

## Department of Entomology

### Name of the Programme M.Sc. (Ag) Entomology

#### Course offer

Group	Course No.	Title of course	Credit Hrs.
Major Course	1. ENT 504	Classification of Insect	3(2+1)
	2. ENT 505	Insect Ecology	2(1+1)
	3. ENT 510	Principles of Integrated Pest Management	2(1+1)
	4. ENT 518	Techniques in Plant Protection	1(0+1)
	5. ENT 501	Insect Morphology	2(1+1)
	6. ENT 502	Insect Anatomy, Physiology & Nutrition	3(2+1)
	7. ENT 507	Biological control of crop pests & weeds	2(1+1)
	8. ENT 508	Toxicology of Insecticides	3(2+1)
	9. ENT 511	Pests of field crops	2(1+1)
<b>Total Credit Load</b>			<b>20 (11+9)</b>
Seminar	1 ENT-599	Master Research	20(0+20)
Research	2 ENT-591	Credit Seminar	1(0+1)
Minor Course	1 PL. PATH 504	Principles of Plant Pathology	3(3+0)
	2 PL. PATH 511	Chemicals in Plant Disease Management	3(2+1)
	3 PP 516	Integrated Disease Management	3(2+1)
<b>Total Credit Load</b>			<b>9(7+2)</b>
Supporting	1 STAT- 511	Statistics – I	4(3+1)
	2 STAT 512	Statistics II (Statistical Design)	3(2+1)
<b>Total Credit Load</b>			<b>7(5+2)</b>
Non Credit Course	1 PGS-501	Library & Information Services	1(0+1)
	2 PGS-504	Basic Concept in Laboratory Techniques	1(0+1)
	3 PGS-505	Agril. Research, Res. Ethics & Rural Development Programme (e-course)	1(1+0)
	4 PGS-506	Disaster Management	1(1+0)
	5 PGS-502	Technical writing and communication skill	1(0+1)
	6 PGS-503	Intellectual properties and its management	1(1+0)
	7 HVE	Human values and professional ethics	2(1+1)
<b>Total Credit Load</b>			<b>08(4+4)</b>
<b>Grand total</b>			<b>63( 25+38)</b>



**DEPARTMENT OF ENTOMOLOGY**

**Name of the Programme M.Sc. (Ag) ENTOMOLOGY**

**Minimum credit requirements for different degree programme**

Subject	Master
Major	20
Minor	09
Supporting	07
Seminar	01
Thesis research	20
<b>Total</b>	<b>57</b>

**Course offered for M.Sc. (Ag) Food Science and Technology**

Group	Course No.	Title of course	Credit Hrs.
<b>Major Course</b>	1. ENT 504	Classification of Insect	3(2+1)
	2. ENT 505	Insect Ecology	2(1+1)
	3. ENT 510	Principles of Integrated Pest Management	2(1+1)
	4. ENT 518	Techniques in Plant Protection	1(0+1)
	5. ENT 501	Insect Morphology	2(1+1)
	6. ENT 502	Insect Anatomy, Physiology & Nutrition	3(2+1)
	7. ENT 507	Biological control of crop pests & weeds	2(1+1)
	8. ENT 508	Toxicology of Insecticides	3(2+1)
	9. ENT 511	Pests of field crops	2(1+1)
<b>Total Credit Load</b>			<b>20 (11+9)</b>
<b>Seminar Research</b>	1 ENT-599	Master Research	20(0+20)
	2 ENT-591	Credit Seminar	1(0+1)
<b>Minor Course</b>	1 PL. PATH 504	Principles of Plant Pathology	3(3+0)
	2 PL. PATH 511	Chemicals in Plant Disease Management	3(2+1)
	3 PP 516	Integrated Disease Management	3(2+1)
<b>Total Credit Load</b>			<b>9(7+2)</b>
<b>Supporting</b>	1 STAT- 511	Statistics – I	4(3+1)
	2 STAT 512	Statistics II (Statistical Design)	3(2+1)
<b>Total Credit Load</b>			<b>7(5+2)</b>
<b>Non Credit Course</b>	1 PGS-501	Library & Information Services	1(0+1)
	2 PGS-504	Basic Concept in Laboratory Techniques	1(0+1)
	3 PGS-505	Agri. Research, Res. Ethics & Rural Development Programme (e-course)	1(1+0)
	4 PGS-506	Disaster Management	1(1+0)
	5 PGS-502	Technical writing and communication skill	1(0+1)
	6 PGS-503	Intellectual properties and its management	1(1+0)
	7 HVE	Human values and professional ethics	2(1+1)
<b>Total Credit Load</b>			<b>08(4+4)</b>
<b>Grand total</b>			<b>63( 25+38)</b>

