GURU KASHI UNIVERSITY

Master of Science in Agriculture

(Entomology) (ENTO)

Session: 2025-26

Faculty of Agriculture

Graduate Attributes

Type of learning outcomes	**The Learning Outcomes Descriptors**
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specific to disciplinary/interdisciplinary areas of learning	Estimate and evaluate methods of population estimation of insect pests in various agro ecosystems. Apply taxonomic keys in correct identification of insect's characterization and classify insect pests of economic importance.
Generic learning outcomes	Create expertise in the identification, ecology, life history of insect pests, physiological aspects and basic principles and strategies in the management of insect pests. Explore for entrepreneurship development. Aspects related to pesticide residue management according to latest developments.

Programme Learning outcomes: A Postgraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 6.0:

Element of the Descriptor	**Programme learning outcomes relating to Undergraduate Certificate**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Proficiency with the basic concepts and management techniques of insect pests, predators, and parasites, as well as their identification, life history, and ecology
General, technical and professional skills required to perform and accomplish tasks	Graduates will apply entomological knowledge, technical skills, and professional ethics to identify, analyze, and solve insect-related problems in agriculture, health, and environmental sectors.
Application of knowledge and skills	Familiarize the students with principles of insect pest management, including concept and philosophy of integrated pest management (IPM).
Generic learning outcomes	Train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomo-pathogenic microorganisms. Develop comprehension relevant to the basic concepts of toxicology, types of insecticides and their formulations along with pesticide residue management and plant protection appliances and quarantine aspects along with its application.
Constitutional, humanistic, ethical, and moral values	Development of understating for eco-friendly management of Pests for sustainable agriculture.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	The knowledge acquired and skill developed in the field of entomology, help in recognizing the applications of latest technologies in all spheres of agriculture and develop crops with improved productivity thereby increasing farmers' income, better human health and decreased environmental pollution as well as meet out the future challenges in agricultural crops and storage grains

<table>
<tr><td>Credit requirements</td><td>
<table>
<tr><th></th><th>Masters' Programme</th></tr>
<tr><td>(i) Course work</td><td></td></tr>
<tr><td>Major courses</td><td>20</td></tr>
<tr><td>Minor courses</td><td>08</td></tr>
<tr><td>Supporting courses</td><td>06</td></tr>
<tr><td>Common courses</td><td>05</td></tr>
<tr><td>Seminar</td><td>01</td></tr>
<tr><td>(ii) Thesis Research</td><td>30</td></tr>
<tr><td>Total</td><td>70</td></tr>
</table>
</td></tr>
<tr><td>Entry requirements</td><td>A student with a Bachelor Degree subject to fulfillment of the eligibility conditions of a programme as specified by the University, shall be eligible for admission to a 2-year PG Programme.</td></tr>
</table>

Program Structure

SEMESTER- I									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
ENTO501	Insect Morphology	Major	2	0	0	2	30	70	100
ENTO502	Insect Morphology Lab	Major	0	0	2	1	30	70	100
ENTO503	Insect Ecology	Major	1	0	0	1	30	70	100
ENTO504	Insect Ecology Lab	Major	0	0	2	1	30	70	100
PATH600	Biological Control of Plant Diseases	Minor (CBCS) (Choose any one)	2	0	0	2	30	70	100
PATH602	Post Harvest Diseases								
PATH601	Biological Control of Plant Diseases Lab	Minor (CBCS) (Choose any one)	0	0	2	1	30	70	100
PATH603	Post Harvest Diseases								
STAT501	Agriculture statistics	Supporting	3	0	0	3	30	70	100
STAT502	Agriculture Statistics Lab	Supporting	0	0	2	1	30	70	100
PGC501	Library and Information Services Lab	Common	0	0	2	1	30	70	100
PGC502	Agricultural Research, Research Ethics and Rural Development Programmes	Common	1	0	0	1	30	70	100
ENTO500	Master Research	Research	-	-	-	4	50	0	50
Total						**18**	**350**	**700**	**1050**

SEMESTER-II									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
ENTO551	Anatomy and Physiology of Insects	Major	2	0	0	2	30	70	100
ENTO552	Anatomy and Physiology of Insects Lab	Major	0	0	2	1	30	70	100
ENTO553	Insect Taxonomy	Major	1	0	0	1	30	70	100
ENTO554	Insect Taxonomy Lab	Major	0	0	2	1	30	70	100
ENTO555	Biological Control of Insect Pests and Weeds	Major	2	0	0	2	30	70	100
ENTO556	Biological Control of Insect Pests and Weeds Lab	Major	0	0	2	1	30	70	100
ENTO557	Host Plant Resistance	Minor	1	0	0	1	30	70	100
ENTO558	Host Plant Resistance Lab	Minor	0	0	2	1	30	70	100
CA551	Fundamentals of Computer Applications	Supporting	-	-	4	2	30	70	100
PGC551	Basic Concepts in Laboratory Techniques-Lab	Common	0	0	2	1	30	70	100
ENTO559	Seminar	Seminar	-	-	-	1	30	70	100
ENTO500	Master Research	Research	-	-	-	5	50	0	50
Total						**19**	**380**	**770**	**1150**

