chaetotaxy.

### ENT 502 Insect Anatomy, Physiology and Nutrition 2+1 Theory

Scope and importance of insect anatomy and physiology.

Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. Embryonic development of insects.

Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapauses. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular micro-organisms and their role in physiology; artificial diets for rearing of phytophagous and carnivorous insects.

### Practical

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets. Embryonic development of insects.

**ENT 503 Insect Taxonomy and Systematics 2+1**

## Theory

History and principles of systematics and its importance. Levels and functions of systematics. Classification of animals: Schools of classification – phonetics, Cladistics and Evolutionary classification. Components of biological classification: hierarchy, Rank, Category and Taxon. Species concepts: Typological, Evolutionary, Biological, Nominalistic and related problems; Cryptic, Sibling and etho-species, infraspeecific categories. Nomenclature: Common vs scientific names. International Code of zoological nomenclature, criteria for availability of names, validity of names. Categories of names under consideration of ICZN. Taxonomic publications, Principles of priority, homonymy, synonymy; type concept in zoological nomenclature. Speciation, allopatric, sympatric and parapatric processes.

Brief evolutionary history of insects; theories relating to origin of insects. Classification of Class Insecta; different classification schemes.

Taxonomic characters, general biology, habit, habitat of insect orders and classification up to important families:

Apterygote Orders: Thysanura, Diplura, Protura, Collembola

Pterygote orders: Exopterygote orders: Palaeoptera: Ephemeroptera, Odonata; Neoptera: Polyneoptera (Orthopteroid group): Plecoptera, Grylloblattodea, Orthoptera, Phasmida, Mantophasmatodea, Dermaptera, Embioptera, Dictyopetra, Isoptera, Zoraptera. Polyneoptera (Hemipteroid group): Psocoptera, Mallophaga, Siphunculata, Hemiptera, Thysanoptera.

Endopterygotes (Neoptera contd.): Neuroptera, Coleoptera, Strepsiptera, Mecoptera, Siphonaptera, Diptera, Lepidoptera, Trichoptera and Hymenoptera.

## Practical:

Collection and preservation of insects. Identification of insect orders. Taxonomic study of economically important orders up to families using keys. Field visit for insect collection. Visit to institutions working on insect taxonomy including ZSI.

**ENT- 504 Insect Ecology and IPM 2+1**

## Objective

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes; study life tables, organization of communities, diversity indices; sampling methodology; and basic principles of pest management and implementing IPM programmes.

## Theory

History and Definition; Basic Concepts; Organization of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Ecosystem apporach to Ecology- Component and subdivitions of Ecology. Basic principles of abiotic factors and their generalized action on insects – Biogeochemical cycling, Biological succession, Degree day concept. Implications for abundance and distribution of organisms including insects – Law of the minimum, Law of tolerance, Bergman's Law, Gogler's Law.

Population and its characters – 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.

Biotic factor - 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. Prey-predator interactions - Basic model- Lotka - Volterra model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators / parasitoids - Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's *d / w*; their association with Dyar's Law and Przibram's Law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of Diversity. Diversity- stability debate.

Insect Pest Outbreak – Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys;

**Pest management as applied ecology:** History and origin, definition and evolution of various related terminologies in IPM, Concept and philosophy, economic threshold concept, and economic consideration. Factors supporting IPM decisions – Tools of pest management and their integration, 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.

## Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters-Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of some 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. Crop loss assessment – direct losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and Implementing IPM system.

## ENT 505 Advanced Entomological Techniques 0+1

Basic principles of light, transmission and scanning electron microscopy, use and maintenance. Spectrophotometry, principles and use. Techniques for isolation, inoculation and culturing of entomopathogenes. Microtomy and preparation of slides for histological toxicological studies; use of Potter's tower. Chromatography, basic principles; use of GC, GLC and HPLC. Gel electrophoresis for prtein and nucleic acid isolation/estimation. Tissue culture techniques in plant protection. Computer applications for prediction/forcasting of pest incidence.

## M.Sc. (Ag.) 2nd Semester

## ENT 551 Biological Control of Crop Pests and Weeds 1+1

### Theory

History, Principles and scope of biological control; important groups of parasitoids, predators and pathogens; Principles of classical biological control- importation, augmentation and conservation.

Attributes of effective natural enemy; importance of strains / races / biotypes / ecotypes; role of multiple parasitism, super parasitism and hyparasitism; Island theory and Sequence theory.

