Department of Agricultural Entomology
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Doctoral Programme *in* Agricultural Entomology

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	17
2.	Minor	11
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	**80**
	Compulsory Non Credit Courses	15

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min.17 credits)			
1.	ENT-601	Advanced Insect Systematics	1+2=3
2.	ENT-602	Immature Stages of Insects	1+1=2
3.	ENT-603	Advanced Insect Physiology	2+0=2
4.	ENT-604	Advanced Insect Ecology	1+1=2
5.	ENT-605	Insect Behaviour	1+1=2
6.	ENT-606	Recent Trends in Biological Control	1+1=2
7.	ENT-607	Advanced Insecticide Toxicology	2+1=3
8.	ENT-608	Advanced Host Plant Resistance	1+1=2
9.	ENT-609	Advanced Acarology	1+1=2
10.	ENT-610	Agricultural Ornithology	1+1=2
11.	ENT-611**	Molecular Approaches in Entomological Research	1+1=2
12.	ENT-612**	Advanced Integrated Pest Management	2+0=2
13.	ENT-613/ Pl.Path-606$^{\$}$	Plant Biosecurity and Biosafety	2+0=2

B) Minor Subjects (Min. 11 credits)			
1.	MICRO-510	Industrial Microbiology	2+1=3
2.	MICRO-601	Advances in Fermentation	2+1=3
3.	NEMA-603	Advances in Nematode Management	2+1=3
4.	Pl. Path-606	Plant Biosecurity and Biosafety	2+0=2
		Total	**8+3=11**
C) Supporting Subjects (Min. 05 credits)			
1.	Biochem-603	Biochemistry in Biotic and Abiotic management	3+0=3
2.	Biochem-607	Advanced Techniques in Biochemistry	0+2=2
D) Seminar (02 credits)			
1.	ENT-691	Doctoral Seminar	0+1=1
2.	ENT-692	Doctoral Seminar	0+1=1
E) Doctoral Research (45 credits)			
1.	ENT-699	Doctoral Research	0+45=45
F) Non Credit Compulsory Courses			
1.	PGS-501	Library and Information Services	0+1=1
2.	PGS-502	Technical Writing and Communications Skills	0+1=1
3.	PGS-503	Intellectual Property and its Management in Agriculture	1+0=1
4.	PGS-504	Basic Concepts in Laboratory Techniques	0+1=1
5.	PGS-505	Agriculture Research, Research Ethics and Rural Development Programmes	1+0=1
6.	PGS-506	Disaster Management	1+0=1

Course Contents

ENT 601 Advanced Insect Systematics 1+2=3

Theory:

Lecture No.	Topic	Weightage (%)
1	Detailed study of 3 Schools of classification numerical	5
2	Evolutionary and cladistics	5
3	Methodologies employed, Development of phyenograml and clodograms	5
4	Molecular approaches for the classification of organisms	5
5	Methods in identification of homology species concepts	5
6	Speciation processes and evidences, Zoogeography	5
7	Study of different views on the evolution of insects alternative phylogenies of insects	10
8	Kukalova Pecle and Kristensen	5
9	Fossil insects and evolution oil insect diversity over geological times	5
10	Detailed study of ICZN – brief history definition, preamble, contents of the code	10
11	Study of important articles of the code, Nomenclature, authorship type concepts	5
12	Study of Appendices & ethics	5
13	Concept of phylocode and alternative naming system for animals	5
14	Detailed study of selected representation of taxonomic publications species descriptions, revisionary work	5
15	Monograph, check lists, founal volumes etc	5
16	Websites for insect taxanomy and data bases	5
17	Molecular taxonomy	5
18	Barcoding species	5

Practical:

Practical No.	Topic to be convened
1-6	Collection, curation and study alone taxon of insects, literature search
7-12	Compilation of check list, study of characters, development of characters table, construction of taxonomic keys for the selected group
13-20	Development of description, photographing, writing diagrams and preparation of specimens for type like preservation
21	Submission of collections mode by of the group
22-28	Multivariate analysis techniques for clustering specimens into diff. taxa, development of phonogram
29-32	Rooting and character polarization for developing cladograms
33-36	Use of computer programmes to develop cladegrams

Suggested Readings:

CSIRO 1990. *The Insects of Australia : A Text Book for Students and Researchers.* 2nd Ed. Vols. 1 & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer – Verlag, Berlin.

