

**CURRICULUM**  
**OF**  
**ENTOMOLOGY**

**BS/BSc (Hons) Agriculture**  
**MS/MSc (Hons) Agriculture**  
**PhD Entomology**

**(Revised 2014)**



**HIGHER EDUCATION COMMISSION**  
**ISLAMABAD**

# **CURRICULUM DIVISION, HEC**

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Mr. Fida Hussain	Director General (Acad)
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# PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

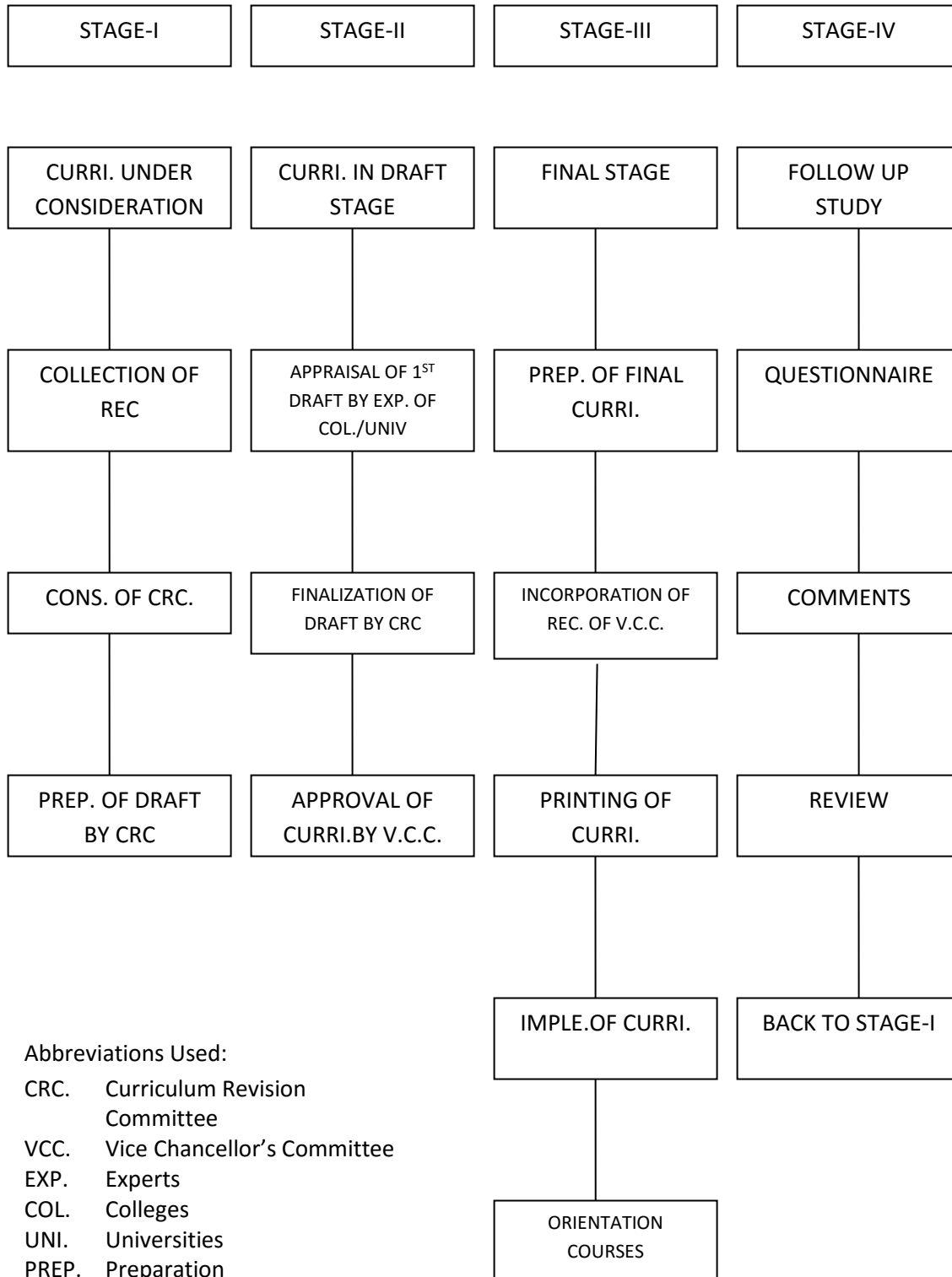
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC ([www.hec.gov.pk](http://www.hec.gov.pk)).

**(Fida Hussain)**  
**Director General (Academics)**

# CURRICULUM DEVELOPMENT PROCESS



**Abbreviations Used:**

- CRC. Curriculum Revision Committee
- VCC. Vice Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations

## INTRODUCTION

The meetings of National Curriculum Revision Committee for BS/BSc (Hons) (4 years), MS/MSc (Hons) (2 years) and PhD courses of Agriculture in Entomology were held on 09-11 October, 2013 at HEC Regional Centre, Islamia University Bahawalpur and 17-19 March, 2014 at HEC Regional Centre, Peshawar to revise and finalize the curricula at Graduate (4 years Program) and Post-Graduate (MS and PhD) level. Following members attended the meeting:-

Prof. Dr. Mohammad Naeem,  
Chairman,  
Department of Entomology,  
The University of Agriculture, Peshawar.

Convener/  
President

Prof. Dr. Muhammad Afzal,  
Dean,  
Faculty of Agriculture,  
Department of Entomology,  
University College of Agriculture,  
University of Sargodha, Sargodha

Member

Prof. Dr. Mian Inayatullah,  
Dean,  
Faculty of Crop Protection Sciences  
Department of Entomology,  
The University of Agriculture, Peshawar

Member

Prof. Dr. Farkhanda Manzoor,  
Department of Zoology,  
Lahore College for Women University,  
Lahore.

Member

Prof. Dr. Rana Hadi,  
Department of Zoology,  
Jinnah University for Women,  
5-C, Nazimabad, Karachi-74600

Member

Prof. Dr. Mansoor ul Hassan,  
Department of Entomology,  
University of Agriculture,  
Faisalabad

Member

Prof. Dr. Muhammad Faheem Malik,  
Dean / Director  
Faculty of Science,  
University of Gujrat

Member

Prof. Dr. Muhammad Naeem, Chairman, Department of Entomology, PMAS, Arid Agriculture University, Rawalpindi.	Member
Dr. Ehsan ul Haq, Principal Scientific Officer/Associate Professor, Department of Plant & Environmental Protection, Park Road, Islamabad. National Agricultural Research Centre (NARC).	Member
Dr. Abdul Ghani Lanjar, Associate Professor, Faculty of Crop Protection, Department of Entomology, Sindh Agriculture University, Tandojam.	Member
Dr. Muhammad Waqar Hassan, Assistant Professor, Department of Entomology, University College of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, Bahawalpur.	Member
Dr. Sumaira Afsheen, Assistant Professor, Department of Entomology, Hafiz Hayat Campus, Gujrat University of Gujrat.	Member (in preliminary meeting)
Dr. Abdul Manan Shaikh, Assistant Professor, Department of Zoology, Shah Abdul Latif University, Khairpur Mirs.	Member
Dr. Syed Basit Rasheed , Assistant Professor, Department of Zoology, University of Peshawar, Peshawar.	Member
Dr. M. Anjum Aqeel, Assistant Professor, Department of Entomology, University College of Agriculture, University of Sargodha, Sargodha.	Member

Dr. Muhammad Kashif Zahoor, Member  
Assistant Professor,  
Department of Zoology, Wildlife & Fisheries,  
Government College University, Faisalabad.

Dr. Muhammad Razaq, Member  
Chairman/Teacher In-charge,  
Department of Entomology,  
Bahauddin Zakariya University, Multan.

Dr. Shahbaz Ahmad, Member  
Assistant Professor  
Institute of Agricultural Sciences  
University of the Punjab.

Dr. Javaid Iqbal, Member /  
Secretary  
Head, Department of Entomology  
University College of Agriculture and Environmental  
Sciences, The Islamia University,  
Bahawalpur

The meeting started with recitation of few Verses from the Holy Quran by Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC while Mr. Fida Hussain, Director General (Academics), presided over the inaugural session and highlighted the aims and objectives of the National Curriculum Revision Committee. He emphasized that the main purpose of revision and devising the curriculum is to bring it at par with the international standard and meet the demand of local market comprising public and private sector. He also stressed the need of new curriculum to facilitate colleges / universities / institutes for teaching Entomology according to the requirements of the agricultural departments / universities of Pakistan. He requested the experts to adhere to the template already proposed in the earlier meeting of Deans / Heads at the HEC. The Committee unanimously nominated Dr. Mohammad Naeem, Professor & Chairman Department of Entomology, the University of Agriculture, Peshawar as Convener/ President and Dr. Javaid Iqbal, Head, Department of Entomology, University College of Agriculture & Environmental Sciences, the Islamia University Bahawalpur as Secretary of the meeting. Both the nominated personnel's thanked the participants and pledged that in drafting the course, the opinion of each and every member would be given utmost importance.

Before formal session, the members were requested to deliberate on the different issues of curriculum revision of Entomology. Each honorable member actively participated and proposed the desired amendments keeping in view the above mentioned objectives of HEC.



The Committee unanimously decided the template for 4 year BSc (Hons) Agriculture in Entomology with the following number of credit hours.

<b>Semester</b>	<b>Credit Hours</b>	<b>Total</b>
1+2+3+4	18+18+18+18	72
5+6+7+8	15+16+16+13	60
Total= 132 Credit Hours		

It was also requested that the universities may add 3 courses of 8 credit hours thus making grand total of not exceeding 140 credit hours keeping in view their available facilities and expertise. The Committee further improved the objectives, course contents pertaining to theory and practical, and books recommended for each subject to be taught to the students of BSc (Hons) Entomology, MSc (Hons) Entomology and PhD Entomology.

### **AIMS AND OBJECTIVE:**

1. Entomology, the study of insects has developed into a very large division of the animal sciences owing to their huge proportion in the animal kingdom and their importance in the applied fields. Substantial changes were made throughout the curriculum which has been updated/expanded.
2. The main objective was to provide broad and balanced courses of Entomology. The intimacy between insect and environment was emphasized to the entomological research in many direction which later proved of immense value in the indigenous control measures so as to provide more food for the ever-growing population of Pakistan.

## Scheme of Study for 4-Year BSc (Hons) Agriculture

	Credits
Mathematics / Biology	6
Statistics 1 & 2	6
Computer / IT	3
Pakistan Studies	2
Islamiat	2
Communications Skills	3
English	3
Basic Agriculture	3
<b>Sub-Total</b>	<b>28</b>

One subject from each of the following disciplines

Agronomy	3
Plant Breeding & Genetics	3
Entomology	3
Plant Pathology	3
Food Technology	3
Horticulture	3
Soil Sciences	3
Agriculture Economics	3
<b>Sub-Total</b>	<b>24</b>

Additional courses from disciplines mentioned below and above

Applied Entomology (Compulsory)	3
Agriculture Extension	3
Forestry & Range Management	3
Animal Science	3
Marketing & Agri Business	3
Agriculture Engineering	3
Rural Development	3
Water Management	3
Any other course	
<b>Sub-Total</b>	<b>24</b>

Semester 1,2,3,4 shall each contain not more than 18 credit hours (a total of maximum of 72 credit hours).

Semester 5, 6, 7, 8 (Including Internship/Project of 4 credit hours) shall be 60 credit hours; while 3 courses carrying 8 credit hours from additional courses may be adjusted in semester 5 to 8.

**Grand Total (72+60+8)                      140**

# **DETAIL OF COURSES**

## **ENTOMOLOGY for BSc (Hons) Agriculture**

### **ENT-401 INTRODUCTORY ENTOMOLOGY 3 (2-1)**

#### **LEARNING OUTCOMES:**

The students would be able to;

1. Know about arthropods and especially insects with their morphological features
2. Identify insects of economic importance and acquire working skills for collecting, mounting, and preserving insects

#### **THEORY:**

Introduction; phylum Arthropoda and its classification; morphology, anatomy and physiology of a typical insect, metamorphosis and its types; insect classification, salient characters of insect orders; examples from major families of economic importance.

#### **PRACTICAL:**

Characters of classes of Arthropoda; collection and preservation of insects; morphology and dissection of a typical insect (digestive, reproductive, excretory, nervous, circulatory and tracheal systems); temporary mounts of different types of appendages of insects; Observations for types of metamorphosis.

#### **RECOMMENDED BOOKS:**

1. Ahmad, I. 2010. Hashriat "Insects". National Book Foundation, Lahore
2. Awastheir, V.B. 2009. Introduction to General and Applied Entomology. Scientific Publisher, Jodhpur, India.
3. Dhaliwal, G.S. 2007. An Outline of Entomology. Kalyani Publishers, Ludhiana.
4. Elzinga, R.J. 2003. Fundamentals of Entomology. Prentice Hall.
5. Gullan, P. J. and P. S. Cranston. 2010. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
6. Lohar, M.K. 2001. Introductory Entomology. Department of Entomology, Sindh Agriculture University Tandojam Sindh, Pakistan.
7. Richards, O.W. and Davies, R. G. 2004. Imm's General Text-book of Entomology, Vol. I. and II, 10<sup>th</sup> Ed. Chapman & Hall, London, N.Y.
8. Romoser, W. S. and Stoffolano, J. G. 1998, The Science of Entomology, WCB McGraw-Hill.
9. Triplehorn, C.A. and Jhonson, N.F. 2005. Borror and DeLong's

- Introduction to the study of Insects. Brooks Cole. 7<sup>th</sup> Ed.
10. Trigunayat, M.M. 2009. A Manual of Practical Entomology. 2<sup>nd</sup> Edition Scientific Publisher (India) Judhupur.
  11. Yousuf, M. Tayyab, M. and Shazia, Y. 2007. Manual of Introductory Entomology, University of Agriculture, Faisalabad.
  12. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6<sup>th</sup> Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A

## **ENT-402 APPLIED ENTOMOLOGY 3 (2-1)**

### **LEARNING OUTCOMES:**

The students would be able to;

1. Acquire knowledge of insect pests of crops, vegetables, fruits, stored grains and household pests.
2. Identification of insect pests, their control methods and pesticide application equipments.
3. Introduction with entomological cottage industries.
4. Enhance the productivity of agricultural crops through insect pest management.