Biology, adaptation, host seeking behaviour of predatory and parasitic group of insects. Mechanism of fertilization, sex determination and regulation of sex ratio in parasitic Hymenoptera.

Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action.

Biological control of weeds: history, important herbivores / pathogens for weed control.

Mass production of quality biocontrol agents- techniques, formulations, quality control, delivery system, economics, field release/application and evaluation.

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.

### Pratical

Identification of common natural enemies (parassitoids, predators, microbes) of crop pests and weeds. Rearing and mass production of parasitoids, predators and their laboratory hosts and weed feeding herbivores. Field collection of parasitoids and predators. Hands-on training in isolating, culturing and identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

## ENT 552 Insects Pests of Field Crops 2+1

### Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect pests and vectors: cereals and millets,

Pests: Storage Ecology. Sources of infestation of storage pests. Nature of damage, seasonal activity, extent of loss, description and biology of important storage

pests: Primary pests – Weevils, lesser grain borer, khapra beetle, pulse beetle, Angoumois grain moth; Secondary pests: Red rust flour beetle, rice moth, Indian meal moth, Cigarette beetle, saw toothed beetle, xxx. Management of storage pests.

Field visit, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests. Identification of important storage pests; Control operations against storage insects.

## ENT 553 Insect Pests of Horticultural and Plantation Crops 1+1

### Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect pests of various crops.

**Fruit Crops:** mango, guava, banana, jackfruit, papaya, pomegranate, litchi, grapes, ber, fig, citrus, aonla, pineapple, apple, peach and other temperate fruits.

**Vegetable crops:** brinjal, tomato, potato, cruciferous vegetables, peas and beans, okra, cucurbits, drumstick, leafy vegetables etc.

**Plantation crops:** coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.;

**Spices and condiments:** pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine, onion etc.

Ornamental, medicinal and aromatic plants and pests in polyhouses / protected cultivation.

### Practical

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

## ENT 554 Agricultural Acarology 1+1

### Theory

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics.

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; soil mites and house dust mites. Management of mites using acaricides, phytpseiid predators, fungal pathogens etc. Culturing of phytophagous, parasitic and predatory mites.

### Practical

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 keys; studying different rearing techniques for mites.

## ENT 555 Agricultural Nematology 2+1

### Theory

History and growth of phytonematology. Economic importance of nematodes to agriculture and horticulture. Characteristics of Phylum Nematode and its relationship with other related phyla, nematode habitats and diversity - plant, animal and human parasites; Beneficial roles of nematodes. General morphology and anatomy of nematodes - digestive, excretory, nervous, reproductive systems, outline of classification of nematodes, nematode biology, physiology and ecology.

Types of parasitism; nature of damage and general symptomatology; interaction of plant-parasitic nematodes with other organisms.

Plant nematode relationships. cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.

Economically important phytonematodes infesting crops.

Principles and practices of nematode management: physical, cultural, biological, legal, plant resistance, chemical, integrated nematode management. Importance of nematodes in international trade and quarantine.

### Practical

Collection of samples, extraction of nematodes from plants and soils, studies on kinds of nematodes - free-living, insect and plant parasites; extraction of migratory endoparasites, staining for sedentary endoparasites; Identification of important plant parasitic nematodes. Examination of different life stages of important plant parasitic nematodes, and their symptoms.

## ENT 556 Plant Resistance to Insects 1+0

### Theory

History and importancee of resistance, principles, classification, components, types and mechanisms of resistance.

Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

Factors affecting plant resistance including biotypes and measures to combat them. 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. Role of biotechnology in plant resistance to insects.

## ENT 557 Commercial Entomology 1+1

### Theory

Bee keeping- History, importance of bee keeping in Indian and world economy. Honey bee species, their identification, habit, colony structure, castes of bee, seasonal management of honey bee colonies. Bee breeding and commercial queen rearing. Pests and diseases of honey bees. Bee poisoning. Bee products, processing and value addition, marketing of products. Establishment and maintenance of apiaries.

Insect pollinators of crops; importance of honey bees in crop pollination, management of bee colonies for pollination.

Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworm. Establishment of sericulture unit and commercial silk worm rearing.

Insects producing resin and dyes: Lac insect- biology, lac cultivation, natural enemies and their management; lac processing. Dye producing insects.