Freeman S & Herron JC. 1998. *Evolutionary Analysis.* Prentice Hall, New Delhi.

Henning W. 1960. *Phytogenetic Systematics.* Urbana Univ. Illonois Press, USA.

Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications.* 2nd Ed. Academic Press, New York.

Mayr E & Ashlock PD. 1991. *Principles of Systematics Zoology*. 2nd Ed. McGraw Hill, New York.

Mayr E. 1969. *Principles of Systematics Zoology*. McGraw Hill, New York.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic and Professional, London.

Ross HH. 1974. Biological Systematics. Addison Wesley Publ. Co., London.

Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists.* Columbia Univ. Press, USA.

ENT-602 Immature stages of insects 1+1=2

Theory:

Lecture No.	Topic	Weightage (%)
1	Coleoptera	5
2	Hemiptera	5
3	Hymenoptera	5
4	Diptera	5
5	Neuroptera	5
6	Other pterygot orders	5
7	Other pterygot order	5
8	Morphology of egg	5
9	Morphology of nymph	5
10	Morphology of larva	5
11	Morphology of pupa	5
12	Identification of different immature stages of pests of fruit crops	5
13	Identification of different immature stages of pests of plantation crops.	5
14	Identification of different immature stages of pests of vegetable crops.	5
15	Identification of different immature stages of pest of remaining crops	5
16	Identification of different immature stages of pests of remaining of stored product insects.	5

Practical:

Practical No.	Topic to be convened
1	Types of immature stages
2	Collection and preservation of immature stages
3&4	Rearing of immature stages Identification of immature insect's up to orders and families
5&6	Diptera
7, 8, 9	Lepidoptera
10, 11, 12	Hymenoptera
13, 14, 15	Coleoptera
16, 17	Field visit for collection, identification
18	Preservation of immature stages of insects

Suggested Readings:

Chu HF. 1992. *How to Know Immature Insects.* William Brown Publ., Lowa.
Peterson A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
Stehr FW. 1998. *Immature Insects.* Vols. I, II. Kendall Hunt Publ., Lowa.

ENT 605: Insect Behaviour 1+1 = 2

Theory:

Lecture No.	Topic	Weightage (%)
1 & 2	Defining Behaviur – concept of umwelt, fixed action pattern's imprinting, complex behavior, induced behavior, learnt behavior and motivation	10
3	History of Ethology- development of behaviourism and Ethology	5
4	Contribution of Darwin, Frisch, Tinbergen and Lorenz	10
5	Studying behavior – Proximate and ultimate approaches	5
6 & 7	Behavioral traits under natural selection, genetic- control of behavior and behavioural polymorphism.	5
8	Orientation – Forms of primary & secondary orientation including taxes and kinesis	5
9,10 & 11	Communication – Primary & Secondary orientation, responses to environmental stimuli /, olfactory and auditory signals in inter and inter specific communication, use of signals in defense, mimicry, polyphenism, evolution of signals	15
12	Reproductive behavior – mate finding courtship, territoriality, parental care, parental investment	10
13	Sexual selection and evolution of sex ratio social behavior – Kin selection, parental manipulation and mutualism ,self organization and insect behavior	10
14 & 15	Foraging – Role of different signals in host searching (plant & insect) and host acceptance, ovipositional behaviour, pollination behaviour, co-evolution of plants and insect pollinators	10
16 & 17	Behavior in IPM, concept of super-normal stimuli, behavioral manipulation as potential tool in pest management	10
18	Use of semiochemicals quality stimuli and visual signals in pest management	5

Practical:

Practical No.	Topic to be convened
1 & 2 3 & 4	Quantitative methods in sampling behaviour Training bees to artificial feeders
5 & 6 7 & 8	Sensory adaptation and habitation in a fly or butterfly model Physical cues in host selection in phytophagous insect
9 & 10 11 & 12	Chemical and odour cues in host selection in phytophogous insect (DBPT or gram perl borer) Colour discrimination in honey bee or butterfly model
13 & 14 15 & 16	lecurning and memory in bees, role of self organization in resource traching by honey bees Evalution of different types of traps against fruitflies with respect to signals
17& 18	Use of honeybees / *Helicoverpa armigera* to understand behavioral polymorphism with respect to rearing and response to pheromone mixtures respectively

Suggested Readings:

Ananthkrishnan TN. (Ed.). 1994. *Functioned Dynamics of Phytophagous Insects.* Oxford & IBH, New Delhi.

Awasthi VB. 2001. *Principles of Insect Behaviour.* Scientific Publ., Jodhpur.

Bernays EA & Chapman RF. 1994. *Host Plant Selection by Phytophagous Insects.* Chapman & Hall, London.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour.* Springer, Berlin.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology.* 3rd Ed. Chapman & Hall, London.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour.* Cambridge University Press, USA.

Mathews RW & Mathews JR. 1978. *Insect Behaviour.* A Wiley- Inter Science Publ. Wiley & Sons, New York.

ENT – 606 Recent Trends in Biological Control 1+1=2

Theory:

Lecture No.	Topic	Weightage (%)
1 2	Scope of Classical Biological Control Augmentative biocontrol	10
3, 4	Introduction & handling of NEs	10
5	Nutrition of entomophagous insects & their hosts	10
6	Dynamics of BC agents vis-à-vis target pest population	10
7	Mass culturing techniques	10
8-9	Insectary facilities, equipments & basic standards of insectary	10
10, 11	Colonization, techniques of release of NEs, recovery evaluation	5
12, 13	Conservation & Augmentation of NEs	5
14, 15	Survivorship analysis & ecological manipulations	10
16	Bankable protect preparation	10
17	Genetically engineered microbes & other NEs	5
18	Genetics of ideal traits in BC agents	5

Practical:

Practical No.	Topic to be convened
1	Mass rearing & release of commonly occurring indigenous NEs.
2 & 3	Assessment of role of NEs
4 & 5, 6	Testing side effects of pesticides on NEs
7	Study of effect of semi chemicals of NEs
8 & 9	Breeding of various BC agent parasitoids
10 & 11	Predators
12,13, 14	Microbes
15, 16	Efficiency analysis of BC agents
17, 18	Project preparation for establishing viable mass production unit

Suggested Readings:

Burges HD & Hussey NW (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression*. Springer Verlag. Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management* . Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

ENT-609 Advanced Acarology 2 (1+1)

Theory:

Lecture No.	Topic	Weightage (%)
1	Comparative morphology Acari	5
2	Phylogeny of higher categories in mites	5
3	Commonly occurring orders and families of Acari in India	5
4 & 5	Diagnostic characteristics of families viz., Tretramychidae, Temipalpidae, Eriopluyidae, Tarsonimidae, phytoseiidae Edettudae	5
6 & 7	Cunaxidae, Stigmacidae, Pymotidae Cheletidae, Acaridae.	5
8 & 9	Pyroglyphidae, Orthogalumnidae, Argasidae Ixodidae Sarcoplidae	5
10	Soil mites in India	5
11 & 12	Management of economical imp sp. of mites in agriculture, veterinary and public health, storage acarology.	15
13	Mites as vectors of plant pathogens.	5
14	Acaricides : Mode of action	10
15	Structure activity relationship of different germs	5
16	Development of resistance in mites and resurgence	5
17	Predatory mites their mass production and utilization in management of mite pests.	15
18	Acaropathogenic fungi, identification, isolation and utilization	10

Practical:

1,2,3	Identification of commonly occurring mites upto species level.
4,5,6	Preparation of keys for identification of mites.
7,8,9, 10	Rearing phytoseiid mites and their role in suppression of spider mites.
11 to 16	Management of mite's pests of crops using acaricides, phytoseiid mites and fungal pathogens.