SEMESTER-III									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
ENTO600	Toxicology of Insecticides	Major	2	0	0	2	30	70	100
ENTO601	Toxicology of Insecticides Lab	Major	0	0	2	1	30	70	100
ENTO602	Apiculture	Major	1	0	0	1	30	70	100
ENTO603	Apiculture	Major	0	0	2	1	30	70	100
PATH653	Epidemiology and Forecasting of Plant Diseases	Minor (CBCS) (Choose any one)	2	0	0	2	30	70	100
PATH555	Plant Quarantine and Regulations								
PGC600	Technical writing and communication skills	Common	0	0	2	1	30	70	100
ENTO500	Master Research	Research	-	-	-	10	200	0	200
Total						**18**	**380**	**420**	**800**

SEMESTER-IV									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
ENTO651	Post Harvest Entomology	Major	1	0	0	1	30	70	100
ENTO652	Post Harvest Entomology Lab	Major	0	0	2	1	30	70	100
ENTO653	Insect Vectors of Plant Pathogens	Minor (CBCS) (Choose any one)	1	0	0	1	30	70	100
ENTO655	Principles of Acarology								
ENTO654	Insect Vectors of Plant Pathogens Lab	Minor (CBCS) (Choose any one)	0	0	2	1	30	70	100
ENTO656	Principles of Acarology Lab								
PGC651	Intellectual Property and its Management in Agriculture	Common	1	0	0	1	30	70	100
ENTO500	Master Research	Research	-	-	-	11	200	0	200
Total						**16**	350	350	700
Grand Total						**71**			

CBCS- Choice based credit system

Semester I

Course Title: Insect Morphology	L	T	P	Credits
Course Code: ENTO501	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 Collect insect fauna and their identification up to family level.
2 Classification of the insects on basis of different orders.
3 Study importance of common names and technical names of insects in agriculture
4 Understand and apply rules of zoological nomenclature for better understanding of phylogeny of insects

Course Contents (Theory)

Unit-I **8 hours**

External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, structure and modification; compound eyes, mouthparts, antennae, their types and functioning; tentorium and neck sclerites.

Unit-II **8 hours**

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. Abdomen Segmentation and appendages; genitalia and their modifications; embryonic and post-embryonic development.

Unit-III **7 hours**

Insect sense organs (mechano-, photo- and chemo- receptors); organogenensis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology.

Unit-IV **7 hours**

Types of immature stages in insect orders, morphology of egg, nymph/ larva and pupa, identification of different immature stages of crop pests and stored product insects. Comparative study of life history strategies in hemi-metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management

Course Title: Insect Morphology Lab	L	T	P	Credits
Course Code: ENTO502	0	0	2	1

Course Content (Practical)

30 hours

• Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia
• Dissection of genitalia. Types of immature stages in insects; their Collection, rearing and preservation
• Identification of immature insects to orders and families, in endopterygote orders, viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.*
- *Gillott C. 1995. Entomology, 2nd Ed. Plenum Press, New York, London.*
- *Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.*
- *Tembhore DB. 2000. Modern Entomology, Himalaya Publishing House, Mumbai.*
- *Chapman, RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.*

Course Title: Insect Ecology	L	T	P	Credits
Course Code: ENTO503	1	0	0	1

Total Hours -15

Learning Outcomes: On successful completion of this course, the students will able to:

1 Impart knowledge on ecological significance of feeding guilds in phytophagous insects.
2 Develop a module for identification of different ways by which insects may defend themselves against predators and parasites.
3 Analyze the sampling techniques for population estimations.

Course Content

Unit-I **5hours**

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 **4 hours**

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 **3 hours**

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 niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

Unit-IV **3 hours**

Community ecology- Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w, Relation between the two and their association with Dyar's Lawand 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. Climate change and insect pest/natural enemy population; ecological engineering.

Course Title: Insect Ecology Lab	L	T	P	Credits
Course Code: ENTO504	0	0	2	1

Course Content (Practical) 30 hours

• Types of distributions of organisms and demonstration of field sampling.
• 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 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

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning

Suggested Reading

- *Begon M, Townsend CR and Harper JL. 2006. Ecology: From Individuals to Ecosystems. 4th Ed. Blackwell Publishing, USA/ UK/ Australia.*
- *Chapman JL and Reiss MJ. 2006. Ecology: Principles and Applications. 2nd Ed. Cambridge Univ. Press, Cambridge.*
- *Fowler J, Cohen L and Jarvis P. 1998. Practical Statistics for Field Biology. 2nd Ed. John Wiley& Sons, Chichester, West Sussex PO19 8SQ, England.*
- *Gotelli NJ and Ellison AM. 2004. A Primer of Ecological Statistics. Sinauer Associates, Inc., Sunderland, MA*
- *Speight MR, Hunta MD and Watt AD. 2006. Ecology of Insects: Concepts and Application.Elsevier Science, Publ., The Netherlands.*
- *Townsend, Colin R., Begon, Michael and Harper, John L. 2008. Essentials of Ecology. 3rd Ed. Blackwell, Publishing, USA/ UK/ Australia*

Course Title: Agriculture statistics	L	T	P	Credits
Course Code: STAT501	3	0	0	3

Total Hours-45

Learning Outcomes: On successful completion of this course, the students will able to:

1 Enumerate statistical principles apply in all the areas of experimental work
2 Recognize the requirement at the national level and farm level for agriculture policy making,
3 Get familiarize with decision making, agriculture development and estimates agriculture and national income
4 Discover the importance of statistics in agriculture, helps to ascertain the volume of crop that needs to be produced based on output and demand of previous year

Course Content

Unit I **10 hours**

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Hypothesis testing.