### Practical

Identification of honey bee species, bee castes; identification and handling of bee- keeping equipments. Handling of honey bees – hive and frame inspection. Honey extraction and processing. Collection of pollen, propolis, royal jelley etc. Preparation of bee-keeping projects for funding. Visit to commercial apiaries and bee reeding farms. Silkworm rearing and management; preparation of silk worm rearing project. Lac host and crop management technology and processing of lac. Products and by-products of lac.

## M.Sc. (Ag.) 3rd Semester

### ENT-601 Toxicology of Insects 2+1

### Theory

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethriods, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, avermectins, botanics, new promosing compounds (diamides, pymetrozine etc.).

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity and insecticides; insecticide compatibility, selective and phytotoxicity.

Insecticide metabolism; pest resistance to insecticides; mechanism and types of of resistanc; insecticides resistance management and pest resurgence.

Insecticides residues, their significance and environmental implications. Insecticides Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

### Practical:

Insecticides formulations and mixures; quality control of pesticides formulations; laboratory and field ecaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visist to toxicology laboratories. Good laboratory practices.

## ENT- 602 Soil Anthropoids and Their Management 1+1

### Theory

Soil fauna; community structure and classification, habitats and their identification. Effect of soil arthropod activity on soil properties. Role of soil arthropods in detritus feeding, litter breakdown and humus formation. Soil arthropods as bio-indicators of habitat qualities. Interrelationship among arthropods and other soil invertebrates and soil microorganisms. Impact of climate change and anthropogenic effects on soil arthropods. Conservation of beneficial soil invertebrates.
Soil inhabiting insect pests and their management: Termites, white grubs, cut worms, mole crickets. Estimation of populations; sampling and extraction methods.

### Practical

Sampling, extraction methods and identification of various types of soil fauna; estimation and assessment of soil invertebrates; techniques of culturing soil invertebrates.

## ENT 603 Vertebrate pest management 1+1

### Objective

To impart knowledge on vertebrate pests like birds, rodents, mammals etc., their economic significance and measures for their management / conservation.

### Theory

Vertebrate pests of crops, their importance.
Rodents: Important species in India, distribution, habit and habitat, replacement of species, damage assessment. Rodent biology and ecology.
Role of birds in agriculture: Important species, distribution, crops attacked, damage assessment. Roosting and nesting behaviour in birds. Beneficial birds, natural control of pests, dispersal of vegetation, nature conservation and regeneration of vegetation.
Other vertebrate pests: monkeys, neel gai, Jackals, elephants etc.
Management of vertebrate pests: Mechanical (trapping, proofing) and physical (acoustic and visual), cultural (cropping practices, alteration of habitats etc.), biological (parasites, predators and pathogens), chemical (poisons, bait preparation). Rodent control operations.

### Practical:

Identification of important rodent and other vertebrate pests of agriculture; food preference and hoarding, social behaviour, damage assessment, field survey and population estimation. Assessment of different preventive and curative methods and rodent control operations.

## ENT 604 Acarine Pests of Crops 1+1

## Theory

Classification of mites (Krantz, 1970 and Evans & Till, 1979).

Important mite Genera infesting different cultivated crops under different families. General biology, feeding mechanism, damge symptoms, seasonality, extent of loss and dispersal of mites infesting cereals, vegetables, fibre yielding crops, fruit crops, tea, sugarcane, plantation crops and ornamental plants. Management of mite pests: Cultural, Mechanical, physical, biological and chemical; Integrated management of mites of different crops.

## Practical

Field visits, collection and identification of important mite pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important mite pests. Efficacy of different mite control measures.

## ENT 605 Ecology of Mites 1+0

## Theory

Sampling and sampling freequency. Stratification of habitat - inter and intra plant

distribution. Estimation of population size. Population chareteristics - spatial distribution, intra tree distribution, potential rate of incresae. Numerical sampling and variance-mean relationship. Sampling and pest management decision.

Morphological, hystological and cytological and chemical aspects of damage. Webbing and it's role in mate finding, locomotion and dispersal, colonisation and host plant effect, webbing and acaricide. Dispersal and dispersal behaviour, agricultural implication of dispersal.

Mating and chemical communication, female pre-copulating behaviour, chemical communication between sexes. Diapause, environmental factors governing the onset and termination of diapause. Characteristics and behaviuor of diapausing forms. Mite’s response to weather variation. Mite species overwintering as diapausing eggs.

Mite-Host plant relationship, effect of plant nutrient threshold for damage and feeding rate.