### **THEORY:**

Introduction; causes of success and economic importance of insects; principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control; introduction to IPM; insecticides, their classification, formulations and application equipments; identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and locust; introduction to entomological industries: apiculture, sericulture and lac-culture.

### **PRACTICAL:**

Collection, identification and mode of damage of insect pests of various crops, fruits, vegetables, stored grains and household; insecticide formulations, their dilutions and safe handling; use of application equipments, instructions for apiculture, sericulture and lac-culture.

### **RECOMMENDED BOOKS:**

1. Atwal, A.S. 2005. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
2. Awastheir, V.B. 2009. Introduction to General and Applied Entomology. Scientific Publisher, Jodhpur, India.

3. Duncton, P.A. 2007. The Insect: Beneficial and Harmful Aspects. Kalyani Publishers Ludhiana.
4. Gullan, P. J. and Cranstan, P. S. 2010. The Insects: An Outline of Entomology. 4<sup>th</sup> edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
5. Lohar, M. K. 2001. Applied Entomology, 2<sup>nd</sup> Ed. Department of Entomology, Sindh Agriculture University Tandojam Sindh, Pakistan.
6. Mathews, G.A. 2004. Pesticide Application Methods, 3<sup>rd</sup>. Ed. John Wiley & Sons, Inc. N.Y.
7. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6<sup>th</sup> Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
8. Pfadt, E.R. 1985. Fundamentals of Applied Entomology, 4<sup>th</sup> Ed. The McMillan Co., N. Y.
9. Robinson, D.H. 2006. Entomology Principles and Practices. Agro-bios.
10. Shah, H.A. and Saleem, M.A. 2002, Applied Entomology, 3<sup>rd</sup> Ed. Izhar Sons Printers, Lahore.
11. Srivastava, K.P. 2005. Text Book of Applied Entomology. Kalyani Publishers, New Delhi.
12. Romoser, W. S. and Stoffolano, J. G. 1998, The Science of Entomology, WCB McGraw-Hill.

## **B. SPECIALIZATION IN ENTOMOLOGY**

The Committee has proposed the following "TITLES" with credit hours for specialization in Entomology during 3<sup>rd</sup> year (5th and 6th semesters) and 4th year (7th and 8th semesters). These are the core "MAJOR (M)" courses, comprising 56-61 credit hours, including 4 credit hours of internship. To fulfill minimum requirements for the completion of the degree, each university may incorporate more courses according to their needs into their scheme of studies (curricula), thus making grand total not exceeding 140 credit hours.

The semester wise split of CORE courses is as under:-

## SCHEME OF STUDIES 5<sup>TH</sup> TO 8<sup>TH</sup> SEMESTER

Course No.	Title	Cr. Hr.	Status
ENT-501	Insect Morphology	3(2-1)	M
ENT-503	Principles of Insect Taxonomy	3(2-1)	M
ENT-505	Insect Ecology	3(2-1)	M
ENT-507	Insect Pests of Household, Man and Animals	3(2-1)	M
ENT-509	Insect Behavior	3(2-1)	M
	<b>Sub Total</b>	<b>15</b>	

### 6<sup>TH</sup> SEMESTER

Course No.	Title	Cr. Hr.	Status
ENT-502	Insect Physiology	3(2-1)	M
ENT-504	Insect Classification and Biodiversity	3(2-1)	M
ENT-506	Agricultural Pests and their Management	4(3-1)	M
ENT-508	Stored Product Pests and their Management	3(2-1)	M
ENT-510	Beneficial Insects	3(2-1)	M
	<b>Sub Total</b>	<b>16</b>	

### 7<sup>TH</sup> SEMESTER

Course No.	Title	Cr. Hr.	Status
ENT-601	Integrated Pest Management	4(3-1)	M
ENT-603	Plant Resistance to Insect Pests	3(2-1)	M
ENT-605	Insecticides and their Application	3(2-1)	M
ENT-607	Range and Forest Entomology	3(2-1)	M
ENT-609	Agriculture and Environmental Pollution	3(2-1)	M
	<b>Sub Total</b>	<b>16</b>	

## 8<sup>TH</sup> SEMESTER

Course No.	Title	Cr. Hr.	Status
ENT-602	Scientific Writing and Presentation	3(2-1)	M
ENT-604	Apiculture	3(2-1)	M
ENT-606	Biological Control of Insect Pests	3(2-1)	M
ENT-608	Internship / Research Project	4(0-4)	M
	<b>Sub Total</b>	<b>13</b>	

**Total of 15+16+16+13 = 60**

**Grand Total =**

**Note:** *University may add 3 courses carrying 8 Credit Hours according to their specialty and facilities. Thus making grand total not exceeding 140 credit hours. The University may re adjust the above semester wise scheme.*

# DETAIL OF COURSES

## 5<sup>TH</sup> SEMESTER

### ENT-501 INSECT MORPHOLOGY 3(2-1)

#### LEARNING OUTCOMES:

The students would be able to;

- Understand the comparative morphology of insect organ systems.
- Understand how the morphology of an organ is related to its function.

#### THEORY:

Introduction; integument and its derivatives; body regions; segmentation, sclerites, sulci and appendages of head, thorax and abdomen with their modifications in economically important insect orders; endoskeleton and internal organ systems; exocrine and endocrine organs.

#### PRACTICAL:

Structure of integument and its derivatives; comparative external and internal morphology of economically important insect orders; preparation for illustrations.

#### RECOMMENDED BOOKS:

1. Beutel, R. G., Friedrich, F., Yang, Xing-Ke and Ge, Si-Qin. 2014. Insect Morphology and Phylogeny. Walter De Gruyter Inc publisher.
2. Chapman, R. F. 2012. The insects: Structure and Function (5<sup>th</sup> Ed.). Cambridge University Press.
3. Dunston P.A. 2004. The Insect Structure, Function and Bio-Diversity. Kalyani Publishers, Ludhiana.
4. DuPorte, E. M. 1959. Manual in Insect morphology. Reinhold Press. University of Minnesota, USA.
5. Gilbert, L.I., Iatrou, K. and Gill, S. S. 2005. Comprehensive Molecular Insect Science. 2<sup>nd</sup> edition, Elsevier/Pergamon.
6. Kerkut, G.A. and Gilbert, L.I. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. 1-12, Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt.
7. Richard, O.W. and Davies, R.G. 1984. Imm's General Textbook of Entomology, Vol. I, revised. 10<sup>th</sup> Ed. (Structure, Physiology & Development). Chapman and Hall, London, N.Y.
8. Snodgrass, R. 1935. Principles of Insect Morphology. Cornell Univ. Press., U.S.A.



**LEARNING OUTCOMES:**

The students would be able to understand the basic concepts of taxonomic hierarchy, identification, taxonomic characters, variations, taxonomic keys and preparation of taxonomic papers.

**THEORY:**

Introduction; history, functions and concepts of insect taxonomy; tasks of taxonomist; taxonomic categories; taxonomic procedures: collection and methods of sampling, identification, taxonomic characters, variations in population; descriptions, taxonomic keys, concepts of species, kinds of species and phylogenies, preparation of taxonomic papers; code of zoological nomenclature, introduction to numerical and molecular taxonomy; phenetics, cladistics.

**PRACTICAL:**

Methods of collection, preservation and labeling of insects; preparation of taxonomic keys; identification of insects; cataloguing and writing descriptions of identified insects; preparation of phenograms, cladogram and phylogenetic trees using morpho-metrics.

**RECOMMENDED BOOKS:**

1. Daly, H.V. Doyen, J.T. Purcell, A.H. and Daly, B.B. 1998. Introduction to Insect Biology and Diversity. Oxford University Press.
2. Kitching, I. Forey, P.L. and Humphries, C.J. 1998. Cladistics: Theory and Practice of Parsimony Analysis, Oxford University, Press, UK.
3. Manzoor, F. 2006. Morphometric Studies on Termite Genus *Odontotermes*. Published by, Higher Education Commission, Islamabad.
4. Mayer, E. and Ashlock, P.D. 1991. Principles of Systematic Zoology, 2<sup>nd</sup> Ed. McGraw-Hill Inc. New York.
5. Schuh, R. T. and Andrew V. Z. B. 2009. Biological Systematics Principles and Applications. Cornell University Press, Sage House, 512 East State Street, Ithaca, New York, USA.
6. Triplehorn, C.A. and Johnson, N.F. 2005. Borror and DeLong's Introduction to the study of Insects. Brooks Cole. 7th Ed.
7. Wheeler, Q.D. 2008. The New Taxonomy. CRC Press London, New York.
8. Whitfield, J. B. and Purcell, A.H. . 2012. Daly and Doyen's Introduction to Insect Biology and Diversity. Third Edition. Oxford University Press.
9. Winston J., 1999. Describing Species: Practical Taxonomic Procedure for Biologists Columbia University Press USA, pp 512.

10. Wiley, E. O. and Lieberman, B. 2011. Phylogenetics, Theory and Practice of Phylogenetic Systematics, Second Edition John Wiley & Sons, Inc., Publication

## **ENT-505 INSECT ECOLOGY**

**3(2-1)**

### **LEARNING OUTCOMES:**

The students should be well versed with the basic concepts of insect ecology, succession, population, ecosystem and insect-ecosystem interactions.

### **THEORY:**

Overview of insect ecology; divisions of ecology; habitat and niche; intra and interspecific interactions; natural and agro-ecosystems; flow of energy in ecosystem; trophic relations: food chain, food web and food mesh concepts; ecological succession; population and its characteristics like natality, mortality, migration, dispersal, key factors, density dependent and density independent factors, introduction to life tables and diversity indices.

### **PRACTICAL:**

Maintenance and measurement of a biotic factors (temperature, humidity, light, wind etc) with different instruments; population sampling, estimation and construction of life tables.

### **RECOMMENDED BOOKS:**

1. Bourtzis, K. and Miller, T. 2003. Insects Symbiosis. CRC Press.
2. Huffaker, C.B. and Robert, L.R. 1984. Ecological Entomology. Wiley Intersciences.
3. Odum, E. P. and Gary W.B. 2005. Fundamentals of Ecology. Thomson Brooks/Cole 10 Davis Drive Belmont, CA 94002 USA
4. Price, P. W., Denno, R.F. Eubanks, M.D. Finke, D.L. and Kaplan, I. 2011. Insect Ecology: Behaviour, Populations and Communities, Cambridge University Press, Cambridge, UK, 801 pages.
5. Rockwood, L.L. 2006. Introduction to Population Ecology. Wiley, John & Sons.
6. Romser, W.S. and Stoffolano, J. G. 1998. The Science of Entomology. 4<sup>th</sup> Edition, WCB McGraw-Hill.
7. Schowalter, T.D. 2006 Insect Ecology: An Ecosystem approach. 2<sup>nd</sup> Ed. Press is an imprint of Elsevier.
8. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3<sup>rd</sup> Ed. Blackwell Science.
9. Symondson, W.O.C. and Liddell, J.E. 1996. The Ecology of Agricultural Pests, Biochemical Approaches. Chapman and Hall, London, UK.

10. Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles, Princeton University Press.
11. Yazdani, S.S. and Agarwal, M.I. 1997. Elements of Insect Ecology. Narosa Publishing House, New Delhi.

## **ENT-507 INSECT PESTS OF HOUSEHOLD, MAN AND ANIMALS 3(2-1)**

### **LEARNING OUTCOMES:**

The student should be able to identify, collect and management of different insects of household, man and animals.

### **THEORY:**

Introduction; identification, biology and control of different insect pests like ants, termites, cockroaches, silver-fish, cricket, powder-post beetle, carpet beetle, cloth-moths, psocids, lice, bed-bugs, fleas, mosquitoes, house flies, wasps, sand flies, stable flies, flesh flies, blow flies, tsetse flies, black flies and midges..

### **PRACTICAL:**

Collection, identification. Demonstration of management of different household, man and animal insect pests.

### **RECOMMENDED BOOKS:**

1. Agarwal, S. 2009. Insect Pests of Cereals and their Management. Oxford Book Co. India.
2. Aldridge, B. 2004. Medical Entomology. Text book of Public Health and Veterinary Sciences. Chapman and Hall, London.
3. Atwal, A.S. and Dhaliwal, 2005. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
4. Bishop, F. C. 1916. Fleas as Pests to Man and Animals, with Suggestions for Their Control. Harvard Uni Press, USA
5. Edmen, H. F. 2013, Handbook of Agricultural Entomology published by John Wiley & Sons 312 pp.
6. Fernald, H.T. 2008. Applied Entomology, An Introductory Textbook of Insects in their Relation to Man. Kessinger Publishing (Amazon).
7. Gold, R. E. and John, S. C. 2010, Hand book of Household & Structural Insect pest published by Entomological Society of America 160 pp
8. James, M.T. and Harwood, R.F. 1969. Herm's Medical Entomology. The Macmillan Company Canada.
9. Jarau, S. and Hrucir, M. 2009, Food exploitation by social insects CRC press 360 pages.