## Semester wise distribution of courses

	Title of the course	Code	Credits
<b>I Semester</b>			
Major	Classification of Insect	ENT 504	3(2+1)
	Insect Ecology	ENT 505	2(1+1)
	Principles of Integrated Pest Management	ENT 510	2(1+1)
	Techniques in Plant Protection	ENT 518	1(0+1)
Minor	Principles of Plant Pathology	PL. PATH 504	3(3+0)
	Chemicals in Plant Disease Management	PL. PATH 511	3(2+1)
Supporting	Statistics – I	STAT- 511	4(3+1)
Compulsory NC	Library & Information Services	PGS 501	1(0+1)
	Basic Concept in Laboratory Techniques	PGS 504	1(0+1)
	Intellectual Properties and its Management	PGS-503	1(1+0)
	Human Value and Professional Ethics		2(1+1)
	<b>Total</b>		<b>23(14+9)</b>
<b>II Semester</b>			
Major	Insect Morphology	ENT 501	2(1+1)
	Insect Anatomy, Physiology & Nutrition	ENT 502	3(2+1)
	Biological control of crop pests & weeds	ENT 507	2(1+1)
	Toxicology of Insecticides	ENT 508	3(2+1)
	Pests of field crops	ENT 511	2(1+1)
Minor	Integrated Disease Management	PP 516	3(2+1)
Supporting	Statistics II (STATISTICAL DESIGN)	ST 512	3(2+1)
Compulsory NC	Agril. Research, Research Ethics & Rural Development Programme	PGS 505	1(0+1)
	Disaster Management	PGS-506	1(1+0)
	Technical writing and communication skills	PGS 502	1(0+1)
	<b>Total</b>		<b>21(12+9)</b>
<b>III Semester</b>			
	<i>Comprehensive Examination</i>		
	Master's Seminar	ENT 591	1(0+1)
	Master' Research	ENT 599	10(0+10)
<b>IV Semester</b>	Master's Research	ENT 599	10(0+10)

<b>ENT 501</b>	<b>Insect Morphology</b>	<b>1+1</b>
<b>Objective</b>	To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.	
<b>Theory</b>		
<b>UNIT I</b>	Principles, utility and relevance insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.	
<b>UNIT II</b>	Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.	
<b>UNIT III</b>	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.	
<b>UNIT IV</b>	Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).	
<b>Practical</b>	<ul style="list-style-type: none"> <li>• Study of insect segmentation, various tagmata and their appendages.</li> <li>• Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.</li> </ul>	

### **Suggested Readings**

Chapman RF. 1998. The Insects 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 Insects Structure, Function and Biodiversity. Kalyani Publ., New Delhi.  
Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.  
Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th 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.

**ENT 502                      Insect Anatomy, Physiology and Nutrition                      2+1**

**Objective**                      To impart knowledge to the students on basic aspects of anatomy of different systems, elementary physiology, nutritional physiology and their application in entomology.

**Theory**

**UNIT I**                              Scope and importance of insect anatomy and physiology.

**UNIT II**                              Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

**UNIT III**                              Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause.

**UNIT IV**                              Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

**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.

**Suggested Readings**

Chapman RF. 1998. Insects Structure and Function. ELBS Ed., London.  
Duntson PA. 2004. The Insects Structure, Function and Biodiversity. Kalyani Publ., New Delhi.  
Kerkut GA & Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.  
Patnaik BD. 2002. Physiology of Insects. Dominant, New Delhi.  
Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, Physiology and Development. Chapman & Hall, New York.  
Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur.  
Wigglesworth VB. 1984. Insect Physiology. 8th Ed. Chapman & Hall, New York.



ENT 505

**Insect Ecology**

1+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. Train students in sampling methodology, calculation of diversity indices, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

**Theory**

**UNIT I**

History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

**UNIT II**

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.

**UNIT III**

Biotic factors- 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 nicheecological 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.

**UNIT IV**

Community ecology- Concept of guild, Organisation of communities - Hutchinson Ratio, May's  $d/w$ , Relation between the two and 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, relevance to pest management. Pest management as applied ecology.