Suggested Readings:

Evans GO. 1992. *Principles of Acarology.* CABI, London.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India. Calcutta.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.

Sadana, GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Pub. House, New Delhi.

ENT-611 : Molecular Approaches in Entomological Research 2+1=3

Theory:

Lecture No.	Topic	Weightage (%)
1-4	Introduction to molecular Biology and scope in Entomological Research,) Central Dogma, Structure of DNA and RNA, Double helix, Genes, DNA and RNA replications, and related terminology.	10
5-8	Techniques in molecular biology – cut, paste, copy and measure and visualize DNA, cloning sequencing, amplification and transformation.	8
9-10	DNA & RNA analysis in insects. Transcription, translation and regulation of DNA.	7
11-12	DNA recombinant technology – Identification of genes/ nucleotide sequence, southern blot analysis and molecular markers.	10
13-14	Genetic improvement of natural enemies – scope methods of genetic improvements, Risks/ limitations.	5
15-16	Genetic improvement of Baculovirus – scope, methods Risk. Studies on cell line techniques.	10
17-18	Genetic improvement of *Bt* and entomopathogenic fungi – scope, methods and Risk.	5
19-20	Genes of interest in Entomological research – sex determination, Neuropeptide, JH esterase, st toxins venoms, chitinase, *Bt* toxin.	5
21-22	C_pT_i (trypsin inhibitor) lectins and protease transgenic plants for pest resistance.	5
23-24	Insect gene transformation methods vector mediated, Agrobacterium mediates and other methods.	10
25-26	Biotechnology in relation to silkworm and honey bee.	5
27-28	Lectin genes for pest suppression – DNA finger printing for taxonomy and phylogeny.	5
29-30	Genetic improvement of inebriate tolerance of natural enemies.	5

31-33	DNA based diagnostic, insect immune system in comparison to Vertebrate, molecular basis of metamorphosis. Bt transgenic technology and implications.	5
34-36	Insecticide resistance. Resistance management strategies in transgenic crops.	5

Practical:

Practical No.	Topic to be convened
1	Study of different instruments used in molecular astrology and terminologies.
2	Isolation of DNA
3	Isolation of RNA
4	Purity determination and base pair estimation.
5	Study of Agarose gel Electrophoresis.
6	Study of restriction mapping of DNA
7	Demonstration of PCR
8	RFLP,
9	RAPD techniques.

Suggested Readings:

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotechnology*. 1st Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.

Rechcigl JE. & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Levis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., New Delhi.

Singh BD, 2008. *Biotechnological (Expanding Horizons).* Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology.* 2nd Ed. Kalyani Publ., New Delhi.

ENT 612: Advances in Integrated Pest Management 2+0=2

Theory:

Lecture No.	Topic	Weightage (%)
1-5	Sampling and surveillance of insect pest Data base management and computer programming. Simulation techniques and system analysis and modeling	20
6-12	Case histories of national and international programmes their implementation, adaptation and criticisms global trade and risk & invasive pests	10
13-16	Genetic engineering and new technologies – Their progress and limitations in IPM Programmes.	10
17-18	Development of benevolent alien genes for pest management case studies.	10
19-20	Scope and limitation & bio-intensive and ecological base IPM programmes	10

21	Application & IPM to farmers real time situations	10
22-28	Challenges, needs and future look, dynamism & IPM under depending cropping systems and climate	10
24	Cropping systems and climate insect pest management under protected conditions	10
30-36	Strategies for pesticide resistance management	10

Suggested Readings:

Dhaliwal GS & Arora R. 2003. *Integrated pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhalwal GS & Curperus GW. 2004. *Integrated Pest Management Potential, Constraints and Challenges.* CABi, London.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integratred Pest Management in the Global Arena.* CABI, London.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York

ENT: 519 COMMERCIAL ENTOMOLGY 1+1=2

Theory:

Lecture No.	Topic	Weightage (%)
1.	Bee Keeping – General colony management during different season. Seasonal management	5
2.	Production & Pollination	5
3.	Artificial green rearing	5
4.	Pest & Diseases of Honey bee , bee Poisoning	5
5.	Production and marketing of quality Honey & Value added Honey products	5
6.	Establishment and maintenance of apiary	5
7.	Study of different species of silkworms, characteristic features	5
8.	Moriculture, silk and its uses	5
9.	Pest & Diseases of Silkworm	5
10.	Rearing & Management of Silk worm	5
11.	Lac Insect, natural enemies & their management	5
12.	Economic & public health Importance & insect Pest in human habitation & habits	10
13-15	Biology, damage & control & moisture houses flies, bed bug, Ants, Termite cockroaches, flies, silverfish, head & body lice , carpet beetles, cloth moths, crickets, wasps, House dust mites.	15
16	Principles and methods of Pest Management in Residential and	10

	Public bui8ldings, insecticides for domestic use	
17	Pre and Post instruction & termite Proof building. appliances for domestic pest control	5
18	methods & Rodent control and organic methods & domestic Pest management	5

Practical:

Lecture No.	Topic
1-2	Assessment & Pest Status in dwellings (labs, canteen or hostel) implementation of pest control against flies, mosquitoes, bed bugs, cockroaches & rodents
3	Pre and Post instruction of termite Proofing methods, control of silver fish in library
4	Visit to poultry unit and assessing Pest Status in Poultries
5	Evaluation of commercially available domestic Pest Control Products through bio-assays
6	Identification of Honey bee, spiders, bee casts and special adaptations, identification and handling of bee-keeping equipments
7	Handling of honey-bee lives and frame inspection. Honey. extraction and processing methods & live products extraction.
8	Preparation of bee-keeping projects for funding
9	Visit to bee nursery and commercial apiaries
10	Silkworm rearing and management of rearing
11	Lac host and crop management and technology and processing of lac
12	Products and bye-products of lac

Suggested Readings:

Aruga H. 1994. *Principles of Sericulture.* Oxford & IBH, New Delhi.

Atwal AS. 2006. *The World of the Honey Bee.* Kalyani Publ., New Delhi.

Ganga G. 2003. *Comprehensive Sericulture.* Vol.II. *Silkworm Rearing and Silk Reeling.* Oxford & IBH, New Delhi.

Partibans S. & David BV. 2007. *Management of Household Pests and Public Health Pests.* Namratha Publ., Chennai.

Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.

Nema-603 Advances in Nematode Management. 2+1=3

Theory:

Lecture No.	Topic	Weightage (%)
1	Isolation	2
2	Identification	2
3	Host specificity	2
4	Mode of action	2
5, 6,7 & 8	Culturing and field application potential of promising biocontrol agents.	6
8 & 9	Predacious and parasitic fungi, nematoxic fungal culture filtrates.	6
10	Isolation	2
11	Identification	2
12	Host specificity	2

13	Mode of action	2
14, 15 & 16	Culturing and field application potential of promising biocontrol agents – Parasitic and nematode antagonistic bacteria.	6
17& 18	Predacious mites and predacious nematodes	6
19	Mass culturing	2
20	Formulation	3
21	Quantity control	2
22	Bio-safety and registration protocols of biocontrol agents.	3
23	Phytoalexins	3
24	Allelochemicals	3
25	Phytotherapeutic substances	3
26	Novel nematicides	4
27	Deployment of resistant varieties and non-host crops in nematode suppressive cropping systems	4
28	Emergence of resistance breaking biotypes.	4
29	Recent regulatory provisions and methods.	2
30	Quarantine and disinfection.	2
31& 32	Nematode management modules for integrated pest and disease management in cropping systems.	8
33 & 34	Nematode management options and approaches for organic farming and precision farming.	8
35 & 36	Application of GIS and GPS technology for surveillance and management.	9

Suggested Readings:

Chen Zx. Chen S.Y, & Dickson D.W. 2004. Nematology : Advances and perspectives Vol. II. Nematode management and utilization, CABI, Walingford.

Jana BL. 2008. Precision farming. Reseache Books and Periodicals Pvt. Ltd., Delhi.