10. Lohar, M.K. 2013. General Entomology. 2<sup>nd</sup> edition, Department of Entomology. Sindh Agriculture University Tandojam Sindh, Pakistan. Pakistan.
11. Metcalf C.L. 1984. Destructive and Useful Insects. Their Habits and Control 4<sup>th</sup> Ed. McGraw-Hill Book Co. Inc. N.Y.
12. Pfadt. R. E. 1985 Fundamental of Applied Entomology. 4<sup>th</sup> Ed. The McMillan Co., N.Y.
13. Service, M. 2012. Medical Entomology for students Cambridge University Press 303 pp.

## **ENT-509 INSECT BEHAVIOUR 3(2-1)**

### **LEARNING OUTCOMES:**

The students will acquire good knowledge of basic concepts of insect behaviour.

### **THEORY:**

Types of behaviour: reflexes, orientation (kinesis and taxes); learning; periodicity; patterns of behaviour; communications; visual; auditory; tactile; chemical. territoriality; nervous, endocrine, genetic and biological functions of behaviour, host finding, feeding and reproductive behaviour, escape, defence, offence and predation; dispersal and migration; dormancy.

### **PRACTICAL:**

Communication, especially chemical communication, mating behaviour, host finding behavior, Auditory behaviour and social behaviour in lab or in field conditions

### **RECOMMENDED BOOKS:**

1. Febre, J.H. 1993. Insect Behaviour. Discovery Publishing House.
2. Fellows, N. and Holloway, G. 2005. Insect Evolutionary Behaviour. CABI
3. Goulson, D. 2003. Bumble Bees: Behaviour and Ecology. Oxford University Press.
4. Harbone, J.A. 1998. Introduction to Ecological Biochemistry. Academic Press. London.
5. Matthews, R. W. and Matthews J. R. 2010. Insect Behavior. 2nd Edition. Springer Dordrecht Heidelberg London New York.
6. Parihar, R. 2001. Reproductive Behaviour and Biology of Sex. Dominant Publishers and Distributors, Delhi.
7. Prakash, M. 2008. Encyclopedia of Entomology II: Insect Behaviour. Discovery Publishing House, PVT. LTD. Darya Ganj, New Delhi.
8. Romser, W.S. and Stoffolano, J. G. 1998. The Science of Entomology. 4th

Edition, WCB McGraw-Hill.

9. Vijay, K. 2008. Insect Behaviour. Vista International Publication House.

## 6<sup>TH</sup> SEMESTER

**ENT-502                      INSECT PHYSIOLOGY                      3(2-1)**

### **LEARNING OUTCOMES:**

The course will cover study of insect development and physiology of exoskeleton, endoskeleton and different systems; hormones and pheromones.

### **THEORY:**

Introduction; embryonic and post-embryonic development, physiology of integument, digestive, tracheal, circulatory, excretory, reproductive, muscular and nervous systems; sense organs and perception; sound and light production, thermoregulation; production and function of hormones and pheromones.

### **PRACTICAL:**

Study of integument; physiology of digestion, tracheal, circulation, excretion, reproduction, musculature and sensation; hormones and pheromones.

### **RECOMMENDED BOOKS:**

1. Ashfaq, A. and Sohail, A. 2002. Manual of Insect Physiology. Pakistan Science Foundation.
2. Chapman, R.F. 1998. The Insects: Structure and Function. 4<sup>th</sup> Ed. Hodder and Stoughton Educational Ltd., U.K.
3. Kerkut, G.A. and Gilbert, L.I. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. 1-12, Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt.
4. Klowden, M.J. 2002. Physiological Systems in Insects. Academic Press.
5. Litwack, G. 2005. Insect Hormones (Vitamins and Hormones). Elsevier Academic Press, California.
6. Liu, N. 2008. Recent Advances in Insect Physiology, Toxicology and Molecular Biology. Research Signpost Publishers.
7. Patanaik, B.D. 2002. Physiology of Insects. Dominant Publishers and Distributors, Delhi, India.
8. Wigglesworth, V.B. 1972. Principles of Insect Physiology. 7<sup>th</sup> Ed. Meltron & Co. Ltd. U.K.
9. Yadave, M. 2003. Physiology of Insects. Discovery Publishing House, New Delhi.

## ENT-504 INSECT CLASSIFICATION AND BIODIVERSITY

3(2-1)

### LEARNING OUTCOMES:

Introduce the students to the basics of insect classification and biodiversity of different orders upto family level.

### THEORY:

Introduction; schemes of classification; types and components of biodiversity, history of insects, phylogenetic affinities of different orders; insect adaptation in various geographical regions; speciation and biodiversity; classification of insect orders up to family level with particular reference to insect fauna of Pakistan;

### PRACTICAL:

Collection, preservation, Identification and classification of insects upto family level, methods of studying biodiversity,

### RECOMMENDED BOOKS:

1. Afzal, M. and Mufti, S.A. 1998. Natural History Research. Pakistan Scientific and Technological Information Center, Islamabad.
2. Collins, W. W and Qualset, C. O. 1998. Biodiversity in Agroecosystems. Lewis Publishers, Boca Raton, New York.
3. Daly, H.V. Doyen, J.T. Purcell, A.H. and Daly B.B. 1998. Introduction to Insect Biology and Diversity. Oxford University Press.
4. Footitt, R.G. and Adler, P.T. 2009. Insect Biodiversity Science and Society. Wiley – Blackwell Publication UK.
5. Gaston, K. J. and Spicer, J. I. 2004. Biodiversity: An Introduction. 2<sup>nd</sup> Edition. Blackwell Science Ltd.
6. Gupta, R.K. 2003. Advances in Insect Biodiversity. Agrobios, New Delhi, India.
7. Richards, O.W. and Davies, R.G. 1984. Imm's General Text Book of Entomology. Vol. II. 10<sup>th</sup> Ed. (Revised), Chapman and Hall, London.
8. Suhail, A. 2008. A Note Book of Classification of Adult Insects (Insect History, Biodiversity, Collection and Classification), 2<sup>nd</sup> Edition, Faisalabad.
9. Triplehorn, C.A. and Jhonson, N.F. 2005. Borror and DeLong's Introduction to the study of Insects. Brooks Cole. 7<sup>th</sup> Ed.
10. Wheeler, W.M. 2006. Insects: their origin and evolution. Discovery Publishing House, New Delhi
11. Whitfield, J. B. and Purcell, A.H. 2012. Daly and Doyen's Introduction to Insect Biology and Diversity. Third Edition. Oxford University Press.

**ENT-506 AGRICULTURAL PESTS AND THEIR MANAGEMENT 4(3-1)**

**LEARNING OUTCOMES:**

To provide the concept of agricultural pests and their management.

**THEORY:**

Introduction; concepts of IPM technology, identification, distribution, host plants, biology, damage and management of mites and insect pests of field crops, vegetables and orchards; brief introduction to important vertebrate pests..

**PRACTICAL:**

Collection, identification, distribution, host plants, biology, nature of damage and management of insect and mite pests of field crops, vegetables and orchards; other important vertebrate pests

**RECOMMENDED BOOKS:**

1. Agarwal, S. 2009. Insect Pests of Cereals and their Management. Oxford Book Co. India
2. Atwal, A.S. and Dhaliwal, G.S. 2005. Agricultural Pests of South East Asia and their Management. Kalyani Publishers, Ludhiana.
3. Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
4. Brooks, J.E., Ahmad, E., Hussain, I., Munir S. and Khan A. A. 1990. A training manual on Vertebrate pest management. 1<sup>st</sup> Edition, Publishers Pan graphics Islamabad.
5. Fenemore, P.G. 2006. Applied Entomology. New age International, Publication.
6. Fernald, H.T. 2008. Applied Entomology, An Introductory Textbook of Insects in their Relation to Man. Kessinger Publishing (Amazon).
7. Gurr, G.M. Wratten, S.D. and Alteri, M.A. 2004. Ecological Engineering for Pest Management: Advances in Halritat Mani Publication for Arthropods. CSIRO, Australia
8. Hashmi, A. A. 1994. Insect Pest Management, Cereal and Cash Crops Vols. I, II and III. Pakistan Agricultural Research Council, Islamabad
9. Hill, D. S. 1993. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press, Cambridge,
10. Lohar, M. K. 2013. Applied Entomology. 2<sup>nd</sup> Ed. Kashif Publications, Hyderabad, Pakistan.
11. Maredia, K.M. Dakouo, D. and Mota-Sanclez, D. 2003. Integrated Pest Management in the Global Arena. CABI publishing UK.
12. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6<sup>th</sup> Edition, Person Education Inc., Upper Saddle River,

New Jersey 07458, U.S.A.

13. Randall, C. and Boubary, K. 2003. Vertebrate Pest Management: A Guide for Commercial Applicators Category 7. Ohio Department of Agriculture-Pesticide Regulation, USA.
14. Shah, H.A. and Saleem, M. A. 2000. Applied Entomology. 2<sup>nd</sup> Ed. Izharsons Printers, Lahore
15. Abrol, D. P. and Shankar, U. 2012. Integrated Pest Management: Principles and Practice. CAB International.

## **ENT-508    STORED PRODUCT PESTS AND THEIR    3(2-1) MANAGEMENT**

### **LEARNING OUTCOMES:**

Concepts of stored product pest management, storage principles and storage losses due to insect pests.

### **THEORY:**

Introduction; identification, biology and management of different stored product pests; principles and types of storages; factors affecting grain and other products in storages; stored product losses and their prevention.

### **PRACTICAL:**

Visits to different godowns and demonstration of sampling methods and estimation; collection, identification and management of different stored product pests; culture of some stored products insect pests under different climatic conditions.

### **RECOMMENDED BOOKS:**

1. Ashfaq, M. Saleem, M. A. and Ahmad, F. 2009. Zari Ajnas ki Mahfooz Zakhira Kari (in Urdu). Pak Book Empire, Lahore.
2. Hill, D.S. 2002. Pests of Stored Food Stuffs and Their Control, Springer Publisher.
3. Rees, D. 2009. Insects of Stored Products. Manson Publishing Company.
4. Zaklandvoi, G. A. and Ratanova. V. F. 1987. Stored Grain Pests and their control. Oxonian Press Pvt. Ltd., London.



**LEARNING OUTCOMES:**

To provide the concepts of beneficial insects; predators and parasitoids, pollinators, scavengers, weed feeders, insects of medicinal and aesthetic value.

**THEORY:**

Introduction; insects of medicinal, food and aesthetic value; insect pollinators and environmental indicators; scavengers, entomophagous (predators and parasitoids) and weed-feeding insects; beneficial insect industries.

**PRACTICAL:**

Practical instructions in beneficial insects rearing; collection and identification of beneficial insects (pollinators, predators and parasitoids).

**RECOMMENDED BOOKS:**

1. Aruga, H. 1994. Principles of Sericulture (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Ashfaq, M. and Suhail, A. 2001. Magasbani kay Jadeed Treeqay (in Urdu), Deptt. of Entomology. U.A. Faisalabad.
3. Ashfaq, M. and Akram, W. 2000. Resham ke Keeray Palna (in Urdu), Deptt. of Entomology. U.A. Faisalabad.
4. Carter G.A. 2004. Bee Keeping. Biotech Books, New Delhi.
5. Ganga, G. and Chetty, J. S. 1997. An Introduction to Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
6. Hashmi, A. A. 1994. Insect Pest Management, Cereal and Cash Crops Vols. I, II and III. Pakistan Agricultural Research Council, Islamabad.
7. Irshad, M. Khan. M.R. and Rafi. M.A. 2005. Insect Pests and their Parasitoids, Predators and Pathogens in Pakistan. PIPS (Pvt.) Ltd. Islamabad.
8. Krishnawami, S. Narasimhanna, M. N. Suryanarayan, S.K. and Kumaraj, S. 1993. Sericultural Mannual II: Slikworm Rearing. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

## 7<sup>th</sup> SEMESTER

### ENT-601 INTEGRATED PEST MANAGEMENT 4(3-1)

#### LEARNING OUTCOMES:

To provide the concept of insect sampling, fluctuation; its measurement, principles; requirements and implementation of IPM.

#### THEORY:

Introduction; history, concept and principles of Integrated Pest Management (IPM); organic farming, economics of pest management, different methods of insect pest scouting and forecasting; losses caused by insect pests to different crops; methods of pest management: cultural, physical, mechanical, legislative, chemical, biological, microbial, biotechnological and genetic control measures, feeding deterrents, insect growth regulators (IGRs) and pheromones.

#### PRACTICAL:

Demonstration of different methods of pest scouting and monitoring, nature and extent of damage; assessment of crop losses by different methods; estimation of economic threshold levels of different crop pests; installation of light and pheromone traps;. Designing of IPM modules of important selected crops.