**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.



## 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. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA
- Gupta RK. 2004. Advances in Insect Biodiversity. Agrobios, Jodhpur.
- Krebs CJ. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
- Krebs CJ. 2001. Ecology The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin-Cummings Publ. Co., New York.
- Magurran AE. 1988. Ecological Diversity and its Measurement. Princeton Univ. Press, Princeton.
- Price PW. 1997. Insect Ecology. 3rd 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. 3rd Ed. Methuen & Co. Ltd., London.
- Speight MR, Hunta MD & Watt AD. 2006. Ecology of Insects Concepts and Application. Elsevier Science Publ., The Netherlands.
- Wilson EO & William H Bossert WH. 1971. A Primer of Population Biology. Harvard University, USA.
- Wratten SD & Fry GLA. 1980. Field and Laboratory Exercises in Ecology. Arnold, London.











**PL PATH 504 Principles of Plant Pathology 3+0**

**Objective** To introduce the subject of Plant Pathology, its concepts and principles.

**Theory**

**UNIT I** Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

**UNIT II** Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

**UNIT III** Host parasite interaction, recognition concept and infection, symptomatology, disease development - role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

**UNIT IV** Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

**UNIT V** Disease management strategies.

**Suggested Readings**

- Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.  
Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.  
Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.  
Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.  
Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.  
Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi. 69





**PL PATH 516    Integrated Disease Management**

**2+1**

**Objective**        To emphasize the importance and need of IDM in the management of diseases of important crops.

**Theory**

**UNIT I**            Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

**UNIT II**            Development of IDM- basic principles, biological, chemical and cultural disease management.

**UNIT III**            IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearl millet, *kharif* pulses, vegetable crops and fruit crops.

**Practical**         Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

**Suggested Readings**

Gupta VK & Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.

**Objective**      The student is exposed statistical methods and statistical inference to help them in understanding the concepts involved in data presentation, analysis and interpretation.

**Theory**

**UNIT I**      Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

**UNIT II**      Discrete and continuous probability distributions Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions. Large sample theory.

**UNIT III**      Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

**UNIT IV**      Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

**UNIT V**      Introduction to multivariate analytical tools- Hotelling's  $T^2$  Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function,  $D^2$  - statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

**Practical**

- Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

**Suggested Readings**

Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.  
Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.  
Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.  
Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.  
Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.  
Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan.  
Morrison DF. 1976. Multivariate Statistical Methods. McGraw Hill.  
Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.  
Learning Statistics <http://freestatistics.altervista.org/en/learning.php>.  
Electronic Statistics Text Book  
<http://www.statsoft.com/textbook/stathome.html>.

**STAT 512**      **Experimental Designs**      **2+1**

**Objective**      The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

**Theory**

**UNIT I**      Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

**UNIT II**      Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

**UNIT III**      Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

**UNIT IV**      Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

**UNIT V**      Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

**Practical**

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

**Suggested Readings**

Cochran WG & Cox GM. 1957. Experimental Designs. 2<sup>nd</sup> Ed. John Wiley.

Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server [www.iasri.res.in/design](http://www.iasri.res.in/design).

<b>PGS 501</b>	<b>Library and Information Services</b>	<b>1(0+1)</b>
<b>Objective</b>	To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.	
<b>Practical</b>	Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; ere sources access methods.	

<b>PGS 504</b>	<b>Basic Concepts in Laboratory Techniques</b>	<b>1(0+1)</b>
<b>Objective</b>	To acquaint the students about the basics of commonly used techniques in laboratory.	
<b>Practical</b>	Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	

### **Suggested Readings**

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.  
 Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

<b>PGS 505</b>	<b>Agriculture Research, Research Ethics and Rural Development Program's</b>	<b>(e-Course) 1(1+0)</b>
<b>Objective</b>	To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.	
<b>Theory</b>		
<b>UNIT I</b>	History of agriculture in brief; Global agricultural research system need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR) International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	

**UNIT II** Research ethics research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

**UNIT III** Concept and connotations of rural development, rural development policies and strategies. Rural development programmes Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

### **Suggested Readings**

Bhalla GS & Singh G. 2001. Indian Agriculture- Four Decades of Development. Sage Publ.  
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.  
Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovations and Initiatives.  
Singh K.. 1998. Rural Development Principles, Policies and Management. Sage Publ.

**PGS 506 Disaster Management (e-Course) 1(1+0)**

**Objective** To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

### **Theory**

**UNIT I** Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change Global warming, Sea Level rise, Ozone Depletion

**UNIT II** Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

**UNIT III** Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response Police and other organizations.

### **Suggested Readings**

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.  
Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe A Handbook of Disaster Management. Routledge.  
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

**PGS 502 Technical Writing and Communications Skills 1(0+1)**

### **Objective**

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

### **Practical**

- **Technical Writing** - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering

of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

- **Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern Weak forms in connected speech Participation in group discussion Facing an interview; presentation of scientific papers.

