



## Master's Programme in Agricultural Entomology

### Course Layout

#### Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	20
2.	Minor	10
3.	Supporting	06
4.	Seminar	01
5.	Research	20
	<b>Total Credits</b>	<b>57</b>
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
<b>A) Major subjects (Min. 21 credits)</b>			
	ENT-501	Insect Morphology	1+1=2
	ENT-502	Insect Anatomy, Physiology and Nutrition	2+1=3
	ENT-504	Classification of Insects	1+1=2
	ENT-505	Insect Ecology	1+1=2
	ENT-507	Biological control of Crop Pests and Weeds	1+1=2
	ENT-508	Toxicology of Insecticides	2+1=3
	ENT-510	Principles of Integrated Pest Management	1+1=2
	ENT-511	Pests of field crops	1+1=2
	ENT-512	Pests of Horticultural and Plantations crops	1+1=2
	ENT-518	Techniques in plant protectin	0+1=1

<b>B) Minor Subjects (Min. 10 credits)</b>			
	MICRO-501	Principles of Microbiology	3+1=4
	Pl.Path.-506	Principles of Plant Disease Management	2+1=3
	MICRO-505	Microbial Biotechnology	2+1=3
<b>C) Supporting Subjects (Min. 06 credits)</b>			
	BIOCHEM-510	Basic Biochemistry	2+1=3
	STAT-507	Design of Experiments for Plant Protection	2+1=3
<b>D) Seminar (01 Credit)</b>			
	ENT-591	Master Seminar	0+1=1
<b>E) Master's Research ( 20 credits)</b>			
		<b>Master's Research</b>	0+20=20
<b>F) Non Credit Compulsory Courses</b>			
	PGS-501	Library and Information Services	0+1=1
	PGS-502	Technical Writing and Communications Skills	0+1=1
	PGS-503	Intellectual Property and its Management in Agriculture	1+0 =1
	PGS-504	Basic concepts in laboratory Techniques	0+1=1
	PGS-505	Agriculture Research, Research Ethics and Rural Development Programmes	1+0 =1
	PGS-506	Disaster Management	1+0=1

## Course Contents

**Course Title : INSECT MORPHOLOGY**

**Course No. : ENT – 501**

**1+1=2**

**Theory Syllabus:**

Lecture No.	Topic	Weightage (%)
1.	Definitions, principles & Utility and relevance of insect morphology	20
2.	Insect body wall: Structure, Chemical composition and functions.	
3.	Cuticular appendages & Processes.	
4.	Body tagmata, segmentation.	
5.	Physical and pigmentary colours, physiological and morphological colour change	
6.	Origin of Insect head, head positions, structure of various areas sclerites and sutures of insect head	20
7.	Tentorium sclerites	
8.	Types of mouth parts- typical chewing and biting type of mouth parts	
9.	Modification of mouth parts- chewing and lapping, siphoning and sponging type of mouth parts	
10.	Modification of mouth parts – Piercing & sucking and Rasping and Sucking.	
11.	Thorax – Sclerites, sutures areas of tergum, Sternum and pleuron pterothorax	30
12.	Wings – Structure, regions, margins and modifications	
13.	Wing coupling apparatus and mechanism of flight	
14.	Legs – Structure and modifications	
15.	Abdomen – Structure, sclerites, Reproductive and Non-reproductive appendages.	
16.	Structure of insect Egg. Cleavage and blastoderm. Vitellophages, formation of germ band, segmentation and gastrulation.	30
17.	Post embryonic development, Types of metamorphosis.	
18.	Insect sense organs – mechanoreceptors, photoreceptors & chemo- receptors	

**B) Practical:**

Practical No.	Topic
1	Collection and Preservation of insects
2-5	Preparation of permanent mounts of different body parts & appendages.
6	Study of External structures of generalized insect-Cockroach
7	Study of various areas, sclerites and sutures of typical insect head and head positions
8	Study of generalized mouth parts of Insect chewing and biting type.
9	Study of modifications of mouth parts- Piercing and Sucking, Rasping and Sucking type
10	Study of modification of mouth parts- chewing & lapping, siphoning & sponging type
11	Study of cuticular appendages & processes of insect cuticle
12	Study of thoracic sclerites
13	Study of insect antennae
14	Study of insect legs
15-16	Study of insect wings
17	Study of Male & Female genitalia
18	Study and metamorphosis in insects

**Suggested Readings:**

Chapman RF. 1998. *The Insect : Structure and Function*. Cambridge Univ. Press, Cambridge.