Li Ilesend TW Kiefer RW & Chipman JW. 1979. Remote sensing and Image interpretation. John Wiley & Sons. New York.

Pioner GO & Janson HB. 1988. Diseases of Nematodes. Vol. I, II CRC Press. Boca Raton, Florida.

Starr JR, Cook R & Bridge J. 2002. Plant Resistance to parasitic Nematodes. CABI, Walingford.

Tarafdar JC, BiPuthi KP & Mahesh Kumar. 2007. Organic Agriculture Scientific Publ. Jodhpur.

Upadhyaya RK. Walia & RK and Dubey OP. 2004. IPM systems in Agriculture. Vol. IX Phytonematodology. Aditya Books. New Delhi.

ENT-607 Advanced Insecticide Toxicology 2+1=3

Theory:

Lecture No.	Topic	Weightage (%)
1-3	Penetration and distribution of insecticides in insect systems.	4
4-5	Insecticide selectivity: Factors of teaching toxicity of insecticides.	5
6-7	Biochemical and physiological target sites of insecticides in insects.	4
8-9	Development of biorationaly , biopesticides and newer molecules.	4

10-12	Their modes of action	4
13-14	Structural activity relationship.	5
15-18	Advances in melaboism of insecticides.	10
19	Joint action of insecticides.	5
20	Activation	4
21	Synergism of potenitation	4
22	Problem associated with pesticide use in agriculture.	4
23-25	Pesticide resistance, resistance mechanisms	10
26	Resistant management strategies.	5
27-28	Pest resurgence and out breaks.	4
29	Persistance pollution	4
30	Health hazards and other effects	5
31	Estimation insecticidal residues sampling, extraction	5
32-33	Estimation of insecticide residues control clean-up, estimation by various methods.	5
34	MRLs their fixation	5
35	Insecticide laws and standards	5

Practical:

Lecture No.	Topic
1-8	Sampling, entraction cleanup and estimation of pesticide residue by various methods.
9-10	Calculation and interpretation of data
11-18	Biochemical and biological techniques for detection of insecticide resistance in insects.

Suggested Readings:

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides,* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Managemdnt.* Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Texicology.* Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action*. Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.

Perry AS, Yamamota I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT-608 Advanced Host Plant Resistance 1+1=2

Theory:

Lecture No.	Topic	Weightage (%)
1	Importance of plant resistance, historical perspective, desirable morphological and biochemical adaptations of resistance.	4
2	Assembly of plant species-gene pool, insect sources- behaviour in relation to host plant factors.	6

3	Physical environment conferring resistance in plant.	4
4	Chemical environment conferring resistance in plant.	4
5	Role of rypsing inhibitors.	4
6	Role of protease inhibitors in plant resistance	4
7	Biochemistry of induced resistance. Signal transduction pathways.	4
8	Methyl jasmonate pathways	4
9	Poliphenol oxidaze pathways, salicylic acid pathways	5
10	Effects of induced resistance, exogenous application of elicitors.	5
11	Biotechnological approaches in host plant resistance.	8
12	Genetic manipulation of secondary plant substances	8
13	Incorporation of resistant gene in crop varieties.	4
14	Marker-aide & selection in resistance breeding.	6
15	Estimation of plant resistance based on plant damage screening and damage rating.	8
16	Evaluation based on insect responses.	6
17	Techniques and determination of categories of plant resistance.	10
18	Break down of resistance in crop varieties.	10

Practical:

Lecture No.	Topic
1-8	Understanding mechanisms of resistance for orientation, feeding oviposition etc., allelochemical bases of insect resistance; macroculturing of test insect like aphids, leaf/plant hoppers, spreader row technique and plant nurseries;
9-10	Mites and stored grain pests field screening microplot techniques, infester row technique
11-18	Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index.

Suggested Readings:

Panda N. 1979. *Principles of Host Plant Resistance to Insects. Allenheld*. Osum & Co., New York.

Rosenthal GA & Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites.* Vol. I, II. Academic Press, New York.

Sadasivam S & Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests.* Marcel Dekker, New York.