### Suggested Readings

- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. Collins' Cobuild English Dictionary. 1995.
- Harper Collins. Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. Comp.Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India. Richard WS.1969. Technical Writing. Barnes & Noble. Robert C. (Ed.). 2005. Spoken English Flourish Your Language.
- Abhishek. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2<sup>nd</sup>Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

**PGS 503 (e-Course) Intellectual Property and Its management in Agriculture 1(1+0)**

### Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

### Theory

- Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

### Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments;
- Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.



## Department of Entomology

### Name of the Programme M.Sc. (Ag) Entomology

#### Semester wise distribution of courses

	Title of the course	Code	Credits
<b>I Semester</b>			
Major	Classification of Insect	ENT 504	3(2+1)
	Insect Ecology	ENT 505	2(1+1)
	Principles of Integrated Pest Management	ENT 510	2(1+1)
	Techniques in Plant Protection	ENT 518	1(0+1)
Minor	Principles of Plant Pathology	PL. PATH 504	3(3+0)
	Chemicals in Plant Disease Management	PL. PATH 511	3(2+1)
Supporting	Statistics – I	STAT- 511	4(3+1)
Compulsory NC	Library & Information Services	PGS 501	1(0+1)
	Basic Concept in Laboratory Techniques	PGS 504	1(0+1)
	Intellectual Properties and its Management	PGS-503	1(1+0)
	Human Value and Professional Ethics		2(1+1)
	<b>Total</b>		<b>23(14+9)</b>
<b>II Semester</b>			
Major	Insect Morphology	ENT 501	2(1+1)
	Insect Anatomy, Physiology & Nutrition	ENT 502	3(2+1)
	Biological control of crop pests & weeds	ENT 507	2(1+1)
	Toxicology of Insecticides	ENT 508	3(2+1)
	Pests of field crops	ENT 511	2(1+1)
Minor	Integrated Disease Management	PP 516	3(2+1)
Supporting	Statistics II (STATISTICAL DESIGN)	ST 512	3(2+1)
Compulsory NC	Agril. Research, Research Ethics & Rural Development Programme	PGS 505	1(0+1)
	Disaster Management	PGS-506	1(1+0)
	Technical writing and communication skills	PGS 502	1(0+1)
	<b>Total</b>		<b>21(12+9)</b>
<b>III Semester</b>			
	<i>Comprehensive Examination</i>		
	Master's Seminar	ENT 591	1(0+1)
	Master' Research	ENT 599	10(0+10)
<b>IV Semester</b>	Master's Research	ENT 599	10(0+10)



## ***Course Curriculum M.Sc. (Ag) Entomology***

<b>ENT 501</b>	<b>Insect Morphology</b>	<b>1+1</b>
<b>Objective</b>	To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.	
<b>Theory</b>		
<b>UNIT I</b>	Principles, utility and relevance insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.	
<b>UNIT II</b>	Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites.	
<b>UNIT III</b>	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.	
<b>UNIT IV</b>	Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors).	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Study of insect segmentation, various tagmata and their appendages.</li><li>• Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.</li></ul>	

### **Suggested Readings**

- Chapman RF. 1998. The Insects 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 Insects Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
- Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
- Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th 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 Curriculum M.Sc. (Ag) Entomology**

<b>ENT 504</b>	<b>Classification of Insects</b>	<b>2+1</b>
<b>Objective</b>	To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.	
<b>Theory</b>		
<b>UNIT I</b>	Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Super class Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained.	
<b>UNIT II</b>	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta Subclass Apterygota–Archaeognatha, Thysanura. Subclass Pterygota, Division Palaeoptera–Odonata and Ephemeroptera. Division Neoptera Subdivision Orthopteroid and Blattoid Orders (=Oligoneoptera Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision Hemipteroid Orders (=Paraneoptera) Psocoptera, Phthiraptera, Thysanoptera and Hemiptera.	
<b>UNIT III</b>	Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera –Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders Hymenoptera.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Study of Orders of insects and their identification using taxonomic keys.</li><li>• Keying out families of insects of different major Orders Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.</li><li>• Field visits to collect insects of different orders.</li></ul>	