David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata-McGraw Hill, New Delhi.

Duntson PA. 2004. *The Insect : Structure. Function and Biodiversity*. Kalyani Publ. New Delhi.

Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.

Richards OW and Davies RG. 1977. *Imm's General Text Book of Entomology*. 10<sup>th</sup> Ed. Chapman & Hall, London.

Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ., Academy, Jodhpur.

Snodgrass RE. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.

**Course No. : ENT-502 Course Title: Insect Anatomy, Physiology and Nutrition**  
**Credit : 2+1=3 Semester : I**

**A) Theory:**

<b>Lecture No.</b>	<b>Topic</b>	<b>Weightage (%)</b>
1 & 2	Scope and importance of insect anatomy and physiology	40
3/4	Structure, modification and physiology of different systems – Digestive system and physiology of digestion.	
5/6	Nervous system and physiology of nerve impulse transmission	
7/8	Male and female reproductive system and types of reproduction	
8/9	Respiratory system – physiology of respiration in Terrestrial and aquatic insects	
10/11	Excretory system and physiology of Excretion	
12/13	Circulatory system	
14/15	Anatomy & Physiology of musculature system	30
16/17	Exocrine and Endocrine glands – structure & Function and role in growth and development.	
18	Thermodynamics – Importance and scope	
20	Insect Integument – Physiology, moulting process/ Sclerotisation	
21/22	Metamorphosis and seasonal adaptations – Types/ significance of metamorphosis – Adaptations - Diapause, hibernation and aestivation	
25-24	Insect Nutrition – Introduction, role of insect nutrition in Pest Management	30
25-26	Carbohydrates, Proteins and their role in Insect nutrition	
27/28	Proteins amino acids, vitamins minerals and other food constituents	
29/30	Extra and Intra-cellular microorganisms and their role in physiology	
31/32	Artificial Diet need and scope in insect rearing constituents, process	

**B) Practical:**

Practical No.	Topic
1	Dissection of different insects to study comparative anatomical details – Digestive system
2/3	Male and Female Reproductive system.
4	Nervous system
5	Preparation of permanent mounts (Slides) of different internal systems.
6	Study of chromatographic analysis, instruments, principles and procedures
7	Chromatographic analysis of free amino acids of haemolymph.
8	Determination of chitin in insect cuticles.
9	Study of insect haemocytes.
10	Studies on determination of respiratory quotient – principles and procedures.
11/12	Preparation of artificial diet- <i>Helicoverpa armigera</i> .Role and scope in insect rearing.
13/14	Evaluation of various diets for rearing insects.
15	Studies on utilization and consumption of natural diet
16	Rearing of insects on artificial diet.
17	Importation of natural enemies, Quarantine regulations
18	Visit to Bio-control Laboratory

**Suggested Readings:**

Chapman RF. 1998. *Insect : Structure and Function*. ELBS Ed., London.

Duntson, PA. 2004. *Insect : Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Kerkut GA & Gilbert LI. 1995. *Comprehensive Insect Physiology. Biochemistry and Pharmacology* Vols. I-XIII. Pergamon Press, New York.

Patnaik B.D. 2002. *Physiology of Insects*. Dominant, New Delhi.

Richards, O.W. & Davies RG. 1977. *Imms' General Text Book of Entomology*. 10<sup>th</sup> Ed. Chapman & Hall, New York.

Saxena R.C. & Srivastava R.C. 2007. *Entomology: At a Glance*. Agrotech Publ., Academy, Jodhpur.