#### RECOMMENDED BOOKS:

1. Atwal, A.S. and Bains, S.S. 2005. Agricultural Pests of South East Asia and their Management. Kalyani Publishers, Ludhiana.
2. Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
3. Binns, M.R. 2000. Sampling and Monitoring in Crop Protection. CABI Publishing Co.
4. Dent, D. 2000. Insect Pest Management. 2nd Edition. CABI Bioscience, UK Centre, Ascot, UK.
5. Dhaliwal, G.S. and Arora, R. 2006. Integrated Pest Management. Kalyani Pub. Ludhiana.
6. Flint, M. L., 2012. IPM in Practice: Principles and Methods of Integrated Pest Management. Univ of California Agriculture & Natural Resources; 2nd edition. Pages 292.
7. Goodenough, J. L. and Mckineon, J.M. 1992. Basics of Insect Modelling. Amer. Soc. Agri. Engineers, USA.
8. House, P. Stevens, I. and Jones, O. 1998. Insect Pheromones and their use in Pest Management. Chapman and Hall, London.
9. Maredia, K.M. Dakouo, D. and Mota-Sanclez, D. 2003. Integrated Pest Management in the Global Arena. CABI publishing UK.

10. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to Insect Pest Management. 3<sup>rd</sup> Ed. Intercept Ltd. U.K.
11. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
12. Subba, R.N.S. Balagopalan, C. and Ramakrishna, S.V. (Eds) 1992, New Trends in Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
13. Upadhyay, R. K. Mukerji, K. G. Chamola, B. P. and Dubly, O. P. 1998. Integrated Pest and Disease Management. A.P.H. Publ. Co., New Delhi.
14. Verma, L.R. Verma, A.K. and Gantam, D.C. 2004. Pest Management in Horticultural Crops (Principles & Practices). Asiatech Publishers Inc. New Delhi, India.
15. Hashmi, A. A. 1994. Insect Pest Management, Cereal and Cash Crops Vols. I, II and III. Pakistan Agricultural Research Council, Islamabad.

## **ENT-603 PLANT RESISTANCE TO INSECT PESTS 3(2-1)**

### **LEARNING OUTCOMES:**

To provide the concept of plant resistance and transgenic crops to insect pests.

### **THEORY:**

Introduction; concepts of resistant and transgenic crops to insect pests; mechanism and factors of resistance; ecological, physiological, asynchrony, induced genetic antixenosis, antibiosis and tolerance; genetic basis of resistance; effect of environment on resistance; biotypes and resistance; measurement of resistance. Effect of transgenic crops on non-target organism

### **PRACTICAL:**

Screening and measurement of relative plant resistance to insects in different crops and transgenic plants; observation about morphological, physiological and bio-chemical plant resistance.

### **RECOMMENDED BOOKS:**

1. Dhaliwal, G. S. and Singh, R. 2004. Host plant resistance to insects: concepts and application. Panima Publishing Corporation, New Delhi.
2. Maxwell, F.G. and Jennings, P.R. 1980. Breeding Plants Resistant to Insect Pests. John Wiley and Sons New York.
3. Panda, N. 1980. Principles of Host Plant Resistance to Insect Pests. Allenheld, London.

4. Panda, N. and Khush, G.S. 1995, Host Plant resistance to Insects. IRRI, Biddles Ltd. Guildford, UK.
5. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
6. Sadasivam, S. and Thayumanavan, B. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker Inc. New York.
7. Saleem, M. A. 2005. Insecticide Resistance and Management. B. Z. University Press, Multan, Pakistan.
8. Painter, R.H. 1951. Insect Resistance in Crop Plants. McMillan Co., N.Y

## **ENT-605 INSECTICIDES AND THEIR APPLICATION 3(2-1)**

### **LEARNING OUTCOMES:**

To provide concept of toxicity and insecticide formulations, mode of action, residues of insecticides and various types of spray equipments.

### **THEORY:**

Introduction; nomenclature, classification on the basis of mode of entry, chemical nature (natural and synthetic insecticides), mode of action, toxicity and insecticides formulations; compatibility, physico-chemical properties, residues of insecticides; insecticide resistance and its management, hazards and safety measures; functioning of various types of hand and power operated equipments for insecticide application. Types of nozzles. Information about insecticide legislation.

### **PRACTICAL:**

Computation, preparation and field application of different formulations of insecticides; identification, classification, handling and maintenance of application equipments. Visit to pesticides industries/field visits.

### **RECOMMENDED BOOKS:**

1. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
2. Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA
3. Dodia, D.A. Petel, I.S. and Petal, G.M. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India) Jodhpur.
4. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi.

5. Mathews G.A. 2002. Pesticide Application Methods. 4<sup>th</sup> Ed. Intercept. UK.
6. Otto, D. and Weber, B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., U.K.
7. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.
8. Saleem, M.A. 2009. Principles of Insect Toxicology. Vol.-I. Izhar sons Printers. Lahore.
9. Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida.

## **ENT-607 RANGE AND FOREST ENTOMOLOGY 3(2-1)**

### **LEARNING OUTCOMES:**

To provide the concept of range and forest entomology in range land and forest ecosystem.

### **THEORY:**

Importance of range and forest entomology in range land and forest ecosystems; insect pests of range and forest trees, lawn insects, their identification, distribution, host plants, biology, nature of damage, estimation of losses and management; competition and complementary role of insects with range livestock.

### **PRACTICAL:**

Survey and collection, preservation and identification of insect pests of range and forest trees; study of nature of damage and demonstration of control measure, Field visits to range/ forests/ forest departments.

### **RECOMMENDED BOOKS:**

1. Barbose, P. and Wagner, M.B. 1989. Introduction to Forest and Shade Tree Insects. Academic Press, NY, London
2. Dajoz, R. 2000. Insects and Forests. Intercept Ltd. UK.
3. Hashmi, A. A. 1994. Insect Pest Management, Horticultural and Forest Crops Volume 2 Pakistan Agricultural Research Council, Islamabad.
4. Jha, K. 2003. Forest Entomology. Ashish Publishing House. India.
5. Jha. L. K. and Sen-Sarma. P.K. 2008. Forest Entomology APH Publishing.
6. Knight, F.B. and Heeiknen, H.J.1980. Principles of Forest Entomology. McGraw-Hill, Book Co. NY.
7. Nair, K. S. S. 2007. Tropical Forest Insect Pests: Ecology, Impact, and Management. Cambridge University Press, UK.

8. Sathe, T.V. 2009. A Text Book of Forest Entomology. Daya Publishing House Delhi.
9. Thakur, M.I. 2000. Forest Entomology: Ecology and Management. S.A.I. Publishing Co.
10. Wylie, R. and Speight M. R. 2012. Insect pests in tropical forestry CABI publishing 399 pp 2<sup>nd</sup> edition.
11. Watts, J. G. 1989. Range land Entomology published by society for Range Management.

**ENT-609 AGRICULTURE AND ENVIRONMENTAL POLLUTION**  
**3(2-1)**

**LEARNING OUTCOMES:**

To provide the concepts of environmental pollution and deterioration with their effects on agriculture, forest and living organisms.

**THEORY:**

Introduction; general concept of pollutants; sources and nature of pollutants; environmental deterioration, its effect on agriculture; green house effect; types of pollution with reference to agriculture and forest; pesticide and fertilizer pollution; effect of pollution on soil, water, air, plants, living organisms; management of pollution.

**PRACTICAL:**

Identification and determination of sources of pollution in various substrates, viz., air, soil, water.

**RECOMMENDED BOOKS:**

1. Misra, S.G. and Mani, D. 1994. Agricultural Pollution. Vols. 1 & 2, Ashih Publishing House, New Delhi.
2. Parkash, R and Choubey, S. M. 1990. Environmental Pollution and Health Hazards. Publication of Society of Biochemistry of India.
3. Rizvi, S.M.H. 1994. Fundamentals of Environmental Pollution. CBS Publishers and Distributers. 485, Jain Bhawan, Bhola Nath Nagar, Shahdara, Delhi.
4. Ashfaq M. and Saleem, M.A. 2010. Environmental Pollution and Agriculture. Pak Book Empire, Lahore.
5. Suhail, A and Ahmad, S. 2003. A Workbook of Agriculture & Environmental Pollution. Deptt. of Agri. Entomology, University of Agriculture, Faisalabad.

## 8<sup>TH</sup> SEMESTER

### ENT-602 SCIENTIFIC WRITING AND PRESENTATION 3(2-1)

#### LEARNING OUTCOMES:

To familiarize the students to research methods, handling of experimental data, writing of a research report and presentation skills

#### THEORY:

Introduction; literature search for entomological information, citation, collection of data, tabulation, analysis and interpretation of research data, report writing, lab/field experimental designs, concepts of synopsis, thesis, research paper, research project and monographs, presentation skills.

#### PRACTICAL:

Use of internet sources and databases for entomological information; layout of experiments; collection of data, tabulation, analysis and interpretation of research data; Writing synopsis, thesis, research paper, research project and monographs; preparation and delivery of multimedia presentations; visit and use of digital libraries.

#### RECOMMENDED BOOKS:

1. Davis, M. 2005. Scientific Papers and Presentations. Academic Press.
2. Dawson, C. 2009. Introduction to Research Methods: A practical guide for anyone undertaking a research project. 4th edition. Howtobooks, UK.
3. Ghani, M.A. and Ashfaq, M. (Edit). 1987. A Resume of Post-Graduate Research, 1929-1985. Deptt. of Entomology, University of Agriculture, Faisalabad.
4. Gilbert, I. and Himalton, C.J. 1983. Entomology: A Guide of Information Sources, Mausell Publishing Co. Ltd.
5. Gomez, K. A. and A. A. Gomez, 1984. Statistical Procedures in Agricultural Research, Second Edition, Wiley New York, Chichester, etc.:, pp. 680.
6. Knisely, K. 2009. A Student Handbook for Writing in Biology, 4th Edition, Sinauer Associates, Inc. W.H. Freeman and Company.
7. Matthews, J. R., John, M. B. and Robert, W. M. 1996. Successful Scientific Writing, A Step-By-Step Guide for Biomedical Scientists. Cambridge University Press.
8. Quinn, G.P. and Michael, J.K. 2002. Experimental Design and Data Analysis for Biology. Cambridge University Press.
9. Fowler, J., Fowler, Jim , Cohen, L. 1998. Practical Statistics for field biology. (2<sup>nd</sup> Edition) Wiley Publishers England.

**LEARNING OUTCOMES:**

To provide the concepts of different species of bees, their behavior and to provide awareness of bee keeping, diseases of bees and their management.

**THEORY:**

Introduction, importance, scope of apiculture industry, bee species and their biology, morphology, behavior and products, bee flora their distribution and flowering time; beekeeping equipments, seasonal management, uniting, dividing and preparation for shifting colonies; bee stings, queen rearing and swarming; pest and diseases of bees and their management; honey extraction; factors affecting honey yield; importance of bees in pollination; honey, its properties and uses; granulation, fermentation and storage of honey, uses of other bee products; beekeeping as an enterprise.

**PRACTICAL:**

Practical demonstration of bee colonies, observation of colonies and different casts; beekeeping equipments; preparation of frames and comb foundation for their hives; colony inspection; visit to apiaries.

**RECOMMENDED BOOKS:**

1. Ahmad, R. 1979. A Guide to Bee Keeping in Pakistan. Extension Book.
2. Devillers, J., Phame, M. and Delegeue, M. 2002. Honey Bees.
3. Goodwin, R.N. and Van Eaton, C. 1999. Elimination of American Foulbrood without the use of Drugs. A Practical Manual for Bee Keepers. National Bee Keepers Association of New Zealand, Napier, New Zealand.
4. Hooper, T. 1991. Guide to Bees and Honey. BAS Printers Ltd. Hampshir, UK.

**ENT-606 BIOLOGICAL CONTROL OF INSECT PESTS 3(2-1)****LEARNING OUTCOMES:**

To enable the students know about principles and practices of biological control.

**THEORY:**

Introduction, concept, history and scope; ecological basis of biological control; natural enemies: predators, parasitoids and insect pathogens (mode of action, application, epizootics); advantages and disadvantages, characteristics of bio-control agents; procedure of biological control: introduction; enhancement of bio control agents (introduction, conservation,



mass culture, augmentation, release, monitoring and importation); rearing techniques of bio-control agents and their host insects; role of biological control in IPM. Commercialization of biocontrol agents, Quality management in biological control agent rearing, establishment of biological control system.

### **PRACTICAL:**

Collection, preservation and identification of predators & parasitoids; laboratory rearing and culturing of important natural enemies; study of extent of parasitism/predation of different bio-control agents; storage, shipping and field release methods, visit to public/ private bio-control labs.

### **RECOMMENDED BOOKS:**

1. Barbosa, P. 1998. Conservation Biological Control. Academic Press.
2. Bellows, T.S. Fisher, T.W. Caltagirone, L.E. Dahlsten, D.L. Huffaker, C. and Gardh, G. 1999. Handbook of Biological Control: Principles and Applications of Biological Control. Academic Press, USA.
3. Copping, L.G. 2004. The Manual of Biocontrol Agents. BCPC
4. De Bach, P. and Rosen, D. 1991. Biological Control by Natural Enemies. CUP Archive.
5. Hajek, A. 2003. Natural Enemies: An Introduction to Biological Control. Cambridge University Press
6. Hawkins, B.A. and Cornell, H.V. 1999. Theoretical Approaches to Biological Control. Cambridge University Press
7. Heikki, M.T. Hokkeanen, J. Lynch, M. 1996. Biological Control: Benefits and Risks. Cambridge University Press.
8. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. Higher Education Commission, Islamabad, Pakistan.
9. Rechcigl, J.E. and Rechcigl, N.A. 1999. Biological and Biotechnological Control of Insect Pests. CRC Press September
10. Van Driesche, R.G. and Bellows, T.S. 1996. Biological Control. An International Publishing Company, New York.
11. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to Insect Pest Management. 3rd Ed. Intercept Ltd. U.K.