## ENT 606 Nematode Taxonomy 1 + 1

### Theory

Gross morphology, Principles of nematode taxonomy - levels of taxonomy, systematics, taxonomy, identification, classification, taxonomic category, taxonomic characters, morphometry, zoological nomenclature, species concept. Characters of phylum Nematode, class or subclass, Adenophorea, Secernentea, outline of classification of nematodes (up to orders), outline of classification of plant parasitic nematodes (up to genera); Diagnostic features of orders - Tylenchida, Aphelenchida, Dorylaimida and Triplonchida; diagnostic features of suborders -Tylenchina, Aphelenchina, Criconematina and Dorylaimina. Diagnosis of important nematode genera - Meloidogyne, Heterodera, Hirschmanniella, Pratylenchus, Radopholus, Hoplolaimus, Rotylenchus, Helicotylenchus, Rotylenchulus, Criconema, Criconemoides,

Hemicycliophora, Hemicriconemoides, Tylenchorhynchus, Anguina, Ditylenchus, Aphelenchoides, Longidorus, Xiphinema, Trichddorus, Aphelenchus, Mononchus / Mylonchulus, Rhabditis, Heterorhabditis and Steinemema.

### Practical

Studies on variations in nematode shapes and sizes, morphological details of cuticle, cuticular markings and ornamentation, variations in stoma, oesophagus, rectum; types and parts of female and male reproductive systems, sense organs, and excretory system. Identification of common nematodes belonging to orders Tylenchida, Dorylaimida,

Aphelenchida, Mononchida and Rhabditida up to generic level; and up to species level for major nematode pests (root-knot, cyst nematodes etc.) of crops.

## ENT 607 Nematode Disease and management 1+1

### Theory

Nematode species, distribution, host range, biology and life cycle, nature of damage, symptoms, interaction with other organisms, and management of nematode diseases in different crops. Cereal crops - ear-cockle and tundu diseases of wheat, molya disease of wheat and barley; rice root nematode, rice root-knot and cyst nematode problems, ufra and white tip diseases of rice; lesion nematodes, cyst nematodes of maize and sorghum. Pulses, Sugar, Fibre, Fodder and Oilseed crops - Pigeon pea cyst nematode, root knot nematode, reniform nematode, lesion, sugarbeet cyst and soybean cyst nematode problems. Vegetable crops - root-knot disease, reniform nematode, potato cyst nematode; stem and bulb nematode. Nematode problems of protected cultivation. Fruit crops - rootknot disease, reniform nematode, slow decline of citrus. Tobacco - root knot disease, stunt and reniform nematode problems, Mushroom - nematode problems. Plantation, medicinal and aromatic crops - burrowing nematode problem of banana, spices and condiments, rootknot and lesion nematode problems of betelvine, coffee and tea, red ring disease of coconut. Forests - Pine wilt, disease. Flower and Ornamental crops - floral malady of tuberose, root knot diseases of gladiolus, crossandra, carnation, jasmine, tuberose; lesion nematode of rose, chrysanthemum and crossandra, bulb and stem diseases of narcissus, onion and lily; foliar disease of chrysanthemum.

### Practical

Diagnosis of causal organisms; identification of different life cycle stages; study of symptoms and histopathology of nematode damage in different crops, experiments for proving pathogenicity and estimation of crop losses, field visits for visual diagnosis of nematode problems.

## ENT-608 Insects Pests of Economically Important Field crops 2+1

Pests of rice and other cereals, important oilseeds and pulses, fiber and sugar yielding crops, their distribution in India, incidence pattern, relative importance in different parts of the country and West Bengal, changing pattern of pest composition, succession in different growth stages, influence of biotic and abiotic factors in pest outbreak and AESA based management methods.

Practical: Identification of pests and natural enemies of the aforementioned crops. Field studies on population dynamics of pests and their biological features as far as possible.

## ENT-609 Insects Pests of Economically Important Horticultural Crops 2+1

Insects pests of important vegetable crops (solanaceous, curcurbitaceous, mulvaceous, cruciferous vegetables), orchard and plantation crops (mango, guava, citrus, cashew and nut, banana, coconut and tea), spices (chillies, onion, garlic, etc.) and ornamental crops grown in India in general and West Bengal in particular, their nature of damage, population dynamics, extent of loss, seasonality, succession and management.

Practical: Identification of the insect.

Practical: Identification of the insect pests of the crops mentioned above and their nature of damage, population dynamics, their nature and management.