Wigglesworth V.B. 1994. *Insect Physiology*. 8<sup>th</sup> Ed. Chapman & Hall, New York

**ENT: 504 Course Title: Classification of Insects (1+1=2)**

**A) Theory:**

<b>Lecture No.</b>	<b>Topic</b>	<b>Weightage (%)</b>
1,2	Brief evolutionary history of insects	10
	Introduction to phylogeny to insects	
	Major classification of subclass Hexapoda	
	Classes – Ellipura (Collembola, Protura)	
	Diplura & insecta	5
3	Distinguishing characters, general biology, habits and habitats of insect's orders and economically imp. families contained in them - Collembola	5
	Protura & Diplura	
	Class Insecta subclass- Apterygota : Archaeognatha	5
	Thysanura	
4	Subclass –pterygota, Division-Palaeoptera Odonata	5
	Ephemeroptera	
	Division – Neoptea, Subdivision : Orthopteroid and Blattoid order : Oligoneoptera : Plecoptera	
8-9	Blattodea, Isoptera	10
	Mantodea, Grylloblattodea	
	Dermaptera	
	Orthoptera	
10	Phasmatodea, Mantophasmatodea	10
	Embioptera, Zoraptera	
	Subdivision : Hemipteroid orders Paraneopteral : Pscoptera	
	Phthiraptera	
11	Thysanoptera	10
	Hemiptera	
12-13	Division : Neuroptera, Subdivision Endopterygota, Section Neuropteroid Coleopteroid orders : Strepsiptera	8
	Megaloptera	
	Raphidoptera	
	Neuroptera	
14-15	Coleoptera	10
	Section : Panarorpoid, orders : Mecoptera, Siphonoptera, Trichoptera	
16	Diptera	5
17	Lepidoptera	10
18	Section Hymenopteroid Orders : Hymenoptera	7

**B) Practical:**

Practical No.	Topic
1.	Field visit to collect insects.
2.	Study of orders of insects and their identification using taxonomic keys, keying out families of insects of different major of orders
3.	Odonata
4.	Orthoptera
5.	Blattoidea
6.	Mantoidea
7.	Isoptera
8.	Hemiptera
9.	Thysanoptera
10.	Field Visit for Collection
11.	Phthraptera
12.	Neuroptera
13.	Coleoptera
14.	Diptera
15.	Field visit for collection
16.	Lepidoptera (Contd...)
17.	Lepidoptera
18.	Hymenoptera

**Suggested Readings:**

CSIRO 1990. *The Insects of Australia: A Text Book of Students and Researchers*. 2<sup>nd</sup> Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

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

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10<sup>th</sup> Ed. Chapman & Hall, London.

Ross HH. 1974. *Biological Systematics*. Addison Wesley Publ. Co.

Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects*. 7<sup>th</sup> Ed. Thomson/ Brooks/ Cole. USA/Australia.



**ENT: 505 Course Title: Insect Ecology (1 + 1 = 2)****A) Theory:**

<b>Lecture No.</b>	<b>Topic to be covered</b>	<b>Weightage (%)</b>
1.	History & definition, basic concept. Organization of Biological world	10
2.	Plato's natural balance vs Ecological dynamics as the modern view. Abundance & diversity of insects, estimates and causal factors	
3,4	Study of abundance & distribution & relation between two. Basic principles of abiotic factors and their generalized action on insects	15
5	Implication, abundance and distribution of organisms including insect, Law of minimum, law of tolerance & biocoenosis, systems approach to ecology	
6	Basic concepts of abundance – model vs real world population growth basic models. Exponential vs logistic models. Discrete vs continuous growth models.	15
7 & 8	Concepts of carrying capacity, Environmental resistance and optional yield. Vital statistics life to life & their application to insect biology	
9.	Survivorship curves. Case studies of insect life table's population dynamic, factors affecting abundance environmental factors dispersal & migration.	10
10.	Seasonality insects, classification & mechanisms of achieving different seasonality, Diapauses, aestivation hibernation	
11.	Biotic factors – food as a limiting factor for distribution and abundance. Nutritional ecology. Food chain – web and ecological succession.	15
12.	Interspecific interactions – Basic factors governing the interspecific interactions. Classification of interspecific interaction. The arguments of cost benefit ratios.	
13.	Competitions – Lotka – Voltera model, concept of niche – ecological homologous, competitive exclusion, Prey-predator interactions	15
14.	Defense mechanisms against Predator/Parasitoids Evolution & mimicry, colouration, concept of predator satiation, evolution of life history stages	
15.	Community ecology concept & guild, organizations of communities, Hutchison Ratio.	20
16.	May's d/w, relation between the two and their association with Dyar's Law and Prizibram's law.	
17.	Relative distribution of organisms, concept of diversity the wallacian view. Assessment of diversity.	20
18.	Diversity – Stability debate, relevance to pest management. Pest management as applied ecology	