### **Suggested Readings**

- CSIRO 1990. The Insects of Australia A Text Book for Students and Researchers. 2nd 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. 10th 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. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

## Course Curriculum M.Sc. (Ag) Entomology

<b>ENT 505</b>	<b>Insect Ecology</b>	<b>1+1</b>
<b>Objective</b>	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. Train students in sampling methodology, calculation of diversity indices, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.	
<b>Theory</b>		
<b>UNIT I</b>	History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.	
<b>UNIT II</b>	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.	
<b>UNIT III</b>	Biotic factors- 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 nicheecological 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.	
<b>UNIT IV</b>	Community ecology- Concept of guild, Organisation of communities - Hutchinson Ratio, May's $d/w$ , Relation between the two and their association with Dyar's Law and Przibransky's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity- stability debate, relevance to pest management. Pest management as applied ecology.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters.</li><li>• Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution.</li><li>• Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit.</li><li>• Fitting Holling's Disc equation. Assessment of prey-predator densities from natural systems and understanding the correlation between the two.</li><li>• Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms.</li><li>• Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values.</li><li>• Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.</li></ul>	

## ***Course Curriculum M.Sc. (Ag) Entomology***

### **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. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA
- Gupta RK. 2004. Advances in Insect Biodiversity. Agrobios, Jodhpur.
- Krebs CJ. 1998. Ecological Methodology. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
- Krebs CJ. 2001. Ecology The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin-Cummings Publ. Co., New York.
- Magurran AE. 1988. Ecological Diversity and its Measurement. Princeton Univ. Press, Princeton.
- Price PW. 1997. Insect Ecology. 3rd 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. 3rd Ed. Methuen & Co. Ltd., London.
- Speight MR, Hunta MD & Watt AD. 2006. Ecology of Insects Concepts and Application. Elsevier Science Publ., The Netherlands.
- Wilson EO & William H Bossert WH. 1971. A Primer of Population Biology. Harvard University, USA.
- Wratten SD & Fry GLA. 1980. Field and Laboratory Exercises in Ecology. Arnold, London.



## **Course Curriculum M.Sc. (Ag) Entomology**

<b>ENT 508</b>	<b>Toxicology of Insecticides</b>	<b>2+1</b>
<b>Objective</b>	To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.	
<b>Theory</b>		
<b>UNIT I</b>	Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.	
<b>UNIT II</b>	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, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc.	
<b>UNIT III</b>	Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.	
<b>UNIT IV</b>	Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.	
<b>UNIT V</b>	Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Insecticide formulations and mixtures.</li><li>• Quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides.</li><li>• Bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action.</li><li>• Toxicity to beneficial insects.</li><li>• Pesticide appliances. Working out doses and concentrations of pesticides.</li><li>• Visit to toxicology laboratories. Good laboratory practices.</li></ul>	

### **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., New York.





## ***Course Curriculum M.Sc. (Ag) Entomology***

<b>ENT 511</b>	<b>Pests of Field Crops</b>	<b>1+1</b>
<b>Objective</b>	To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.	
<b>Theory</b>	Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.	
<b>UNIT I</b>	Insect pests of cereals and millets and their management. Polyphagous pests grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).	
<b>UNIT II</b>	Insect pests of pulses, tobacco, oilseeds and their management.	
<b>UNIT III</b>	Insect pests of fibre crops, forages, sugarcane and their management.	
<b>Practical</b>	<ul style="list-style-type: none"><li>• Field visits, collection and identification of important pests and their natural enemies.</li><li>• Detection and estimation of infestation and losses in different crops.</li><li>• Study of life history of important insect pests.</li></ul>	

### **Suggested Readings**

Atwal AS, Dhaliwal GS & David BV. 2001. Elements of Economic Entomology. Popular Book Depot, Chennai.  
Dhaliwal GS, Singh R & Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.  
Dunston AP. 2007. The Insects Beneficial and Harmful Aspects. Kalyani Publ., New Delhi  
Evans JW. 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 RP. 1987. Management of Rodent Pests. ICAR, New Delhi.  
Saxena RC & Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Jodhpur.