Unit II **15 hours**

Concept of p-value. Tests of significance-t, F and chi-square (X^2); Data transformation and missing plot techniques.

Unit III **15 hours**

Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs.

Unit IV **5 hours**

Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Course Title: Agriculture statistics Lab	L	T	P	Credits
Course Code: STAT502	0	0	2	1

Course Content (Practical)

30 Hours

- Correlation analysis. Regression analysis (exponential, power function, quadratic, multi-variate, selection of variables, validation of models, ANOVA and testing of hypothesis).
- Tests of significance (Z-test, t-test, F-test and Chi-square test). Analysis of variance.
- Completely randomized design.
- Randomized block and latin square designs.
- Missing plot and analysis of covariance.
- 24 and 33 simple and confounded experiments.
- Split plot designs. Factorial in split plot designs.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring

Suggested readings:

- Panse, V.G. and Sukhatme, P.V. 1954. *Statistical methods for agricultural workers. Pp. 361.*
- *Gupta, S.C. and Kapoor, V.K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.pp. 0.*
- *Snecdecor, G.W. and Cochran, W.G. 1989. Statistical Methods, 8th Edition. Wiley-Blackwell. Pp.524.*
- *Rangaswamy, R. 2016. Textbook of Agricultural Statistics. New Age International (P) Ltd. New Delhi. pp. 531.*

‘

Course Title: Biological Control of Plant Disease	L	T	P	Credits
Course Code: PATH600	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 To study principles and application of ecofriendly and sustainable management strategies of plant diseases
2 Study of virulence analysis and genetic diversity
3 Acquire knowledge about disease distribution, symptomatology, etiology, epidemiology and control
4 Understand the description of important phytopathogenic genera
5 Study about identification of fungal cultures and biocontrol agents

Course Content

Unit I **7 hours**

Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

Unit II **7 hours**

Types of biological interactions, competition: mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

Unit III **11 hours**

Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. Compatibility of bioagents with agrochemicals and other antagonistic microbes.

Unit IV **9 hours**

Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

Course Title: Biological Control of Plant Diseases Lab	L	T	P	Credits
Course Code: PATH601	0	0	2	1

Course Content

30 hours

- Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen in-vitro and in vivo conditions;
- Preparation of different formulations of selected bioagents and their mass production;
- Quality parameters of biocontrol agents;
- One week exposure visit to commercial biocontrol agents production unit.

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Readings

- *Campbell R. 1989. Biological Control of Microbial Plant Pathogens. Cambridge Univ. Press,Cambridge.*
- *Cook RJ and Baker KF. 1983. Nature and Practice of Biological Control of Plant Pathogens. APS, St. Paul, Minnesota.*
- *Fokkemma MJ. 1986. Microbiology of the Phyllosphere. Cambridge Univ. Press, Cambridge.*
- *Gnanamanickam SS (Eds). 2002. Biological Control of Crop Diseases. CRC Press, Florida.*

Course Title: Post Harvest Diseases	L	T	P	Credits
Course Code: PATH602	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 Comprehend methods of post harvest technology and its role in providing better quality produce to the consumer.
2 Understand functional foods and nutraceuticals Understand utilization of the produce and methods for shelf-life extension.
3 Learn quality control and various standards required for domestic and export market
4 Interpret the feasibility of implementing integrated disease management programs (IDMP) in agricultural crops
5 Acquire knowledge about management of post harvest diseases

Course Content

Unit I **5 hours**

Concept of post-harvest diseases, definitions, importance with reference to management and health, principles of plant disease management as pre-arvestand post-harvest, Types of post-harvest problems both by biotic and abiotic factors.

Unit II **9 hours**

Role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens ,pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control of plant pathogens by resident and introduced antagonists

Unit III **5 hours**

Integrated approaches in controlling diseases and improving the shelf life of produce using nutritional, bio-control agents and other agents, control of aflatoxigenic and my cotoxigenic fungi, application and monitoring for health hazards.

Unit IV **10 hours**

Study of symptoms, toxicosis of various pathogens, knowledge of Codex Alimentarious for each product and commodity. Physical and biological agents/practices responsible for development/ prevention of post-harvest diseases traditional and improved practices.

Course Title: Post Harvest Diseases Lab	L	T	P	Credits
Course Code: PATH603	0	0	2	1

Course Content (Practical)

30 hours

- Isolation, characterization and maintenance of important post-harvest pathogens.
- Role of different storage conditions for disease development.
- Application of antagonists against pathogens under in vitro and in vivo conditions.
- Comparative efficacy of different chemicals, fungicides, phyto-extracts and bioagents.

Transaction Mode

, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Narayanasamy, P. 2005.* Postharvest Pathogens and Disease Management.*John Wiley & Sons, New Jersey, United States. Pp. 672.*
- *Singh, D., Sharma, R.R., Devappa, V. and Kamil, D. 2021. Postharvest Handling and Diseases of Horticultural Produce.CRC Press. London. Pp.454.*
- *Snowden,A.L. 1992.Post-Harvest Diseases and Disorders of Fruits and Vegetables. Volume 2: Vegetables CRC Press, London. Pp. 642.*

Course Title: Library and Information services Lab	L	T	P	Credits
Course Code: PGC501	0	0	4	2

Learning Outcomes: On successful completion of this course, the students will able to**:**

1 Identify library services and availability of resources in order to develop a realistic overall plan for research
2 Use general information resources to increase familiarity with the topic and disciplinary vocabulary
3 Learn about the research topic, question or thesis to achieve a manageable focus appropriate to the assignment criteria, available resources, and evidence needed to support thesis
4 Identify keywords, synonyms and related terms in order to flexibly Effective search

Course Content

- Introduction to Library and its services; five laws of library science; type of documents;
- Classification and cataloguing; organization of documents;
- Sources of information primary, secondary and tertiary;
- Current awareness and SDI services; tracing information from reference sources;
- Library survey; preparation of bibliography; use of Online Public Access Catalogue;
- Use of CD-ROM databases and other computerized library services, CeRA,
- J-Gate; use of Internet including search engines and its resources; e-resources.