**B) Practical:**

Practical No.	Topic to be convened
1.	Types of distribution of organisms
2.	Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters
3.	Measures of central tendencies, poison distribution Negative binomial distribution
4.	Determination of optimal sample size
5.	Learning to fit basic population growth models and testing the goodness of fit
6.	Fitting Hollings' disc equation
7.	Assessment of Prey-predator densities from natural systems, understanding the correlation between the two.
8.	Assessing and describing niche of some insects of a single guild
9.	Calculation of niche breadth, activity breadth
10.	Diagrammatic representation of niches of organisms
11.	Calculation of some diversity indices Shannon's, Simpson's and Avalanche index
12.	Understanding their associations and parameters that affect their values
13.	Problem solving in ecology
14.	Field visits to understand different ecosystems and to study insect occurrence in these systems.

**Suggested Readings:**

- Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2<sup>nd</sup> Ed. Cambridge Univ. Press, Cambridge.
- Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Inc., Sunderland, MA.
- Gotelli NJ. 2001. *A Primer of Ecology* 3<sup>rd</sup> Ed. Sinauer Associates, Inc. Sunderland, MA.
- Gupta, RK. 2004. *Advances in Insect Biodiversity*. Agrobios. Jodhpur.
- Krebs CJ. 1998. *Ecological Methodology*. 2<sup>nd</sup> Ed. Benjamin-Cummings Publ. Co. New York.
- Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance*. 5<sup>th</sup> Ed. Benjamin-Cummings Publ. Co., New York.
- Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton Univ. Press, Princeton.
- Price PW. 1997. *Insect Ecology*. 3<sup>rd</sup> Ed. John Wiley, New York.
- Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology Classic Papers with Commentaries*. University of Chicago Press, Chicago.
- Southwood TRE & Henderson PA. 2000. *Ecological Methods* 3<sup>rd</sup> Ed. Methuen & Co. Ltd., London.
- Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.

**ENT: 507 Course Title: Biological Control of Crop Pests & Weeds (1+1=2)****A) Theory:**

Lecture No.	Topic to be convened	Weightage (%)
1	History, principles & Scope of Biological Control	20
2	Important groups of parasitoids, predators & pathogens	
3 & 4	Principles of classical Biological Control, Importation, Augmentation & Conservation	
5 & 6, 7	Biology, adaptation, host seeking behavior & semiochemicals of predatory & parasitic groups of insects	
8 & 9, 10	Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa, etc. & their mode of action	20
11 & 12	Biological control of weeds using insects	
13 & 14	Mass production techniques of quality Biocontrol agents, formulations, economics, field release/ application & evaluation	
15 & 16	Successful Biocontrol, projects, analysis, trends and future possibilities of Biocontrol	30
17	Importation of NEs, Quarantine regulations	
18	Biotechnology in Biological Control	

**B) Practical:**

Practical No.	Topic
1	Collection, Isolation and preservation of – Parasitoids
.2	Collection, Isolation and preservation of – Predators
3 & 4	Collection, Isolation and preservation of – Microbes
5	Collection, Isolation and preservation of Weed Killers
6-8	Mass Production techniques of Parasitoids
9-10	Mass Production techniques of Predators
8 & 9	Mass Production techniques of Microbes
11-13 & 14	Mass Production techniques of Weed Killers
15,16	Quality Control & Registration Standards
17,18	Visit to Bio-control Laboratory

**Suggested Readings:**

Burges, H.D. & Hussey, N.W. (Eds.) 1971. *Microbial Control of Insects and Mites*. Academic Press, London.