## ENT-649 Seminar – I 0+1

## M.Sc. (Ag.) 4th Semester

### ENT 651 Insect Pathology 1+1

### Theory

History of insect pathology. Entomopathogenic microorganisms: bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanism in insects against pathogens.

Field utilization of pathogens for pest management and mass production techniques of pathogens; quality control, storage and delivery system. Safety and registration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

### Practical

Familiarization with equipment used in insect pathology laboratory. Identification of different groups of insect pathogens and symptoms of infection. Isolation, culturing and testing pathogenicity of different groups of pathogens. Testing Koch's postulates. Estimation of pathogen load. Bioassay of microbial pesticides.

### ENT 652 Insect Plant Disease Relationships 1+0

### Theory

Brief introduction to agents causing diseases to plants: Fungi, Bacteria, Viruses, Phytoplasma and RLOs. Phytotoxemia - associated insect groups. History of development in the knowledge of animal vectors of plant diseases.

Mechanism of plant virus transmission: Mechnical and Biological. Vectors of plant virus Fungi, Insects, Mites, Nematodes.

Insect vectors; feeding mechanism and type of virus transmission. Virus - vector relationship, historical advancement. Classification of viruses on the basis of transmission. Different theories relating to mechanism of virus transmission. Bimodal and dependent transmission, cross protection.

Plant virus transmission by chewing insects (Beetles, Grasshoppers, Caterpilars). Transmission of plant viruses by sucking insects: Aphids, Leaf and Plant hoppers, psyllids, whiteflies, mealy bugs and thrips.

Transmission of plant viruses by mites and nematodes. Transmission of Phytoplasma, RL0s, fungi and bacteria by insects. Management of vectors of plant diseases

## ENT 653 Pests of Public Health and Veteranary Importance 1+1

## Theory

Economic and public health importance of insect pests in human habitation and habitats: mosquitoes, houseflies, myasis and blood sucking flies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals.

Mosquitoes - different species, distribution and disease transmission; biology of important species.

House flies, disease transmission and biology. Myasis and blood sucking flies, bed bugs, biting and sucking lice, fleas, ticks, their biology, disease transmission.

Pests of residential places: Rodents, termites, ants, carpet beetles, cloth moths, crickets, house dust mites, cockroaches etc.

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety; pre- and post- construction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Principles of control of pests of public health and veterinary importance; insecticides - considerations for selection, organic methods of domestic pest control.

## Practical

Assessing pest status in dwellings (laboratories,. canteen or hostel), implementation of pest control against flies, mosquitoes, bed bugs, cockroaches and rodents. Practical exposure to pre- and post-construction termite proofing measures. Control of silverfishes in the library. Visit to poultry units and assessing pest status in poultries. Identification of pests and disease vectors of domestic animals. Evaluation of commercially available domestic insect pest control products through bioassays.

## ENT 654 Plant Quarantine 1+0

## Objective

To acquaint the learners about the principles and role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine - domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting materials; case histories of exotic pests / diseases and their status.

Plant protection organization in India. Insecticide Act and related regulations for registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio- control agents.Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest / pathogen infestations; VHT and other safer techniques of disinfestation / salvaging of infected material.

WTO - regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

## ENT 657 Storage Entomology 1+1

### Theory:

Post-harvest losses due to pests and importance of Storage Ehtomology. Pests associated with stored grains, their products and seeds: insects, mites, rodents, birds and microorganisms. Systematic position, identification, distribution, host range, biology, nature and extent of damage of insect and mite pests of storage. Sources of infestation of storage pests.

Rodents and birds as storage pests.

Storage ecology with special emphasis on role of temperature, moisture, oxygen availability, crowding etc. on stored materials and pests. Stored grain deterioration process, physical and biochemical changes and consequences. Storage structures: types of storage structures - traditional, improved and modern storage structures in current usage. Ideal seed / grain storage structures.

Management of storage pests: Preventive measure - Hygiene / sanitation, disinfestations of stores and receptacles, legal methods. Curative measures - Non- chemical (ecological, mechanical, physical, cultural, biological and mechanical); Chemical - chemicals used for prophylactic and curative measures ; their characteristics, use.and precautions in handling. Integrated approach to stored grain pest management.

### Practical

Collection, identification and familiarization with pests infesting stored grains / seed / stored products and nature of damage caused by them; detection of infestation and estimation of losses in grain / seed stores ; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage.

## ENT 699 Seminar-II 0+1

## ENT 700 Master’s Research 0+20