**PL PATH 504 Principles of Plant Pathology 3+0**

**Objective** To introduce the subject of Plant Pathology, its concepts and principles.

**Theory**

**UNIT I** Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

**UNIT II** Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

**UNIT III** Host parasite interaction, recognition concept and infection, symptomatology, disease development - role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

**UNIT IV** Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

**UNIT V** Disease management strategies.

**Suggested Readings**

Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.  
Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.  
Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.  
Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.  
Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.  
Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi. 69



## ***Course Curriculum M.Sc. (Ag) Entomology***

### **PL PATH 516 Integrated Disease Management**

**2+1**

**Objective** To emphasize the importance and need of IDM in the management of diseases of important crops.

#### **Theory**

**UNIT I** Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

**UNIT II** Development of IDM- basic principles, biological, chemical and cultural disease management.

**UNIT III** IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearl millet, *kharif* pulses, vegetable crops and fruit crops.

**Practical** Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

#### **Suggested Readings**

Gupta VK & Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.

**STAT 511      Statistical Methods for Applied Sciences      3+1**

**Objective**      The student is exposed statistical methods and statistical inference to help them in understanding the concepts involved in data presentation, analysis and interpretation.

**Theory**

**UNIT I**      Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

**UNIT II**      Discrete and continuous probability distributions Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions. Large sample theory.

**UNIT III**      Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

**UNIT IV**      Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

**UNIT V**      Introduction to multivariate analytical tools- Hotelling's  $T^2$  Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function,  $D^2$  - statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

**Practical**

- Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F; Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution; Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

**Suggested Readings**

Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.  
Dillon WR & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.  
Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.  
Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.  
Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.  
Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan.  
Morrison DF. 1976. Multivariate Statistical Methods. McGraw Hill.  
Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.  
Learning Statistics <http://freestatistics.altervista.org/en/learning.php>.  
Electronic Statistics Text Book  
<http://www.statsoft.com/textbook/stathome.html>.

## **Course Curriculum M.Sc. (Ag) Entomology**

**STAT 512      Experimental Designs      2+1**

**Objective**      The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

### **Theory**

**UNIT I**      Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

**UNIT II**      Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

**UNIT III**      Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

**UNIT IV**      Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

**UNIT V**      Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

### **Practical**

- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot and strip plot designs; Transformation of data; Analysis of resolvable designs; Fitting of response surfaces.

### **Suggested Readings**

Cochran WG & Cox GM. 1957. Experimental Designs. 2<sup>nd</sup> Ed. John Wiley.

Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.

Pearce SC. 1983. The Agricultural Field Experiment A Statistical Examination of Theory and Practice. John Wiley.

Design Resources Server [www.iasri.res.in/design](http://www.iasri.res.in/design).

<b>PGS 501</b>	<b>Library and Information Services</b>	<b>1(0+1)</b>
<b>Objective</b>	To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.	
<b>Practical</b>	Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; ere sources access methods.	

<b>PGS 504</b>	<b>Basic Concepts in Laboratory Techniques</b>	<b>1(0+1)</b>
<b>Objective</b>	To acquaint the students about the basics of commonly used techniques in laboratory.	
<b>Practical</b>	Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	

**Suggested Readings**

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.  
Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

<b>PGS 505</b>	<b>Agriculture Research, Research Ethics and Rural Development Program's</b>	<b>(e-Course) 1(1+0)</b>
<b>Objective</b>	To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.	
<b>Theory</b>		
<b>UNIT I</b>	History of agriculture in brief; Global agricultural research system need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR) International Agricultural Research Centres (IARC),	



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partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

**UNIT II** Research ethics research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

**UNIT III** Concept and connotations of rural development, rural development policies and strategies. Rural development programmes Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

### Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture- Four Decades of Development. Sage Publ.

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovations and Initiatives.

Singh K.. 1998. Rural Development Principles, Policies and Management. Sage Publ.

### PGS 506 Disaster Management (e-Course) 1(1+0)

**Objective** To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

#### Theory

**UNIT I** Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change Global warming, Sea Level rise, Ozone Depletion

**UNIT II** Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

**UNIT III** Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response Police and other organizations.

### Suggested Readings

Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe A Handbook of Disaster Management. Routledge.

Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

### PGS 502 Technical Writing and Communications Skills 1(0+1)

#### Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

#### Practical

- **Technical Writing** - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research

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communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

- **Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern Weak forms in connected speech Participation in group discussion Facing an interview; presentation of scientific papers.

### Suggested Readings

- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. Collins' Cobuild English Dictionary. 1995.
- Harper Collins. Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. Comp.Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India. Richard WS.1969. Technical Writing.
- Barnes & Noble. Robert C. (Ed.). 2005. Spoken English Flourish Your Language.
- Abhishek. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2<sup>nd</sup>Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

**PGS 503**            **(e-Course) Intellectual Property and Its management in Agriculture**            **1(1+0)**

### Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

### Theory

- Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

### Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments;

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- Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