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

Dhaliwal, G.S. & Arora, R. 2001. *Integrated Pest Management : Concepts and Approaches*. Kalyani Publ., New Delhi.

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

Huffaker, C.B. & Messenger, P.S. 1976. *Theory and Practices of Biological Control*. Academic Press, London.

Ignacimuthu, S.S. & Jayaraj, S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.

Saxena, A.B. 2003. *Biological Control of Insects Pests*. Anmol Publ., New Delhi.

Van Driesche, & Bellows

**ENT- 508 Course Title: Toxicology of Insecticides (2+1=3)**

**A) Theory:**

Lecture No.	Topic	Weightage (%)
1	Definition and scope of insecticide toxicology, history of chemical control	10
2	Pesticide use and pesticide industry in India	
3,4,5	Classification of insecticides and acaricides based on mode of entry, chemical nature, mode of action, chemical composition	30
6 & 7	Structure & mode of action of organochlorines	
8 & 9	Structure & mode of action of carbamates & organophosphate	
10	Structure & mode of action of pyrethroids	
11-12	Neonicotenoids & spinosad and avermectins	
13	Oxadiazines & Phenyl pyrazoles	
14	Insect Growth regulators	
15	Botanical pesticides	
18-19	Principles of toxicology	20
20 & 21	Evaluation of insecticide toxicity	
22 & 23	Joint action of insecticide, synergism, potentiation & antagonism	
24 & 25	Factors affecting toxicity of insecticides	
26 & 27	Insecticide compatibility, selectivity, phytotoxicity	
28 & 29	Insecticide metabolism, pest resistance to insecticides	20
30,31, 32	Mechanism & types of resistance, insecticide resistance management	
33, 34	Insecticide residues, their significance & environmental implications	20
35 & 36	Safe use of insecticide symptom of poisoning & first aid and antibiotic	

**B) Practical:**

Practical No.	Topic to be covered
1, 2 & 3	Study of quality parameters of insecticide formulations and mixture
4 & 5	
6 & 7,8	Field evaluation of insecticides for their bioefficacy phytotoxicity and compatibility.

9,10	Bioassay techniques / probit analysis
11 & 12	Evaluation of toxicity of insecticides, joint action & co-toxicity coefficient
13, 14	Toxicity of insecticides to beneficial insects
15	Good laboratory practices
16	Visit to toxicological laboratories

### Suggested Readings:

Chattopadhyay SB. 1985. *Principles and procedures of Plant Protection*. Oxford & IBH, New Delhi.

Gupta HCL. 1999. *Insecticides : Toxicology and uses*. Agrotech Publ., Udaipur.

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.

Perry AS, Yamamoto 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. Neo York.

## ENT: 510 Course Title: Principles of IPM (1+1=2)

### A) Theory:

Lecture No.	Topic	Weightage (%)
1	History of Pest management	20
2	<ul style="list-style-type: none"> <li>▪ Origin of pest Management,</li> <li>▪ Definitions</li> <li>▪ Evolution of various related terminologies</li> </ul>	
4	Understanding the agricultural ecosystem, Planning the Agril. ecosystem, cost/ benefit, benefit/risk, Tolerance of pest damage, Ecological principles	20
5	Economic injury level, Economic threshold level, Determination of economic threshold	
7	Integration of tactics, essential requisites for decision making in IPM, Decision making system	40
8	Constraints in IPM implementation, Strategies for IPM implementation.	
9	IPM and sustainable Agriculture, Potential in IPM	
10	Tools of pest management- cultural, physical & Legislative control, Historical acts, The insecticide Act, 1968, Central bodies and laboratories	
11	Registration of insecticides, Licenses for manufacture and sale, central insecticides laboratory, state insecticides testing laboratory, Prevention of Food Adulteration Act, 1954	