## **ENT-608                      INTERNSHIP/RESEARCH PROJECT                      4(0-4)**

(Including report writing and presentation)

Students will be required to undertake internship at various agricultural research organizations, private companies, extension/adaptive farms and private farms, university fields/laboratories aimed at their practical training As per feasibility of the institution. Upon completion of internship/research, students are required to submit a report and give presentation of internship/research experiments.

## **\*Evaluation Chart**

1. 25% To the supervisor of host institution/internal supervisor.
2. 25% Reporting, collection and presentation, evaluated by the proposed committee/respective supervisor.
3. 25% Written examination conducted by the proposed committee/ respective supervisor: 50% from academics and 50% from internship/research report.
4. 25% Oral examination conducted by proposed internal examiner/ external examiner / proposed committee.

*\*The respective departments can modify the above evaluation criteria.*

# CURRICULUM FOR MSc (Hons) and PhD ENTOMOLOGY

## SCHEME OF STUDIES

### NOTE:

1. For the award of degree for MSc (Hons) Entomology, thesis carries minimum of 6 credit hours.
2. Minimum credit hours of course work for MSc (Hons) Entomology (excluding thesis) should be 24 including minor subjects which shall not exceed one-third of the total course work.
3. For award of PhD degree, minimum credit hours of course work should be 18 (excluding thesis) followed by a comprehensive examination for granting candidacy as PhD researcher as per HEC guidelines.
4. PhD thesis must be evaluated by at least two PhD experts from technologically/academically advanced foreign countries in addition to local committee members as per HEC guidelines.

The following titles are recommended for Post-graduate courses for all the universities. However, each university shall be free to add more or re-arrange these in accordance with the facilities available. A student will take only those courses which the Supervisory Committee recommends for him/her.

<b>S.No.</b>	<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
1.	ENT-701	Research Methods in Entomology	3(2-1)
2.	ENT-702	Origin and Phylogeny of Insects	3(3-0)
3.	ENT-703	Environmental Entomology	2(2-0)
4.	ENT-704	Advanced Insect Morphology	3(2-1)
5.	ENT-705	Advanced Insect Ecology	3(2-1)
6.	ENT-706	Numerical Taxonomy	3(2-1)
7.	ENT-707	Advanced Insect Physiology and Embryology	3(2-1)
8.	ENT-708	Molecular Entomology	3(2-1)
9.	ENT-709	Insecticide Resistance and Management	3(2-1)
10.	ENT-710	Insects in Relation to Plant Diseases	3(2-1)

11.	ENT-711	Medical and Veterinary Entomology	3(2-1)
12.	ENT-712	Acarology	3(2-1)
13.	ENT-713	Classification of Immature Insects	3(2-1)
14.	ENT-714	Insecticide Toxicology	3(2-1)
15.	ENT-715	Insect Nutrition	3(2-1)
16.	ENT-716	Insecticides and Public Health	3(2-1)
17.	ENT-717	Advances in Biological Control of Insect	3(2-1)
18.	ENT-718	Advances in Insect Behaviour	3(2-1)
19.	ENT-719	Special Problem	1(1-0)
20.	ENT-720	Seminar	1(1-0)
21.	ENT-721	Pesticides Application Equipments	3(1-2)
22.	ENT-722	Advances in Pest Management Research	3(2-1)
23.	ENT-723	Insect Cytogenetics and Cytotaxonomy	3(2-1)
24.	ENT-724	Insect Pathology	3(2-1)
25.	ENT-725	Insect Biochemistry	3(2-1)
26.	ENT-726	Chemical Ecology of insects	3(3-0)
27.	ENT-727	Forensic Entomology	3(2-1)
28.	ENT-728	Insect Neurobiology	3(2-1)
29.	ENT-729	Insect Rearing Techniques	3(2-1)
30.	Thesis	MSc (Hons.) thesis	
31.	Thesis	PhD, thesis	

**Note:** *Courses taken for MSc (Hons) will not be taken again in PhD degree program as per HEC rules*

## DETAIL OF COURSES

### ENT-701 RESEARCH METHODS IN ENTOMOLOGY 3(2-1)

#### LEARNING OUTCOMES:

To enable students get familiarized with modern equipments used in Entomological Research and provide concept of software in data analysis.

#### THEORY:

Introduction; techniques and apparatus for entomological research: temporary and permanent mounts, microtomy, use of ocular grid, micrometry and scientific photography; bio-assay techniques; atomic absorption spectrophotometer, gas chromatography, high performance liquid chromatography, UV-visual spectrophotometer, amino acid analyzer, electrophoresis, PCR, recombinant DNA techniques, ultra-centrifugation, scanning and transmission, electron microscopy and computer software/ bioinformatics in entomology; methods of sampling, analysis of data and report writing; lab/ field experimental techniques.

#### PRACTICAL:

Insect sampling, collection and preservation techniques; rearing devices; exercises in microtomy, preparation of permanent slides, soft wares for morphometrics and data analysis; scientific photography; electron microscopy; maintenance and measurement of microclimate; bioassay; demonstration of insect DNA amplification through PCR methods. use of different equipment in entomological experiments, tabulation, analysis and interpretation of data.

#### RECOMMENDED BOOKS:

1. Bancroft, J.D. and Stevens, A. 1990. Theory and Practice of Histological Techniques. Chaschill Livingstone, London.
2. Binns, M.R. 2000. Sampling and Monitoring in Crop Protection. CABI Publishing Company
3. Cappiello, A. 2007. Advance in LC-MS Instrumentation. Elsevier Publishers, USA.
4. Erlich, H. 1992. PCR Technology: Principles and Applications for Amplification. W.H. Freeman & Company, New York.
5. Singh, P. and Moore, R.F. 1985. Handbook of Insect Rearing. Vol, I & II, Elsevier, U.S.A.
6. Dent, D., Walton, M. P. 1997. Methods in ecological and agricultural entomology, Published by CAB International, University of Michigan, USA
7. Drake, V. A., Reynolds, D. R. 2012. Radar Entomology: Observing Insect Flight and Migration. Published by C.A.B. International, University of Greenwich, UK

**LEARNING OUTCOMES:**

To provide the basic concept of insect origin in the time dimension.

**THEORY:**

Introduction; evolutionary groups of insects; geological time table in relation to origin; evolutionary history of insects; theories of origin of insects; mechanisms of evolution: cytological, cytotaxonomic and embryological evidences; phylogenetic theories; origin of species and higher categories; phylogenetic arrangement of orders and families; variation; fossil history of insects.

**RECOMMENDED BOOKS:**

1. Dodson, E.C. and Dodson, I. 1986. Evolution, Process and Product. 4<sup>th</sup> Ed. I.W.S. Publishers.
2. Grimaldi, D. and Engel, M.S. 2005. Evolution of Insects. Cambridge University Press.
3. Hennig, W, 1981. Insect Phylogeny. Wiley Intersciences, London.
4. Kapoor, V.C. 1987. Origin and Evolution of Insects. Kalyani Publishers, New Delhi.
5. Triplehorn, C.A. and Johnson, N.F. 2005. Borror and DeLong's Introduction to the Study of Insects. Books Cole. 7th Ed.
6. Wiley, E.C. 1981. Phylogenetics. The Theory and Practice of Phylogenetic Systematics. John Wiley and Sons Inc., New York.

**LEARNING OUTCOMES:**

To provide the basic concept of impact of environment on insects, and insects as indices of environmental changes.

**THEORY:**

Introduction; environment and its spheres, diversity of insects in different ecosystems; interactions of various groups of insects with biological, chemical and physical constituents of the environment; physical and chemical characterization of environmental contaminants, impact of pollutants on insects and non-target organisms at different levels; biological responses to pollutants and biogeochemical cycles; insects as indicators of levels of pollution. GIS in relation to insects.

## **RECOMMENDED BOOKS:**

1. Cbiran, D.D. 2010. Environmental Science. 8<sup>th</sup> Edition Jones and Bartlett Publishers, London
2. Gregory, K.J. Simmons, I.G. Brazel, A.J. Day, W.J. Keller, E.A. Sylverter, A.G. and Yanez. A,A. 2009. Environmental Science: a Students companion. SAGE London.
3. Huffaker, C.B. 1999. Ecological Entomology. John Wiley Sons.
4. McEwen, F.L. and Stephenson, G.I. 1979. The Use and Significance of Pesticides in the Environment. John Wiley and Sons Inc., N.Y.
5. Perry, A.S. 1998. Insecticides in Agriculture and Environment: Retrospects and Prospects. Elsevier, New York.
6. Ashfaq, M. and Saleem, M.A. 2010. Environmental Pollution and Agriculture. Pak Book Empire, Lahore, Pakistan.
7. Yazdani, S.S. and Agarwal, M. I. 1997. Elements of Insect Ecology. Narosa Publishing House, New Delhi.
8. Ananthakrishnan, T. N. and Sivaramakrishnan K. G. 2008, Ecological Entomology : Insect life in odd Environment, Scientific Publication 142 pp

## **ENT-704    ADVANCED INSECT MORPHOLOGY    3(2-1)**

### **LEARNING OUTCOMES:**

To provide the concept of structure and function of various organs and organ systems of insects.

### **THEORY:**

Introduction; comparative morphology, structure of integument, sclerites and processes (setae, spines, spurs, scales, etc.); structure of insect head and its endo-skeleton; appendages and modifications of insects mouth-parts; segmentation of head, thorax and their appendages; endo-thorax, modification of wings, wing coupling apparatus, wing development, modification of insect leg, abdomen and its appendages, insect genitalia, development in various insect orders and families; proctiger and caudal appendages, morphology of digestive, circulatory, respiratory, excretory, nervous, muscular and reproductive organs, scent, sound and light producing apparatus; tricho-bothria in adult and immature insects; thermoregulatory, visual, auditory and glandular organs in insects.

### **PRACTICAL:**

Comparative structure of insect head, thorax, abdomen and their appendages in different insect orders; preparation of temporary and permanent mounts of different body parts and integument; comparative structure of genitalia in various insect orders, examination of different types

of setae, spines, spurs and scales in insects; dissection of soft-parts and organ systems; study of visual, auditory, thermoregulatory, scent, sound producing and luminous organs.

### **RECOMMENDED BOOKS:**

1. Chapman, R.F. 2002. The Insects: Structure and Function. 3<sup>rd</sup> Ed. Hodder and Stoughton Ltd., U.K.
2. Duporte, E.M. 1977. Manual of Insect Morphology. Reinhold Publishing Corp., N.Y.
3. Kerkut, G.A. and Gilbert, L.I. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. 1-12, Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt
4. Matsuda, R. 1970-75. Morphology and Evolution of Insect Head, Thorax, Abdomen. Mem. Ent. Soc. Canada.
5. Matsuda, R. 1975. Morphology and Evolution of Abdomen. Pergamon Press.
6. Rockstein, M. (Edit.). 1973-1974. Advances in Insect Physiology. Vols. 1-6 2<sup>nd</sup> Edition. Academic Press, N.Y.
7. Snodgrass, R. 1993. Principles of Insect Morphology. Cornell Uni. Press, U.S.A.
8. Beutel, R. G. and Friedrich, F. 2013. Insect Morphology and Phylogeny. Science. 450 pages.
9. DuPorte, E. M. 1959. Manual in Insect morphology. Reinhold Press. University of Minnesota, USA

## **ENT-705    ADVANCED INSECT ECOLOGY    3(2-1)**

### **LEARNING OUTCOMES:**

To provide the advance concepts of population growth of insects in different environmental parameters and to simulate the population structures in various climatic conditions to software technology.

### **THEORY:**

Population growth, theories, life-tables, key factors, analyses, regression, co-existence, co-habitation, competition and mutual displacement, variation, speciation and diversity. A mathematical approach to the dynamics of single and multi-species populations and communities with analytical and simulation model techniques: mathematical and statistical techniques applied to population systems and community ecologies; critical survey of models of population growth, niche matrices, competition, predation, ecological genetics, species diversity and distribution, and ecological succession.



## **PRACTICAL:**

Use of computer simulations in population of insects: computer modeling used by Ecologists to clarify and interpret large field data by clustering, transforming, matrices and multi-variate analysis.

## **RECOMMENDED BOOKS:**

1. Atwal, A.S. and Bains, S.S. 2005. Applied Animal Ecology. Kalyani Publishers, Ludhiana.
2. Bernstein, R. 2003. Population Ecology: An Introduction to Computer Simulations. Willy, New York.
3. Blackith, R.E. and Rayment, R.A. 1984. Multivariate Morphometrics. Academic Press, London.
4. Price, P.W. 2003. Insect Ecology. 3rd Ed. Wiley Interscience Publishers, N.Y.
5. Rockwood, L.L. 2006. Introduction to Population Ecology. Wiley, John & Sons, Incorporated.
6. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3<sup>rd</sup> Ed. Wiley-Blackwell.
7. Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles. Princeton University Press.
8. Schowalter, T. D. 2011. Insect Ecology: An Ecosystem Approach. 3rd Ed. Elsevier Inc. Jamestown Road, London.
9. Denno, R. F. and Eubanks, M. D. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press, New York. USA.

## **ENT-706 NUMERICAL TAXONOMY 3(2-1)**

### **LEARNING OUTCOMES:**

To provide awareness of mathematical modeling of the origin of various insect groups and their relationships.