Suggested readings:

- *Gita, S. 2012. Library and Information Services. LAP Lambert Academic Publishing.USA. pp. 76.*
- *Kishore, A. 2021. A Conceptual approach to library and information science A complete self study guide.2nd edition. AKB Publication. Jaipur. pp. 250*

Course Title: AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	L	T	P	Credits
Course Code: PGC502	2	0	0	2

Total Hours-30

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1. Identify library services and availability of resources in order to develop a realistic overall plan for research
2. Use general information resources to increase familiarity with the topic and disciplinary vocabulary
3. Learn about the research topic, question or thesis to achieve a manageable focus appropriate to the assignment criteria, available resources, and evidence needed to support thesis
4. Identify keywords, synonyms and related terms in order to flexibly

UNIT I **9 hours**

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.

UNITII **7 hours**

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

UNITIII **7 hours**

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

UNIT IV **7 hours**

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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- Bhalla GS and 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. Mittal Publ.

Course Title: Master Research	L	T	P	Credits
Course Code: ENTO500	NA	NA	NA	5

Learning Outcomes:
On successful completion of this course, the students will able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments

Semester II

Course Title: Anatomy and Physiology of Insects	L	T	P	Credits
Course Code ENTO551	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 Identify different layers of insect's exoskeleton and their composition and functioning.
2 Describe the male and female reproductive systems of insects and identification the internal and external structures associated with each sex.
3 Possess knowledge about the major parts of an insect's head capsule, including sclerites, sutures, and appendages.
4 Understand the structure and functioning of insect mouthparts and their evolution.

Course Contents

Unit-I **8 hours**

Scope and importance of insect physiology; physiology of integument, moulting , chemistry of cuticle, bio systhesis of chitin

Unit-II **8 hours**

Growth, hormonal control, metamorphosis and diapause; pheromone secretion, transmission, perception and reception.

Unit-III **8 hours**

Physiology and mechanism of digestion, circulation, respiration, excretion, reproduction, secretion (exocrine and endocrine glands) and nerve impulse transmission in insects.

Unit-IV **6 hours**

Importance of 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.

Course Title: Anatomy and Physiology of Insects Lab	L	T	P	Credits
Course Code: ENTO552	0	0	2	1

Course Content (Practical) 30 hours

• Determination of chitin in insect cuticle;
• Examination and count of insect haemocytes; preparation and evaluation of various diets;
• Consumption, utilization and digestion of natural and artificial diets.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *Chapman RF. 1998. Insects: Structure and Function. ELBS Ed., London.*
- *Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.*
- *Gullan PJ and Cranston PS. 2000. The Insects: An Outline of Entomology, 2nd Ed. Blackwell Science, UK.*
- *Patnaik BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi.*
- *Simpson SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier),*
  London, UK.

Course Title: Insect Taxonomy	L	T	P	Credits
Course Code: ENTO553	1	0	0	1

Total Hours-15

Learning Outcomes: On successful completion of this course, the students will able to:

1. To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same.
2. To introduce the students to the classification of insects up to the level of families
3. Hands-on experience in identifying the families of insects with an emphasis on the practical aspects.
4. Ability to properly collect, preserve and label insect specimens

Course Content

Unit I **3 hours**

History of insect classification; principles of systematics and its importance. Identification, purpose, methods character matrix, taxonomic keys. Descriptions subjects of descriptions, characters, nature of characters, analogy v/s homology, parallel v/s convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

Unit-II **4 hours**

Brief evolutionary history of insects introduction to phylogeny of insects and Classification of Superclass Hexapoda –Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained. International Code of Zoological Nomenclature, Phylocode, its brief explanation and uses. Process of speciation and interbreeding allopatric species. Molecular systemnatics, DNA barcoding, karyological and biochemical approachesin taxonomy. Insect labeling protocols and procedures.

Unit-III **4 hours**

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.

Unit-IV **4 hours**

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 Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Course Title: Insect Taxonomy Lab	L	T	P	Credits
Course Code: ENTO554	0	0	2	1

Course Content (Practical) 30 hours

• Study of Orders of insects and their identification using taxonomic keys

• Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera;

• Field visits to collect insects of different orders.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading

- *CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca.*
- *Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi.*
- *Gullan PJ and Cranston PS. 2010. The Insects: An outline of Entomology. 4th Ed. Wiley-Blackwell Publications, West Sussex, UK.*
- *Mayr E. 1971. Principles of Systematic Zoology. Tata McGraw Hill, New Delhi.*
- *Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.*

Course Title: Biological Control of Insect Pests And Weeds	L	T	P	Credits
Course Code: ENTO555	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 Appraise the students about potential of useful insects in agricultural pest management
2 Acquaint with economic importance of different categories of insects
3 Evaluate efficacy of various bio pest control agents
4 Do mass production of natural enemies of pest insects

Course Content

Unit-I **9 hours**

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

Unit-II **7 hours**

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa,etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

Unit-III **8 hours**

Mass production of quality bio-control agents- techniques, formulations, economics, field release/ application and evaluation. Development of insectaries, their maintenance.