Smith CM, Khan ZR & Pathak MD. 1994. *Teachniques for Evaluating Insect Resistance in Crop Plants.* CRC Press, Boca Raton, Florida.

ENT-515 General Acarology 1+1=2

Theory:

Lecture No.	Topic
1	History of Acarology
2	Importance of mites as a group.
3 & 4	Hibitat, Collection and preservation of mites.
5 & 6	Introduction to morphology and biology of mites and ticks.
7,8 & 9	Broad classification-major orders and important families of Acari including diagnostic characterstics.

10	Economic importance.
11	Seasonal occurrence
12	Nature of damage
13	Host range of mite pests of different crops, mite pests in polyhouses.
14	Mite pests of stored products and honeybees.
15	Management of mites using acaricides.
16	Phytoseiid predators.
17	Funal pathogens.
18	Culturing of phytophagous, parasitic and predatory mites.

Practical:

Lecture No.	Topic
1-3	Collection of mites from plants, soil and animals.
4-5	Extraction of mites from soil, plants and stored products.
6-8	Preparation of mounting media and slide mounts.
9-10	External morphology of mites.
11-15	Identification of mites up to family level using keys.
16-18	Studying different rearing techniques for mites.

Suggested Readings:

Chhillar BS, Gulati R & Bhatnagar P. 2007. *Agricultural Acarology.* Daya Publ. House, New Delhi.

Gerson U & Smiley RL. 1900. *Acarine Biocontrol Agents – an illustrated key and Manual.* Chapman & Hall, New York.

Gupta SK. 1985. *Handbook of Plant Mites of India*. Zoological Survey of India, Calcutta.

Gwilyn O & Evans GO. 1998. *Principles of Acarology.* CABI, London.

Jeppson LR., Keifer HH & Baker EW. 1975. *Mites Injurious to Economic Plants.* University of California press, Berkeley.

Krantz GW. 1970. *A Manual of Acarology*. Oregon State Univ. Book Stores, Corvallis, Oregon.

Qiang Zhiang Z. 2003. *Mites of Green Houses – Identification. Biology and Control.* CABI, London.

Sadana GL. 1997. *False Spider Mites Infesting crops in India.* Kalyani Publ. House, New Delhi.

Walter DE & Proctor HC. 1999. *Mites- Ecology. Evaluation and behaviour.* CABI, London.

ENT-513 Storage Entomology 1+1=2

Theory:

Lecture No.	Topic	Weightage (%)
1	Introduction and history of storage entomology.	5
2	Concepts of storage entomology and significance of insect pests.	5
3	Post harvest losses in to *vis-v-vis* total production of food grains in India.	3
4	Scientific and socio-economic factors responsible for grains losses.	3
5	Important pests namely insects, mites, rodents, birds and micro-	7

	organisms associated with stored grain and field conditions including agricultural products.	
6	Traditional storage structure	5
	Association of stored grain insects with fungi and mites.	
7 & 8	Their systematic position, identification, distribution, host range, biology, nature and intent of damage, role of field and cross infestations and natural enemies.	12
9	Types of losses in stored grains and their effect on quality including biochemical changes.	5
10	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.	5
11	Stored grain deterioration process, physical and biochemical changes and consequences.	2
12	Grain storage types of storage structures i.e. traditional, empowered and modern storage structures in current usage.	8
13	Ideal seeds and commodities storages conditions.	2
14	Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows.	8
15	Role of bird pests and their management.	5
16	Control of insect pests, mites and micro-organism.	8
	Preventive measures – Hygiene/sanitation, disinfestations of stored/receptacles, legal methods.	
17.	Curative measures – Non-chemical control measures ecological, mechanical, physical, cultural, biological and engineering.	5
	Chemical control – prophylactic and curative.	5
18	Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants.	2
	Integrated approaches to store rain pest management.	5

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, FAI, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem.* Marcel Dekker, New York.

Khader V. 2004. *Textbook on Food Storage and Preservation.* Kalyani Publ., New Delhi.

Khare, BP. 1994. *Stored Grain Pests and Their Management*. Kalyani Publ., New` Delhi.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products.* Marcel Dekker, New York.