### **THEORY:**

Introduction; aims and principles of numerical taxonomy; data and its types; taxonomic characters, their selection, coding and weightage; parsimony, handling of data; taxonomic evidence, estimation of taxonomic resemblance, construction of a taxonomic system; theory of ranking; population analysis by different methods; phenetic analysis; comparison of faunal elements and contemporary approach to classification; phenograms / dendrograms / cladogram/phylogram.

### **PRACTICAL:**

Characterization, coding and preparation of matrices, generation of

phenograms by applying coefficients of association, correlation and taxonomic distance formulae; parsimony, construction of phenograms/dendrograms/cladogram.

### **RECOMMENDED BOOKS:**

1. Clifford, H.T. and Stephenson, W. 1986. An Introduction to Numerical Classification. Academic Press, New York, London.
2. Dung, G. and Everitt, B.S. 1982. An Introduction to Mathematical Taxonomy. Cambridge Uni. Press, Cambridge.
3. Duncan, T. and Stuessy, T.F. (Eds.) 1985. Cladistics. Theory & Methodology. New York, Van Nostrand Reinhold, Press.
4. Blackith, R.E. and Rayment, R.A. 1984. Multivariate Morphometrics. Academic Press, London.
5. Sneath, P.H.A. and Sokal, R.P. 1973. Numerical Taxonomy. W. R. Freeman & San-Francisco, USA.
6. Wheeler, Q.D. 2008. The New Taxonomy. CRC Press London, New York.

## **ENT-707     **ADVANCED INSECT PHYSIOLOGY AND EMBRYOLOGY****

**3 (2-1)**

### **LEARNING OUTCOMES:**

To provide concepts of comparative physiology, their functions and origin in different insect orders and families.

### **THEORY:**

Introduction; advances in physiology of integument, growth, development, diapause, digestion, respiration, circulation, excretion, reproduction, reception and perception; neuro-muscular physiology; enzymatic functions, biological clocks; embryonic development and organogenesis in different groups of insects; study of comparative embryology in different groups of insects, physiology of locomotion and resistance; hormones, pheromones, glandular secretion, thermoregulation, sound and light production.

### **PRACTICAL:**

Genetic and hormonal control of insect growth, development and breaking of diapause; digestion in different parts of alimentary canal and salivary glands; oxygen consumption, carbon dioxide production and determination of respiratory quotient; qualitative and quantitative analysis of haemocytes; estimation of blood proteins, uric acid in excreta and water loss; pheromones as sex attractants; determination of visual, gustatory, olfactory, acoustic, thermoregulatory responses and experiment on wing beat frequency.

## **RECOMMENDED BOOKS:**

1. Berridge, M.J. and Treherne, J.E. 1982. Advances in Insect Physiology. Vol 16, Academic Press Inc.
2. Blum, M.S. 1985. Fundamentals of Insect Physiology. John Wiley and Sons, N.Y.
3. Chapman, R.F. 1998. The Insects; Structure and Function. 4<sup>th</sup> Ed. American Elsevier Publishing Co., Inc. N.Y.
4. Howse, P. Stevens, I. and Jones, O. 1998. Insect Pheromones and their Use in Pest Management. Chapman and Hall, London.
5. Kerkut, G.A. and Gilbert, L.I. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. 1-12, Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt.
6. Rockstein, M. (Edit.). 1973-1974. Advances in Insect Physiology Vols. 1-6 2<sup>nd</sup> Ed. Academic Press, N.Y.
7. Wigglesworth, V.B. 1984. Insect Physiology, Springer.

## **ENT-708 MOLECULAR ENTOMOLOGY 3(2-1)**

### **LEARNING OUTCOMES:**

To provide the modern concepts of molecular Entomology and its applications..

### **THEORY:**

Introduction; Insects as a model for molecular study (Drosophila, Red flour beetle, Mosquitoes, Honeybee). insect genomes; nucleus, chromosomes, DNA and RNA; Gene structure and function; gene transcription and translation; concept of introns and exons; central dogma of molecular biology; Primer Design and polymerase chain reaction (PCR), gene cloning and sequencing; restriction analysis, gene libraries; mitochondrial and genomic DNA for insect species identifications and insect population diversity/biotyping; Use of molecular markers in insects, DNA for phylogenetic analysis and construction of phylogenies; RAPD, RFLP, PCR-RFLP, microsatellites and SNPs; linkage and chromosomal mapping, genes regulatory processes, mutagenesis; molecular basis of insect functions (insect behavior, insecticidal resistance), gene knock-ins and knock-outs by RNA interference, barcoding, DNA and protein sequence alignments and use of bioinformatics tools.

### **PRACTICAL:**

Demonstration of insect DNA extractions, PCR amplification, gel electrophoresis, gene cloning and plasmid DNA extractions, DNA hybridization (Southern and northern blots); RAPD, RFLP analysis techniques, use of Bio-Informatics software tools.

## **RECOMMENDED BOOKS:**

1. Gilbert, L. 2005. Comprehensive Molecular Insect Science. 1-7 Vol.
2. Glick, B.R. and Pasternek, J..J. 1998. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press. Washington D.C.
3. Hall, B.G. 2007. Phylogenetic Trees Made Easy: A How to Manual. 3<sup>rd</sup> Ed. Sinauer Associates.
4. Handler, A. M. James, A.A. (Eds.).2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
5. Alfred M. Handler, Anthony A. James. 2000. Insect Transgenesis: Methods and Application. CRC Press.
6. Hoy, M.A. 2013. Insect Molecular Genetics. An Introduction to Principles and Applications, Academic Press. 3<sup>rd</sup> Edition
7. Glick, B.R. Pasternak, J.J. and Patten C.L. 2009, Molecular Biotechnology: Principles and Applications of recombinant DNA. ASM Press Publishers. 4<sup>th</sup> Edition.
8. Walker, J.M. and Rapley, R. 2009. Molecular Biology and Biotechnology Royal Society of Chemistry Publishers. 5<sup>th</sup> Edition.
9. Smith, J.E. 2009. Biotechnology. Cambridge University Press; 5<sup>th</sup> Edition
10. Acquaaah, G. 2003. Understanding Biotechnology: An Integrated and Cyber-Based Approach. Prentice Hall; 1 edition.
11. Blomquist, G.J. and Richard, G.V. 2003. Insect pheromone biochemistry and molecular biology, Elsevier Academic.

## **ENT-709 INSECTICIDE RESISTANCE AND MANAGEMENT 3(2-1)**

### **LEARNING OUTCOMES:**

To provide the modern concepts of insecticide resistance in various insect populations.

### **THEORY:**

Introduction; development and types of resistance; mechanism of resistance: physiological, behavioural, biochemical and genetic; metabolism of insecticides; detoxification mechanism in insects: phase-I reactions such as oxidation, hydrolysis, reduction and dehydrochlorination; phase-II reaction such as conjugation; multiple pathways, induction of detoxification enzymes; management of resistance; case histories of insecticide resistance management (IRM).

## **PRACTICAL:**

Determination of resistance, monitoring, development of resistant and susceptible strains, collection of potentially resistant strains of insects from the insecticide sprayed fields; biochemical basis of resistance; demonstration of resistance breaking techniques.

## **RECOMMENDED BOOKS:**

1. Denholm, I. 1999. Insecticide Resistance from Mechanism to Management. Prentice Hall. London.
2. Green, M.B. LeBaron, H.M. and Moberg, W.K. (Eds.). 1990. Managing Resistance to Agrochemicals. American Chemical Society. Washington.
3. Gupta, H.C.L. 1999. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
4. Onstand, D.W. 2007. Insect Resistance Management. Academic Press.
5. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
6. Peshin, R. 2009. Evaluation of Insecticide Resistance Management Program: Theory and Practice.
7. Roush, R.T. and Tabashnik, B.E. (Eds.). 1990. Pesticide Resistance in Arthropodes. Chapman & Hall. New York.
8. Saleem, M. A. 2005. Insecticides Resistance and Management. B.Z. University Press, Multan.
9. Tlo, D. and Webbler, B. 1992. Insecticides Mechanism of Action of Resistance. Intercept Ltd. UK.
10. US National Academy of Sciences. 1986. Pesticide Resistance: Strategies and Tactics for Management. National Academy Press. Washington.
11. Walia, S. and Parmar, B.S. 1995. Pesticide, Crop Protection and Environment. Oxford & IBH Publishing Co. New Delhi, Calcutta.
12. Watson, D.L. and Brown, A.W. 1997. Pesticide Management and Insecticide Resistance. Academic Press Inc. USA.
13. Wilkinson, C.F. 1976. Insecticides Biochemistry and Physiology. Heyden, London, New York, Rheine.
14. Onstad D. W. 2008. Insect Resistance Management: Biology, Economics, and Prediction. Academic Press, Elsevier Ltd. Jamestown Road, London UK.

**ENT-710      INSECTS IN RELATION TO PLANT      3(2-1)**  
**DISEASES**

**LEARNING OUTCOMES:**

To provide the broad overview of insects in relation to plant diseases with special emphasis on their vector status.

**THEORY:**

Introduction; identification, biology of insect and mite vectors of plant diseases; mode of transmission of plant pathogens by insects and mites; insect adaptation for pathogen transmission, interrelationship of insect, plant and microorganism, horizontal and vertical transmission, beneficial microorganisms in insect control, study of causal organisms, etiology, symptoms and control of important fungal, bacterial and viral diseases of crop plants transmitted by insects and mites.

**PRACTICAL:**

Identification of insect and mite vectors and pathogens; rearing and handling of insect vectors for plant pathological studies. Study of mode of transmission of plant pathogens by insect and mite vectors.

**RECOMMENDED BOOKS:**

1. Boucias, D.G. 1998. Principles of Insect Pathology. Chapman Hall, London.
2. Jeppson, L.R. Keifer, H.H. and Baker, E. W. 1975. Mites Injurious to Economic Plants. Univ. Calif. Press.
3. Leach, J.B. 2007. Insect Transmission of Plant Diseases. Biotech Books. Delhi, India.
4. Tanada, Y. 1992. Insect Pathology. Academic Press.
5. Cater, W. 1973. Insects in Relation to Plant Disease

**ENT-711      MEDICAL AND VETERINARY ENTOMOLOGY      3(2-1)**

**LEARNING OUTCOMES:**

To provide the knowledge of identification, biology, epidemiology of insects and other arthropods of medical importance.

**THEORY:**

Introduction; epidemiology; identification, biology and management of insects and other arthropods of medical and veterinary importance; insect and some other arthropods transmitting diseases, their symptoms

and diagnosis; venoms, defense secretions and allergens. Economics of livestock and poultry pests with emphasis on different flies, midges, mosquitoes, ticks, mites, beetles and other important insects of medical and veterinary importance.

### **PRACTICAL:**

Surveillance, collection, identification and management of different insects and arthropod pests of medical and veterinary importance in relation to diseases of man and domestic animals.

### **RECOMMENDED BOOKS:**

1. Aldridge, B. 2004. Medical Entomology: Text Book of Public Health and Veterinary. Chapman and Hall, London.
2. Busvine, J.R. 1980. Insects and Hygiene. 3<sup>rd</sup> Ed. Chapman and Hall, London.
3. Harwood, R.F. and James, M.T. 1979. Entomology in Human and Animal Health. 7<sup>th</sup> Ed. Macmillan Publishing Co., Inc., N.Y.
4. James, M.T. and Hardwood, R.F. 1969. Herms Medical Entomology. The Macmillan Company Canada.
5. Kettle, D.S. 1995. Medical and Veterinary Entomology. (2<sup>nd</sup> Ed.), CAB International, UK.
6. Mullen, G. 2009. Medical and Veterinary Entomology. 2<sup>nd</sup> Ed. Academic Press.
7. Service, M. 2004. Medical Entomology for Students. Cambridge University Press.
8. Williams, R.E. 2009. Veterinary Entomology: live stock & Companion Animals CRC press, 343 pp.
9. Tyagi, B.K. 2003, Medical Entomology: A Hand book of medically Important Insects & other arthropods Scientific Publisher 262 pp
10. Eldridge, F.B. & Edman, J.D. 2003. Medical Entomology: A textbook on Public Health and Veterinary problems caused by Arthropods. Kluwer Academic Publishers 672 pp

## **ENT-712 ACAROLOGY 3(2-1)**

### **LEARNING OUTCOMES:**

To provide knowledge of the importance of mites and their impacts on crops, vegetables, fruits and stored products.

### **THEORY:**

Introduction; methods of collection, rearing and preservation of different mites and other related organisms; external and internal morphology; physiology, reproduction and development; classification of mites, mites as pests of important crops, vegetables, fruit trees, stored products

and their management; parasitic and predatory mites; losses caused by and management of mite pests; ecology and dispersal; methods of estimation of mite population; mites and plant diseases; resistance mechanism in mites.

### **PRACTICAL:**

Collection, preservation, sampling and rearing techniques and identification of phytophagous, predatory, parasitic and stored grain mites; preparation of permanent slides of mites; estimation of mite population and losses in crops, vegetables, fruit plants and stored grains.