Unit-IV **6 hours**

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semio chemicals in biological control.

Course Title: Biological Control of Insect Pests And Weeds Lab	L	T	P	Credits
Course Code: ENTO556	0	0	2	1

Course Content (Practical) 30 hours

• Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers
• Visits to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds
• Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Burges, H.D. and 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. and Arora, R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.*
- *Gerson, H. and Smiley, R.L. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman & Hall, New York*
- *Ignacimuthu SS and Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi*

Course Title: Host Plant Resistance	L	T	P	Credits
Course Code: ENTO557	1	0	0	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:

1 Impart knowledge on the sources of resistant plants to insect pest.
2 Learn about various factors affecting plant resistance to insects.
3 Apply various techniques of plant resistance to insect pest
4 Acquaint with the breeding techniques for insect resistance in crops.

Course Content

Unit-I **4 hours**

History and importance of resistance; principles, classification, components, types and mechanisms of resistance. Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

Unit-II **4 hours**

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

Unit-III **4 hours**

Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Unit-IV **3 hours**

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

Course Title: Host Plant Resistance	L	T	P	Credits
Course Code: ENTO558	0	0	2	1

Course Content (Practical) 30 hours

• Screening techniques for measuring resistance
• Measurement of plant characters and working out their correlations with plant resistance
• Testing of resistance in important crops
• Bioassay of plant extracts of susceptible/ resistant varieties
• Demonstration of antibiosis, tolerance and antixenosis

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Dhaliwal, G.S. and Singh, R. (Eds). 2004. Host Plant Resistance to Insects – Concepts and Applications. Panima Publ., New Delhi.*
- *Maxwell, F.G. and Jennings, P.R. (Eds). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons, New York.*
- *Smith, C.M. 2005. Plant Resistance to Arthropods – Molecular and Conventional Approaches. Springer, Berlin*
- *Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, London.*

Course Title: Fundamentals of Computer Applications Lab	L	T	P	Credits
Course Code: CA551	0	0	4	2

Total Hours-60

Learning Outcomes: On successful completion of this course, the students will able to**:**

1 Learn and understand about basics of MS-Word, Excel, preparation of Graphs
2 Read, understand, and interpret material on technology. They will have an appreciation for some of the ideas, issues, and problems involved in writing about technology and in workplace writing.
3 Understand the operating systems, peripheral devices, networking, multimedia and internet
4 Familiarize with basic sources and methods of research and documentation on topics in technology, including on-line research.

Course Content (Practical) 60 hours

- Ms-word: creating a document, saving and editing, use of options from tool bars, format, insert and tools (spelling and grammar)
- Alignment of text, creating a table, merging cells, column and row width.
- Ms-excel: entering expressions through the formula tool bar and use of inbuilt functions, sum, average, max, min.
- Creating graphs and saving with and without data in Ms-excel.
- Ms-access: creating database, structuring with different types of fields.
- Ms-power point: preparation of slides on power point.
- Internet Browsing: browsing a web page and creating of E-Mail ID. Agri. net (ARIS).

Suggested Readings:

- *Salaria, R.S. 2017. Computer Fundamentals. Daryaganj, New Delhi. pp. 486.*
- *Manish, S. and Bhatt, A. 2016. Computers in Agriculture: Fundamentals and Applications. New India Publishing Agency. New Delhi. pp. 190.*
- *Manjunath, B.E. 2010.Computer Basics. Vasan Publications, Bengaluru, Karnataka. pp. 356*

Course Title: Seminar	L	T	P	Credits
Course Code: ENTO559	0	0	1	1

Learning Outcomes: On successful completion of this course, the students will able to:

1 Show competence in identifying relevant information, defining and explaining topics under discussion
2 Present the classical and innovative work related to entomology subject.
3 Reach across diverse disciplines to apply theories, methods and knowledge bases from multiple fields to a single question or problem
4 Judge when to speak and how much to say, speak clearly and audibly in a manner appropriate to the subject

Course Content

Seminar topic will be suggested by faculty

Course Title: BASIC CONCEPTS IN LABORATORY TECHNIQUES	L	T	P	Credits
Course Code: PGC551	0	0	2	1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Course Content (Practical)

• Safety measures while in Lab;
• Handling of chemical substances;
• Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;
• 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;
• Neutralisation 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, sandbath, waterbath, oilbath;
• 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 and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

Course Title: Master Research	L	T	P	Credits
Course Code: ENTO500	NA	NA	NA	5

Learning Outcomes: On successful completion of this course, the students will able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyses data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments

Semester III

Course Title: Toxicology of Insecticide	L	T	P	Credits
Course Code: ENTO600	2	0	0	2

Total Hours-30

Learning Outcomes: On successful completion of this course, the students will able to:

1 Recognize the major classes of insecticide and understand their mode of action
2 Demonstrate the various processes involved in toxic dynamics of insecticides
3 Get awareness regarding the limitations of insecticide use such as resistance, safe use of pesticide residue and environmental contamination
4 Develop a basic understanding on performing insect bioassays

Course Content

Unit-I **6 hours**

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India. Insecticide Act, registration procedures, label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Unit-II **10 hours**

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiaryamines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

Unit-III **8 hour**

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. bioassay definition, objectives, criteria, factors, problems and solutions.