12	Cultural control – Planting time, seed, plant spacing, Tillage, plant diversity, crop rotation, Nutrient management, water management, sanitation, Harvesting practices	
13	Physical control – Hot or cold treatment, moisture, Light traps, mechanical control – Hand picking, exclusion by screens and barrier, Trapping and suction devices, clipping, pruning and crushing, integration with other tactics	
14	Pest survey and surveillance, Forecasting, Area wide control of insect pests (fruit fly)	20
15	Types of surveys including remote sensing methods, factors affecting surveys	
16	Political, social and legal implications of IPM	
17	Pest risk analysis, pesticide risk analysis and partial budgeting	
18	Case studies to successful IPM programmes.	

### B) Practical:

Practical No.	Topic
1 & 2	Characterization of Agro ecosystem
3 & 4	Sampling methods – Sequential sampling, variable intensity sampling, double sampling binomial sampling estimating abundance of natural enemies
5 & 6	Factors affecting sampling nature, size and number of samples, Crop loss assessment, direct losses, indirect losses, avoidable losses, unavoidable losses.
7 to 9	Population estimation methods, Absolute estimates, Relative methods, Population indices, Life tables
10 to 14	Computation of EIL and ETL
15	Crop modeling
16	Designing & IPM
17 & 18	Implementation of IPM

### Suggested Readings:

- Dhaliwal, G.S. & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches*. Kalyani Publ., New Delhi.
- Dhaliwal, G.S., Singh, R. & Chhillar, B.S. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
- Flint, M.C. & Bosch, R.V. 1981. *Introduction to Integrated Pest Management*. 1<sup>st</sup> Ed., Springer, New York.
- Horowitz, A.R. & Ishaaya, I. 2004. *Insect Pest Management : Field and Protected Crops*. Springer, New Delhi.
- Ignacimuthu, S.S. & Jayaraj, S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.
- Metcalf, R.L. & Luckman, W.H. 1982. *Introduction to Insect Pest Management*. John Wiley & sons, New York.

Pedigo, R.L. 2002. *Entomology and Pest Management*. 4<sup>th</sup> Ed. Prentice Hall, New Delhi.

Norris, R.F., Caswell-Chen, E.P. & Kogan, M. 2002. *Concepts in Integrated Pest Management*. Printice Hall, New Delhi.

Subramanyam, B. & Hagstrum, D.W. 1995. *Integrated Management of Insect in Stored products*. Marcel Dekker, New York.

## ENT: 511 Course Title : Pests of Field Crops (1+1=2)

### A) Theory:

Lecture No.	Topic	Weightage (%)
1/2	<b>Systematic position, marks of identification distribution, host range, biology, seasonal incidence and management system.</b> <b>Pests of Rice</b> – Stem borer, Green leaf and Brown Plant hopper, leaf roller, gall midge, Army worm, Rice hispa, Blue beetle etc.	10
3/4	<b>Pests of Sorghum</b> – Stem bores, shootfly, midge, Jassids, ear head caterpillar, Pests of maize, stem borers and leaf eating caterpillars, <b>pests of wheat</b> – stem borer, aphids and rodents.	20
5&6	<b>Polyphagous pests</b> – Armyworm, white grubs, cutworm, Termites, <i>Helicoverpa</i> , <i>Spodoptera</i> and Locust	15
7	<b>Non insect Pests</b> – Rodents, mites, Snail & slugs and birds	10
8-9	<b>Pest of pulses</b> – Borer complex, mites	5
10-11	<b>Pests of oilseeds</b> – Groundnut leaf miner, thrips, pod flies white grubs, castor semi looper, leaf eating caterpillar, capsule borer	5
12-13	<b>Pests of Tobacco &amp; safflower</b> aphids, leaf eating, caterpillars, cut worm, safflower aphids, sunflower leaf eating caterpillar, mustard sawfly.	5
14-10	<b>Pests of fiber crops</b> – Sucking pest complex, boll worm complex, IPM	10
15-16	Pests of sugarcane – Borers complex, white grub, white woolly aphids, & mites	10
17	Pests of forage & their management	5
18	Field visit	5

### B) Practical:

Practical No.	Topic
1 -18	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

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**Suggested Readings:**

Atwal, AS, Dhaliwal, G.S. & David, B.V. 2001. *Elements of Economic Entomology*. Popular Book Depot, Chennai.