### **RECOMMENDED BOOKS:**

1. Chhillar, B.S. and Gulati, R. 2007. Agricultural Acarology. Daya Publishing House.
2. Evans, G.O. 1992. Principles of Acarology. C.A.B. International Cambridge University Press, Cambridge.
3. Helle, W. and Sabelis, M.W. (Edit.), 1985. Spider Mites, Their Biology, Natural Enemies and Control. Vols. IA. and IB. Elsevier Oxford, U. K.
4. Khuhro, R.D. 1998. Introduction to Acarology. Kashif Publications, Hyderabad (Sindh), Pakistan.
5. Krantz, G.W. 1978. A Manual of Acarology. 2<sup>nd</sup> Ed. Oregon State Univ. Book Store Inc., Corvallis, Oregon, USA.
6. Krantz, G.W. and Walter, D.E. 2009. A Manual of Acarology. Texas Tech. University Press.
7. Rodriguez, J.G. (Edit.), 1979. Recent Advances in Acarology. Vol. I & II. Academic. Press Inc., N.Y.
8. Schuster, R. and Murphey, P.W. 1991. The Acari, Reproduction, Development and Life History Strategies. Chapman & Hall, USA.
9. Woolley, T.A. 1988-01. Acarology, Mites and Human Welfare. JohnWiley & Sons.
10. Zhang, Z.Q. 2003. Mites of Green Houses: Identification Biology and Control. Elsevier, New York.
11. Sabelis, M. W. 2010. Trends in Acarology: Proceedings of the 12th International Congress. Springer Dordrecht Heidelberg London, UK.

## **ENT-713 CLASSIFICATION OF IMMATURE INSECTS 3(2-1)**

### **LEARNING OUTCOMES:**

To impart knowledge about important structure of eggs and immature stages of insects of different orders.

### **THEORY:**

Introduction; eggs and immature stages of insects; types of eggs and chaetotaxi of various immature stages for their identification purposes; development of keys for identification of eggs and immature stages of



economically important orders up to family level, classification and phylogeny of various insect groups through their eggs and immature stages.

### **PRACTICAL:**

Collection, preservation, preparation and identification of immature stages up to family level; study of chaetotaxi; use of keys for identification of eggs, larvae and immature stages and construction of cladograms by using the above characters.

### **RECOMMENDED BOOKS:**

1. Chu, H.F. 1983. How to know the Immature Insects. W.M.C. Brown Co., Publishers, Iowa, USA.
2. Johnson, F.N. and Triplehorn, A.C. 2004. Introduction to The Study of Insects. 7<sup>th</sup> Ed. Books Cole.
3. Lawrence, J.F. Hastings, A.M. Dallintz, M.J. Palmy, T.A. and Zurcher, E.J. 1999. Beetle larvae of the world. CSIRO. Australia.
4. Peterson, A.R. 1960. Larvae of Insects. Part-II, 4<sup>th</sup> Ed. Edwards Brothers Inc., Arbor, Michigan.
5. Peterson, A.R. 1962. Larvae of Insects. Part-I, 4<sup>th</sup> Ed. Edwards Brothers Inc., Arbor, Michigan.
6. Stehr, F. 1991. Immature Insects. Vol. I&II. Kendall - Hunt Publishing, U.S.A.

## **ENT-714                      INSECTICIDE TOXICOLOGY    3(2-1)**

### **LEARNING OUTCOMES:**

To impart knowledge about toxicity of important groups of insecticides in insects and higher animals with reference to their biochemical and genetic basis of mechanism of action.

### **THEORY:**

Introduction; general concepts of insecticide toxicology; theory and principles of bioassay; chemistry and comparative toxicology of some common insecticides; mechanism of action of major groups of insecticides; mammalian and phytotoxicity of insecticides; enzyme activation and inhibition by insecticides at various levels; detoxification mechanisms; joint action of insecticides, (synergism and antagonism); handling and standardization of insects in insecticide tests; methods for testing of formulations of different groups of insecticides under field and laboratory conditions.

### **PRACTICAL:**

Laboratory equipment used in toxicology experiments; gross symptoms produced by representative insecticide groups; relationship between dosages and responses; use of time-mortality determination in comparing the relative

toxicity of insecticides; preparation of spectral transmittance and concentration transmittance curves; bioassay of insecticides.

### **RECOMMENDED BOOKS:**

1. Gupta, H.C.L. 2001. Insecticides: Toxicology and Uses. Agrotech Publishing Academy, Udaipur.
2. Hassal, K.A. 1990. The Biochemistry and Uses of Pesticides: Structure, Metabolism, Mode of Action and Uses in Crop Protection. ELBS/Macmillan, U.K.
3. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi, Madras, Bombay, Calcutta, London.
4. Robert. I. and Krieger, W.C. 2001. Handbook of Pesticide Toxicology. 2<sup>nd</sup> Ed. Elsevier Inc.
5. Saleem, M.A.2004. Principles of Insect Toxicology. Izhar sons Printers, Lahore.
6. Sree Ramulu, U.S. 1995. Chemistry of Insecticides and Fungicides. (2<sup>nd</sup> Ed.) Oxford & IBH Publishing Co. Pvt. New Delhi, Bombay, Calcutta.
7. Srivastava, R.P. 1989. A Text Book of Insect Toxicology. Himanshuw Publication.
8. Wilkinson, C.F. 1976. Insecticides Biochemistry and Physiology. Heyden, London, New York, Rheine.
9. Yu, S.J. 2008. The Toxicology and Biochemistry of Insecticides. University of Florida, USA.
10. Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida.

## **ENT-715 INSECT NUTRITION**

**3(2-1)**

### **LEARNING OUTCOMES:**

To impart knowledge on insect synthetic diets for promotion of their natural growth and development.

### **THEORY:**

Introduction; dietary requirements of insects; micro and macro nutrients with their role in insects diet; determination of AD (approximate digestibility), ECI (efficiency of conversion of ingested food in bio mass), ECD (efficiency of conversion of digested food in to bio mass), RCR (relative consumption rate), RGR (relative growth rate), artificial diets for insects rearing; micro-organisms and insect nutrition, co-efficient of digestion, growth and development, metabolism; nutrition and host specificity; phago-stimulation, tritrophic interaction between insect and predator/parasitoids.

## **PRACTICAL:**

Preparation of synthetic diets for different groups of insects; rearing of insects on synthetic, semi-synthetic and natural diets; determination of co-efficient of utilization.

## **RECOMMENDED BOOKS:**

1. Cohen, A.C. 2004. Insect Diets: Science and Technology. CRC Press.
2. Gilmour, D. 1965. The Metabolism of Insects. Oliver and Boyed. Edinburgh and London.
3. Rodrigues, J. G. 1972. Insects and Mite Nutrition. Significance and Implications in Ecology and Pest Management. North Holland Publ. Co., Amsterdam, London.
4. Singh, P. 1977. Artificial Diets for Insects, Mites and Spiders. Plenum Publ. Corporation, N.Y.
5. Fraenkel, G. S. 1947. Bibliography on Insect Nutrition. Cornell University Press, USA
6. Rodriguez, J. G. 1973. Insect and mite nutrition: significance and implications in ecology and pest management, North-Holland Pub. Co.
7. Simpson, S. J. Mordue, A.J. and Hardie, J. 1999. Insect-Plant Relationships, Springer.
8. Taylor, S. 2005. Advances in Food and Nutrition Research, Elsevier Science.
9. Chapman, R.F. 1998. Insects: Structure and Function. 4<sup>th</sup> Ed. American Elsvier. Publ. Co. Inc., New York

## **ENT-716 INSECTICIDES AND PUBLIC HEALTH 3(2-1)**

### **LEARNING OUTCOMES:**

To provide advance concepts of insecticide poisoning, residual effects and their perception on safe use of insecticides.

### **THEORY:**

Insecticides poisoning and its importance to public health; toxic effects of insecticides on indoor inhabitants, farmers, field workers and their domesticated animals; distribution of pesticide residues in soil, ground water, drinking wells and air; symptoms of poisoning due to insecticide residues in blood, fat bodies and the acute diseases they cause; public health and environmental consideration; farmers perception of acute poisoning and safe measures; first aid procedures; laboratory verification; treatment of insecticide poisoning; insecticides monitoring; safe use of insecticides; knowledge of antidotes; transport, storage and disposal of insecticides; insecticide labeling.

## **PRACTICAL:**

Determination of pesticide residues in soil, water, vegetables fruits, milk, cereals, human blood, fat bodies and vital organs; Survey for finding farmers/public perception about pesticide poisoning.

## **RECOMMENDED BOOKS:**

1. Dhaliwal, G.S. and Singh B. 2000. Pesticides and Environment. Commonwealth Publishers. New Delhi. India.
2. Gupta, H.C.L. 2001, Insecticides: Toxicology and Uses. Agrotech Publishing Academy, Udaipur
3. Oudejans J.H.1991. Agropesticides and Functions in Integrated Crop Protection. ESCAP. United Nations. Bangkok, Thailand.
4. Ashfaq, M. and Saleem. M.A. 2010. Environmental Pollution and Agriculture. Pak Book Empire, Lahore, Pakistan.

## **ENT-717    ADVANCES IN BIOLOGICAL CONTROL OF INSECT 3(2-1)**

### **LEARNING OUTCOMES:**

To provide latest concepts of the principles of biological control, rearing, screening, introduction, augmentation and conservation of natural enemies, super, multi and hyper parasitism and their problems in biological control.

### **THEORY:**

Introduction; history, development and scope of biological control with special reference to Pakistan; ecological basis of biological control; biological characteristics of natural enemies (predators, parasitoids, microorganism); scope and problems in introduction, rearing, release, augmentation, conservation and establishment of natural enemies; estimating parasitism levels, host-parasitoid and host-predator interaction; numerical and functional response, strategies for rearing high quality of insect bio-control agents integration of chemical and biological control; problems of super, multi and hyper-parasitism and predators; effect of pesticides on natural enemies, effect of natural enemies on non-target organism, Steps in commercialization. Case studies of biological control insect pests, future opportunities and challenges of biological control,

### **PRACTICAL:**

Survey and collection of natural enemies, identification, rearing of parasitoids, predators and micro-organisms of economic importance; study of extent of parasitism / predation of different biocontrol agents, parasitism estimates by host dissection, host-rearing.. Methods for supplying insects and methods of release in the field. Visit to bio-control labs.

## **RECOMMENDED BOOKS:**

1. Gunasekaran, M. and Weber, D. 1996. Molecular Biology of the Biological Control of Pests and Diseases of Plants. ESA Publications, U.S.A.
2. Gunaskaran, M. 1995. Molecular Biology of Biological Control of Pests and Diseases. Fisk University.
3. Hajek, A. 2004. Natural Enemies: An Introduction to Biological Control. Cambridge University Press.
4. Irshad, M. 2008. Biological Control of Insects and Weeds in Pakistan. HEC Islamabad.
5. Lentern, J.C.V. 2003. Quality Control and Production of Biocontrol Agents. Theory and testing procedures.
6. Maramorosch, K. 1991. Biotechnology for Biological Control of Pests and Vectors. CRC Press, U.S.A.
7. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6<sup>th</sup> Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
8. Rechcigl, J.E. Rechcigl, N.A. 1998. Biological and Biotechnological Control of Insects Pests. CRC Press.
9. Upadhyay, R. K. 2003 Advances in Microbial Control of Insect Pests. Kluwer Academic / Plenum Publishers. New York USA

## **ENT-718    ADVANCES IN INSECT BEHAVIOUR**

**3(2-1)**

### **LEARNING OUTCOMES:**

To provide advance knowledge of different patterns of insect behaviour,

### **THEORY:**

Introduction; sensory receptors (mechanoreception, hygromoreception, thermoreception and photoreception); nervous system and behaviour; hormones and behaviour; displacement (causes of migration, classes of migration, adaptive nature of migration); communication (bio-luminescence chemical, acoustic, visual and tactile), circadian rhythms in insects, orientation, navigation and homing; sexual behaviour and reproduction; host selection and feeding behaviour; defense (behavioral, structural, coloration defenses); population behaviour; solitary and social behaviour;

### **PRACTICAL:**

Survey and communication behaviour, migration and its types, host selection, hormones and their role in behaviour, pheromones and their role in tactile behaviour, reproductive behaviour.

## **RECOMMENDED BOOKS:**

1. Dentinger, D.L. Giebultowicz, J. and Sanders, D.S. 2001. Insect Timing: Circadian Rhythmicity to Season Availability. Elsevier.
2. Febre, J.H. 1993. Insect Behaviour. Discovery Publishing House.
3. Fellows, M. and Holloway, G. 2005. Insect Evolutionary Behavior. CABI
4. Greenfield M.D. 2002. Signals and Receivers: Mechanism and Evolution of Arthropod Communication. Oxford University Press.
5. Parihar, R. 2001. Reproductive Behaviour and Biology of Sex. Dominant Publishers and Distributors, Delhi.
6. Prakash, M. 2008. (Encyclopedia of Entomology II) Insect Behaviour. Discovery Publishing House, PVT. LTD. Darya Ganj, New Delhi.
7. Research Journals: Journal of Insect Behavior.
8. Ryan, M.F. 2002. Insect Chemoreception Fundamental and Applied. Kluwer.
9. Vijay, K. 2008. Insect Behaviour. Vista International Publication House.

**ENT-719                      SPECIAL PROBLEMS                      1(1-0)**

**ENT-720                      SEMINAR                      1(1-0)**

## **ENT-721 PESTICIDES APPLICATION EQUIPMENT 3(1-2)**

### **LEARNING OUTCOMES:**

To provide latest knowledge of pesticides application equipments with special reference to recent trends in agriculture.

### **THEORY:**

Introduction; history and scope of development of pesticides application equipment; different systems of application of pesticides; dusting equipment: maintenance and operation of hand dusters, bellow type dusters, rotary hand and power dusters; various types of sprayers; components of a spray machine, maintenance and operation of compression and pump systems, granular applicators; comparative study of ground and aerial application equipments; calibration methods and measurement of droplet size; fog and smoke generators.