Unit-IV **6 hours**

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis.

Course Title: Toxicology of Insecticide	L	T	P	Credits
Course Code: ENTO601	0	0	2	1

Course Content (Practical) 30 hours

• Insecticide formulations and mixtures
• Laboratory and field evaluation of bio-efficacy of insecticides
• Bioassay techniques
• Evaluation of insecticide toxicity
• Toxicity to beneficial insects
• Pesticide appliances
• Working out doses and concentrations of pesticides

Transaction Mode

Learning Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative

Suggested readings

- *Gupta, H.C.L.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.*
- *Ishaaya, I. and Degheele, (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.*
- *Matsumura, F. 1985. Toxicology of Insecticides. Plenum Press, New York.*
- *Prakash, A. and Rao, J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York.*
- *Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.*

Course Title: Apiculture	L	T	P	Credits
Course Code: ENTO602	1	0	0	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Learn about production, processing and utilization of various hive products.
2. Understand the role of different insects as pollinators of crops
3. The course will be useful for providing self-employment to the learner

Course Content

Unit-I **3 hours**

Historical development of apiculture at global level and in India; Classification of bees; global distribution of genus Apis and races; Morphology and anatomy of honey bee; Honey bee biology, ecology, adaptations; Honey bee behaviour – nest founding, comb construction, brood care, defense, other in-house and foraging activities; Bee pheromones; Honey bee communication.

Unit-II **4 hours**

Commercial beekeeping as an enterprise; Design and use of bee hives; Apicultural equipment; Seasonal bee husbandry; Honey bee nutrition and artificial diets; Absconding, swarming, drifting – causes and management; Curbing drone rearing; Laying worker menace – causes, signs and management.

Unit-III **4 hours**

Bee genetics; Principles and procedures of bee breeding; Screening of honey bee colonies; Techniques in mass queen bee rearing; Mating nuclei and their establishment; Selective mating; Queen bee management; Bee packages. Honey – composition, properties, crystallization, post-harvest handling and processing; Honey quality standards and assessment; Apicultural diversification –potential and profitability; Production/ collection of bee pollen, propolis, royal jelly, bee venom and bees wax and their post-harvest handling; Apitherapy; Value addition of hive products; Development of apiculture project.

Unit-IV **4 hours**

Ecto parasitic and endo parasitic bee mites – biology, ecology, nature and symptoms of damage, management tactics; Wax moths, wasps and ants –

biology, ecology, nature and symptoms of damage, management tactics; Predatory birds, their damage potential and management tactics; Pesticide poisoning to honey bees, signs and protection; Protocols in evaluation of pesticide toxicity to honey bees. Non-Apis pollinators, their augmentation and conservation; Role of bee pollinators in augmenting crop productivity; Managed bee pollination of crops.

Course Title: Apiculture Lab	L	T	P	Credits
Course Code: ENTO603	0	0	2	1

Course Content (Practical) 30 hours

• Morphological characteristics of honey bee
•Mouthparts; digestive, respiratory and reproductive adaptations in different castes of honey bees
• Recording of colony performance
• Seasonal bee husbandry practices
• Swarming, queen lessness, laying workers menaces, etc. and their remedies
• Innovative techniques in mass queen bee rearing; selection and breeding of honey bees
• Production technologies for various hive products
• Bee enemies and diseases and their management
• Recording pollination efficiency
• Application of various models for determining pollination requirement of crop
Preparation of bee floral chart

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings

- *Abrol DP and Sharma D. 2009. Honey Bee Mites and Their Management. Kalyani Publishers, New Delhi, India.*
- *Abrol DP. 2009. Honey bee Diseases and Their Management. Kalyani Publishers, New Delhi, India.*
- *Rahman, A. 2017. Apiculture in India, ICAR, New Delhi*
- *Mishra RC. 2002. Perspectives in Indian Apiculture. Agro-Botanica, Jodhpur, India.*
- *Abrol DP. 2010. Bees and Beekeeping in India. Kalyani Publishers, New Delhi, India.*
- *Atwal AS. 2001. World of Honey Bees. Kalyani Publishers, New Delhi-Ludhiana, India*

Course Title: Epidemiology and Forecasting of Plant Diseases	L	T	P	Credits
Course Code: PATH653	2	0	0	2

30 hours

Learning Outcomes: After completion of this course, the learner will be able to:

1 Catalogue and Understand the biotic and abiotic causes of plant diseases for the study of Growth, reproduction, survival and dispersal of important plant pathogens.
2 Assess the concept of host parasite interaction, recognition concept and infection.
3 Recognize the biofertilizers, disease development, role of enzymes, toxins, growth regulators to identify the disease.
4 Acquaint about defense strategies and altered plant metabolism as affected by plant pathogens.

Course Content

Unit I **8 hours**

Epidemic concepts, simple interest and compound interest disease, Historical development. Elements of epidemics and their interaction. Structures and patterns of epidemics. Modelling, system approaches and expert systems in plant pathology.

Unit II **8 hours**

Genetics of epidemics. Models for development of plant disease epidemics. Common and natural logarithms, function fitting, area under disease progress curve and correction factors, inoculum dynamics. Population biology of pathogens, temporal and spatial variability in plant pathogens.

Unit III **7 hours**

Epidemiological basis of disease management. Survey, surveillance and vigilance. Remote sensing techniques and image analysis. Crop loss assessment.