Dhaliwal, G.S., Singh, R. & Chhillar, B.S. 2006. *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.

Dunston, A.P. 2007. *The Insects : Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi.

Evans, J.W. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.

Nair MRGK. 1986. *Insect and Mites of Crops in India*, ICAR, New Delhi.

Prakash, I. & Mathur, R.P. 1987. Management of Rodent Pests. *ICAR, New Delhi*.

Saxena, R.C. & Srivastava, R.C. 2007. *Entomology at a Glance*. Agrotech Publ. Academic, Jodhpur.

**ENT: 512 Course Title: Pests of Horticultural and Plantation Crops Credits: (1+1=2)**

**A) Theory:**

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature of loss, seasonal history, their integrated management.

Lecture No.	Topic to be convened	Weightage (%)
1.	Mango	30
2.	Guava, banana, jackfruit, papaya	
3.	Pomegranate, litchi, grapes	
4.	Ber, fig, aonla	
5.	Citrus	
6.	Pineapple, apple, peach & temperate fruits	30
7.	Tomato, potato, brinjal, okra	
8.	Raddish, carrot, beetroot, cole crops	
9.	French bean, onion, garlic	
10.	All gourds	
11.	Gherkin, drumstick, leafy vegetables	25
12.	Coffee, tea, rubber	
13.	Coconut, areca nut	
14.	Cashew, cocoa	
15.	Pepper, cardamom, clove, chillies	
16.	Turmeric, ginger, beetle vine	15
17.	Ornamental, medicinal, and aromatic crops	
18.	Protected cultivation	



**B) Practical:**

Practical No.	Topic to be convened
1-8	Collection, preservations and identification of important pests of horticultural crops
9-12	Collection, preservations and identification of natural enemies of pests of horticultural crops
13-18	Study of life history of important insect pests and natural enemies
	Apple, peach & temperate fruits
	Potato
	All gourds
	Coconut
	Cardamom, nutmeg
	Medicinal plants
	Aromatic crops
	Protected cultivation
	Polyhouse
	Field visit
	Rearing techniques of important pests
	Field visit

**Suggested Readings:**

Hall, D.W. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas*. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO. Rome.

Jayas, D.V. White, N.D.G. & Muir, W.E. 1995. *Stored Grain Ecosystem*. Marcel Dekker, New York.

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

Khare, B.P. 1994. *Stored Grains Pests and Their Management*. Kalyani Publ. New Delhi.

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

**ENT- 518 Course Title: Techniques in plant protection (0+1=1)****Practical:**

Lecture No.	Unit	Topic to be convened	Weightage (%)
1	I	Plant protection equipments	30
2		Principles & operation of plant protection equipments	
3		Selection & application of pesticides	
4		Selection and application of bio-agents	
5		Seed dressing, soaking, root-dip-treatment	
6		Dusting, spraying and application of insecticides through irrigation water	

7	II	Soil solarization, sterilization, deep ploughing & flooding	10
8		Techniques to check the spread of pests through seed, bulb, corms, cuttings & cut flowers	
9	III	Use of light, transmission & scanning electron microscopy	10
10	IV	Protein isolation from pests & host plants	30
11		Quantification of protein by using spectrophotometer	
12-13		Molecular weight determination using SDS/PAGE	
14-15	IV	Use of Tissue culture techniques in plant protection	20
16-17		Computer application for predicting and forecasting pest attack	
18		Computer application for identification of pests	

**Suggested Readings:**

Alford, D.V. 1999. *A Textbook of Agricultural Entomology*. Blackwell Science, London.

Crampton, J.M. & Eggleston, P. 1992. *Insect Molecular Science*. Academic Press, London