Unit IV **7 hours**

Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasting, some early forecasting and procedures based on weather and inoculum potential, modelling disease growth and disease prediction. Salient features of important forecasting models.

** • The visit to Flowerdale, Shimla, CSIR- Institute of Microbial Technology (IMTECH), Chandigarh and National Bureau of Plant Genetic Resources (NBPGR), New Delhi visit need to including in study scheme for practical exposure of Students.

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested Reading:

- *Campbell CL and Madden LV. 1990. Introduction to Plant Disease Epidemiology. John Wiley & Sons, New York.*
- *Cooke B, Jones DM and Gereth KB. 2018 The Epidemiology of Plant Diseases. Springer Publications.*
- *Cowling EB and Horsefall JG. 1978. Plant Disease. Vol. II. Academic Press, New York.*
- *Laurence VM, Gareth H and Frame Van den Bosch (Eds.). The Study of Plant Disease Epidemics. APS, St. Paul, Minnesota.*
- *Nagarajan S and Murlidharan K. 1995. Dynamics of Plant Diseases. Allied Publ., New Delhi.*
- *Thresh JM. 2006. Plant Virus Epidemiology. Advances in Virus Research 67, Academic Press, New York.*

Course Title: Plant Quarantine and Regulations	L	T	P	Credits
Course Code: PATH555	2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1 Obtain knowledge on the principles and the role of plant quarantine at national and international level.
2 Absorb about the quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.
3 Categorize about plant protection organization in India, acts related to registration of pesticides and transgenics.
4 Learn about the history of quarantine legislations, PQ order 2003, environmental acts,
5 Formulate Industrial registration; APEDA, import and export of bio-control agents.

Course Content

Unit I **8 hours**

Historical development in plant quarantine, Definitions of pest, and transgenics asper Govt. notification; Organizational set up of plant quarantine in India. Relativeimportance; quarantine – domestic and international. Quarantine restrictions inthe movement of agricultural produce, seeds and planting material; case historiesof exotic pests/ diseases and their status.

Unit II **8 hours**

Acts related to registration of pesticides and transgenics. History of quarantinelegislations, Salient features of PQ Order 2003. Environmental Acts, Industrialregistration; APEDA, Import and Export of bio-control agents.

Unit III **7 hours**

Identification of pest/ disease free areas; contamination of food with toxigens,microorganisms and their elimination; Symptomatic diagnosis and other techniquesto detect pest/ pathogen infestations; VHT and other safer techniques ofdisinfestation/ salvaging of infected material.

Unit IV **7 hours**

WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practicesfor pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.Visit to plant quarantine station and PEQ facilities.

Transaction Mode

e-Team Teaching, e-Tutoring,Lecture, Seminar, Dialogue, Peer Group Discussion

Suggested readings:

- *Kahn, R. 1988. Plant Protection &Quarantine.CRCPress,Boca Raton, Florida, United States. Pp. 248.*

- *Ebbels, D.L. 2003. Principles of Plant health & quarantine. Central Science Laboratory, York, UK. Pp. 228.*
- *Mehrotra, R.S. 2011. Plant Pathology, McGraw Hill Education, New York, United States. Pp. 910.*

Course Title: Technical writing and communication skills	L	T	P	Credits
Course Code: PGC600	0	0	2	1

Learning Outcomes:

On successful completion of this course, the students will able to:

1 Understand and know how to follow the stages of the writing process (prewriting/writing/rewriting) and
2 Apply them to technical and workplace writing tasks
3 Produce a set of documents related to technology and writing in the workplace and will have improved their ability to write clearly and accurately
4 Understand the basic components of definitions, descriptions, process explanations, and other common forms of technical writing

Course Content

Unit I **3 hours**

Various forms of scientific writings: theses, technical papers, review, manuals etc., various parts of thesis and research communications: title page, authorship contents page, preface.

Unit II **4 hours**

Introduction, review of literature, material and methods, experimental results and discussion;

Unit III **4 hours**

Writing of abstracts, summaries, citations etc.

Unit IV **4 hours**

Commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; paginations, numbering of tables and illustrations; writing of numbers and dates in scientific write-ups; editing and proof reading; writing a review article, access methods.

Suggested readings:

- *Day, R.A. and Gastel, B. 2011. How to Write and Publish a Scientific Paper, 7th Edition. Greenwood Press, United States. pp. 300.*
- *Laplante, P.A. 2011. Technical Writing: A Practical Guide for Engineers and Scientists.CRC Press, London. pp. 250.*
- *Greenlaw, R. 2012. Technical Writing, Presentational Skills and Online Communication: Professional Tools and Insights. Idea Group, U.S. pp*

Course Title: Master Research	**L**	**T**	**P**	**Credits**
Course Code: ENTO500	NA	NA	NA	9

Learning Outcomes:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.

Semester IV

Course Title: Post Harvest Entomology	L	T	P	Credits
Course Code: ENTO661	1	0	0	1

Total Hours-15

Learning Outcomes: On successful completion of this course, the students will able to**:**

1 Study extent of losses in stored grains and their products.
2 Diagnose various types of pest(insects and non-insects) problems in stored conditions
3 Disseminate preventive and curative measures of pest management in stored grains.
4 Study the importance of sanitation and other non-chemical methods of pest control

Course Content

Unit-I **4hours**

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses into vis-à-vis total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Concept of seed vault.

Unit-II **4 hours**

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

Unit-III **4 hours**

Ecology of insect pests of stored commodities/ grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions.

Unit-IV **3 hours**

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/ sanitation, disinfestations

of stores/ receptacles, legal methods. Curative measures- Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control prophylactic and curative- Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Insecticide resistance in stored product pests and its management; recent advances (MAS, PPP, HS) in storage pest management; integrated approaches to stored grain pest management.

Course Title: Post Harvest Entomology Lab	L	T	P	Credits
Course Code: ENTO662	0	0	2	1

Course Content (Practical) 30 hours

• Collection, identification and familiarization with the stored grains/ seed insect pests and nature of damage caused by them
• Detection of hidden insect infestation in stored food grains
• Estimation of uric acid content in infested produce; estimation of losses in stored food grains
• Determination of moisture content in stored food grains
• Familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques
• Treatment of packing materials and their effect on seed quality
• Field visits to save grain campaign, central warehouse and FCI warehouses

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Hall DW. 1970. Handling and Storage of Food Grains in Tropical and Subtropical Areas. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.*
- *Jayas DV, White NDG and Muir WE. 1995. Stored Grain Ecosystem. Marcel Dekker, New York.*
- *Khader V. 2004. Textbook on Food Storage and Preservation. Kalyani Publishers, New Delhi.*
- *Subramanyam B and Hagstrum DW. 1995. Interrelated Management of Insects in Stored Products. Marcel Dekker, New York.*

Course Title: Insect Vectors of Plant Pathogens	L	T	P	Credits
Course Code: ENTO663	1	0	0	1

Total Hours-15

Learning Outcomes: On successful completion of this course, the students will able to**:**

1 Learn typical features of insect vectors of plant pathogens
2 Understand significance of insect vectors vis-à-vis other pest insects of plants
3 Check potential of insect vectors in spreading crop diseases
4 Analyze the feasibility of implementing integrated disease management programs (IDMP) in agricultural crops and feasibility of using vector management as part of IDMP.

Course Content

Unit-I **4 hours**

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

Unit-II **4hours**

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

Unit-III **4 hours**

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips. Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

Unit-IV **3 hours**

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Course Title: Insect Vectors of Plant Pathogens	L	T	P	Credits
Course Code: ENTO664	0	0	2	1

Course Content (Practical) 30 hours

• Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes
• Rearing and handling of vectors;
• Demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies
• Estimating vector transmission efficiency, studying virus-vector relationship.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

- *Basu AN. 1995. Bemisia tabaci (Gennadius) – Crop Pest and Principal Whitefly Vector of Plant Viruses. Oxford and IBH, New Delhi.*
- *Harris KF and Maramarosh K. (Eds.). 1980. Vectors of Plant Pathogens. Academic Press, London.*
- *Maramorosch K and Harris KF. (Eds.). 1979. Leafhopper Vectors and Plant Disease Agents. Academic Press, London*
- *Youdeovei A and Service MW. 1983. Pest and Vector Management in the Tropics. English Language Books Series, Longman, London.*

Course Title: Principles of Acarology	L	T	P	Credits
Course Code: ENTO665	1	0	0	1

Total Hours-15

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1. To acquaint the students with external morphology of different groups of predatory and phytophagous mites
2. Train in identification of commonly occurring families of plant associated mites
3. Provide information about important pests of crops and predatory mites
4. Provide information about their management

Course Content

Unit-I **4 hours**

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Soil arthropod mites and their classification, habitats and their identification.

Unit-II **4 hours**

Introduction to morphology and biology of mites and ticks. Broad classification major orders and important families of Acari including diagnostic characteristics.

Unit-III **4 hours**

Estimation of populations; sampling and extraction methods for soil arthropods. Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees.

Unit-IV **3 hours**

Management of mites using acaricides, phytoseiid predators, fungal pathogens, etc. Culturing of phytophagous, parasitic and predatory mites. Mode of action of acaricides, resistance of mites and ticks to acaricides, its management.

Course Title: Principles of Acarology Lab	L	T	P	Credits
Course Code: ENTO666	0	0	2	1

Course Content (Practical) 30 hours

• Collection of mites from plants, soil and animals
• Extraction of mites from soil, plants and stored products
• Preparation of mounting media and slide mounts
• External morphology of mites
• Identification of mites up to family level using key and management of mites

Suggested readings:

- *Anderson JM and Ingram JSI. 1993. Tropical Soil Biology and Fertility: A Handbook of Methods. CABI, London.*
- *Chhillar BS, Gulati R and Bhatnagar P. 2007. Agricultural Acarology. Daya Publ. House, New Delhi.*
- *Dindal DL. 1990. Soil Biology Guide. A Wiley-Inter Science Publ., John Wiley and Sons, New York.*
- *Gerson U and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York.*
- *Qiang Zhiang Z. 2003. Mites of Green Houses- Identification, Biology and Control. CABI, London.*

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Course Title: Intellectual Property and its management in Agriculture	L	T	P	Credits
Course Code: PGC651	1	0	0	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:
1. To equip students and stakeholders
2. Knowledge of Intellectual Property Rights (IPR) related protection systems,
3. Significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.
4. Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Course Content

Unit-I **3 hours**

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.

Unit-II **4 hours**

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.

Unit-III **4 hours**

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.

Unit-IV **4 hours**

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 and 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 and Aesthetic Technologies*

Course Title: Master Research	L	T	P	Credits
Course Code: ENTO500	NA	NA	NA	11

Learning Outcomes:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyses data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of entomology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.