### **PRACTICAL:**

Study of different parts, assembling and maintenance of sprayers, dusters and granule applicators; working of different application equipment, study of different types of spray guns, lances, hoses and nozzles; aerosols and aerosol bombs; calibration and measurement of droplet size through different spraying equipments.

### **RECOMMENDED BOOKS:**

1. Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA
2. Mathews, G.A. 1992. Pesticides Application Methods. 4<sup>th</sup> Ed. Longman Inc., N.Y.
3. Matthews, G.A. and Hislop, E.C. 1993. Application Technology for Crop Protection. CAB International. Wallingford Oxon OX10 8DE, UK
4. Mathews, G.A. and Thornhill, E.W. 1995. Pesticide Application Equipments for use in Agriculture. FAO Agriculture Series Bulletin
5. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
6. Pfadt, E.R. 1985. Fundamentals of Applied Entomology. 4<sup>th</sup> Ed. The MacMillan Co., N.Y.
7. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.

**LEARNING OUTCOMES:**

To impart knowledge about the advances in pest management areas with special reference to genetically modified crops, growth regulators and genetic control of pests.

**THEORY:**

Introduction; recent advances in pest scouting, determination of economic thresholds; transgenic and genetically modified crops; organic pest management, microbes/ bio-pesticides, genetic control of insect pests; insect growth regulators; stem injection method, pheromones with reference to capillary evaporation in mating disruption technique; remote sensing of insect pests; use of radiation and radioisotopes, modules of IPM,

**PRACTICAL:**

Determination of pest status through modern scouting techniques for verification of economic threshold, problems of transgenic and genetically modified crops and their insect pests, use of insect growth regulators, stem injection methods, pheromones and mating disruption techniques, use of radiation in male sterilization techniques and their competition with normal males.

**RECOMMENDED BOOKS:**

1. Awasthi, V.B. 2007. Agricultural Insect Pests and their Control. Scientific Publishers (India) Jodhpur.
2. Dent, D. 1996. Integrated Pest Management. Chapman and Hall, London.
3. Flint, M. L. 2012. IPM in Practice: Principles and Methods of Integrated Pest Management. Univ of California Agriculture & Natural Resources; 2nd edition. Pages 292.
4. Gurr, G.M. Wratten, S.D. and Alteri, M.A. 2004. Ecological Engineering for Pest Management: Advances in Halritat Mani Publication for Arthropods. CSIRO, Australia
5. Mayer, C.D. 2004. Biotechnological Approach for the Integrated Management. Wiley Intersciences, London.
6. Maredia, K.M. Dakouo, D. and Mota-Sanclez, D. 2003. Integrated Pest Management in the Global Arena. CABI publishing UK.
7. Metcalf, P.I. 1990 - to date. Advances in Pest Control Research. Vols. I- to date. Inter-sciences Publishers, N.Y.
8. Upadhyay, R.K. Mukerji, K.G. Chawla B.P. and Dubey, O.P. 1998. Integrated Pest and Disease Management. A.P.H. Publishing Corp., New Delhi.



**LEARNING OUTCOMES:**

To impart modern knowledge in chromosomal morphology and chromosomal deficiencies in solving the problems of cytotaxonomy

**THEORY:**

Introduction; cell structure through electron microscopy; chromosomal structure, morphology, number, diversity, types and deficiencies; chromosomes and parthenogenesis; chromosomal mapping, chromosomal ecology; concept of gene; gene-determined characters; environmental effect on gene expression; sex determination in insects; mutations and variations; use of chromosomes and DNA in taxonomy.

**PRACTICAL:**

Study of a typical insect reproductive cell through phase contrast and electron microscopy, types, morphology, number and chromosomal deficiencies in important insects groups for identification / classification; study of insect resistance through gene markers and their loci; study of different types of genetic variations in insects; genetical identification of species and biotypes.

**RECOMMENDED BOOKS:**

1. Blackman, R.L. Hemitt, G.M. and Ashburner, M. 1980. Insect Cytogenetics. Black-Well Scientific Publications, Oxford, London.
2. Dnyansayer, V.R. 1992. Cytology and Genetics. Tata McGraw-Hill Publishing Co. New Delhi.
3. Hajorie, A.H. 1994. Insect Molecular Genetics. Academic Press, USA.
4. Hoy, M.A. 2003. Insect Molecular Genetics: An Introduction to Principles and Applications.
5. Hoy, M. A. 2000. Insect Transgenesis: Methods and Application. CRC Press.
6. Swanson, C.P. Merz, T. and Young, W.J. 1998. Cytogenetics. The Chromosomes in Division, Inheritance and Evolution, 3<sup>rd</sup> Ed. Prentice Hall of India Pvt. Ltd, New Delhi.

**LEARNING OUTCOMES:**

To impart knowledge in the area of insect diseases against pathogens and micro-biota.

**THEORY:**

Introduction; history, scope, types of insect pathogens; transmission, host range, persistence and virulence of insect pathogens; types of injuries and methods of infection by pathogens in insects; pathogenic diseases, their diagnosis and zoonosis; extra-cellular and intracellular micro-biota of healthy insects; resistance and immunity in insects against pathogens management of microbial diseases of useful insects; role of pathogens in IPM.

**PRACTICAL:**

Isolation, purification, culture and identification of insect pathogens from the diseased insects collected from the fields; diagnosis of different pathogenic diseases; managements of microbial diseases of useful insects; determination of extent of pathogenicity.

**RECOMMENDED BOOKS:**

1. Boucias, D.G. 1998. Principles of Insect Pathology. Chapman Hall, London.
2. Burges, H.D. and Hurrey, N.W. 1972. Microbial Control of Insects and Mites. Academic Press London.
3. Poinar, G.O. Jr. and Thomas, G.M. 1978. Diagnosis for the Identification of Insect Pathogens, Press. N.Y.
4. Tanada, Y. and Kaya, H. K. 1993. Insect Pathology. Academic Press, New York.

**LEARNING OUTCOMES:**

To impart knowledge in the area of energy metabolism, nerve impulses and biochemical changes.

**THEORY:**

Introduction; energy metabolism and production in insects; biochemistry of cuticle, muscles, flight, synaptic transmission, light production, biochromes, enzymes, hormones and kairomones; insect growth regulators and diapause; metabolism and role of carbohydrates, proteins and lipids; signaling cascades, insecticidal effect on insect metabolism; biochemical defence in insects.

## **PRACTICAL:**

Characterization of insect species, biotypes, biochemicals, pheromone extraction, its identification and control in insects; hormonal control of insect growth and development; quantitative analysis of amino acids, proteins, uric acids in haemolymph; etc.

## **RECOMMENDED BOOKS:**

1. Candy, D.J. and Kilby, B.A. 1978. Insect Biochemistry and Function. 2<sup>nd</sup> ed. Chapman and Hall London.
2. Chapman, R.F. 1998. Insects: Structure and Function. 4<sup>th</sup> Ed. American Elsevier. Publ. Co. Inc., New York.
3. Gilmour, D. 1961. The Biochemistry of Insects. Academic Press London.
- Blomquit, G. J. and Vogt, R.G. 2003. Insect pheromone biochemistry and molecular biology, Elsevier Academic.
4. Kerkut, G.A. and Gilbert, L.I. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. 1-12, Pergamon Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt
5. Morgan, E.D. 2004 Biosynthesis in insects. T.J. Intl. USA.
6. Rockstein, M. 1978. Biochemistry of Insects. Academic Press, New York, U.S.A
7. Turner, R.B. 1977. Analytical Biochemistry of Insects. Elsevier Scientific Publishing Company New York.

## **ENT-726 CHEMICAL ECOLOGY OF INSECTS 3(3-0)**

### **LEARNING OUTCOMES:**

To provide knowledge in the area of insect behavioral chemical and physical interaction, host selection and sexual communication.

### **THEORY:**

Introduction, odor dispersion in still air and wind; effect of wind speed and air temperature; chemo- orientation in walking and flying insects; insect-plant interactions; pollinators ecology,; parasitoids, host relationship, sources of parasitoid behavioral chemicals; chemical and physical interactions; warning coloration and mimicry; warning coloration and predator learning; modes of mimetic resemblance; sexual communication with pheromones and use of insect pheromones in plant protection.

### **RECOMMENDED BOOKS:**

1. Barbosa, P. and D. Letournean. 1989. Novel Aspects of Insect Plant Interactions. John Wiley & Sons . New York.
2. Bell, W.J and Carde, R.T. 1994. Chemical Ecology of insects. Chapman and Hall. London.
3. Harbone, J.A. 1998. Introduction to Ecological Biochemistry. Academic

Press. London.

4. Jutsum, A.R. and Gorgen, R.F.S. 1989. Insect Pheromones in Plant Protection. John Wiley & Sons. UK.

## **ENT-727 FORENSIC ENTOMOLOGY 3(2-1)**

### **LEARNING OUTCOMES:**

To impart knowledge about various insect groups to solve medico-legal cases and different puzzling crimes.

### **THEORY:**

History and scope of Forensic Entomology. Study of various insect groups and other arthropods related to medico-legal investigations like puzzling events of murder, suicide, and trafficking determination of time or post-mortem intervals and location of the death. Review and survey of insect life histories, life cycle and faunal succession of arthropods related to medico-legal cases and survey of the insects involved in forensic science:

Review of classification of ages in decomposition of human and animal remains, uses of insect and arthropods in investigation of death and the duration of PMI. Forensic entomology in public health, arthropods borne disease, litigation and role of forensic entomology in formulation of health policy.

### **PRACTICAL:**

Sampling, rearing, and preservation techniques in forensic entomology; Study of the decomposition of corpses and dead bodies; Survey, identification and biology of insects and arthropods of forensic importance; Study and analysis of court room proceedings regarding medico-legal cases; Data processing and preparation of project reports.

### **RECOMMENDED BOOKS:**

1. Byrd, J.H. and Costner, J.L. 2009. Forensic Entomology: The Utility of Arthropods in Legal Investigations, 2nd Edition, CRC Press, New York.
2. Catts, E.P. and Haskell N.H. 1990. Entomology and Death. A Procedural Guide. Joyce's Print Inc. Clemson, SC.
3. Goff, M. L. 2000. A fly for the prosecution: how insect evidence helps solve crimes. Harvard University Press, Cambridge.
4. Greenberg, B. and Kunich, J.C. 2002. Entomology and the Law: Flies as Forensic Indicators, Cambridge University Press, Cambridge.
5. Smith, K.G.V.1986. A Manual of Forensic Entomology, Comstock's Publishing Associates, Cornell University Press, Ithaca, N.Y.

**LEARNING OUTCOMES:**

To provides an introduction to neurobiology in insects with a focus on olfaction.

**THEORY:**

Introduction; General principles of neuroscience; structure and components of the insect nervous system, ionic basis for resting, receptive and active potentials; synaptic transmission; olfactory system circuitry, coding and plasticity, basis of Cognitive Neuroscience, phases, neural circuits, cellular and molecular mechanism/ pathways underlying learning & Memory. Concepts of molecular neurophysiology, Introduction to extracellularly, intracellularly recordings, patch clamp technique, neuron imaging. Role of Neurotransmitters, neuromodulators and neurohormones,

**PRACTICAL:**

Insects as Model Organisms in Neuroscience to understand particular features of the neuronal networks in learning and memory, Plan, perform and analyse experiments in basic neurobiology, Dissection of insect brain, Learning and memory experiments with insects. Olfactory experiments in the lab especially with honeybee and other model insects. Demonstration for different phases of learning and memory with experiments.

**RECOMMENDED BOOKS:**

1. Kandel, E.R. Schwartz, J. And Jessel T. 2000. Principles of Neural Science, 5<sup>th</sup> Edition.
2. Burrows, M. 1996. The Neurobiology of an Insect Brain. Oxford University Press.
3. Christensen, T. A. 2004. Methods in Insect Sensory Neuroscience (Frontiers in Neuroscience). CRC Press
4. Kesner, R. P. and Olton, S. D. 1990. Neurobiology of Comparative Cognition. Psychology Press.
5. Anna Menini, A. 2010. The Neurobiology of Olfaction. CRC Press.
6. Bill S. Hansson. B.S. 2010. Insect Olfaction: 1<sup>st</sup> Edition. Springer Berlin Heidelberg publisher
7. D.R. Papaj D. R. and Lewis, A.C.. 1993. Insect Learning. Ecology and Evolutionary Perspectives. Springer publishers.
8. Menzel, R. and Benjamin, P.R. 2013. Invertebrate Learning and Memory, 1<sup>st</sup> Edition. Academic Press
9. Galizia, G. Eisenhardt, D. and Giurfa, M. 2012. Honeybee Neurobiology and Behaviour. Attribute to Randolph Menzel. Springer Publishers.

**LEARNING OUTCOMES:**

To provide knowledge about insect rearing techniques for natural predators, parasites and other insects of economic importance.

**THEORY**

Introduction; basic concepts and general principles of insect rearing; feeding and reproductive biology of different insects of economic importance; Insect diets (development of diets, components of diets, diet assessment, quality control and microbiology of insect diet); Insectary environments; Packaging technology; Insect rearing management (objectives, colony establishment and maintenance). Mass rearing techniques of insects on artificial diet/natural host. Quality control in mass-rearing systems

**PRACTICAL**

Operation of standard rearing equipment (balances, volumetric equipment, pH meters, microscopes, spectrophotometers, various kinds of diet processing equipment); Diet preparation methodology; practical instructions in the rearing of different important insect on artificial diet and natural host.. Visit to different insect rearing laboratories.

**RECOMMENDED BOOKS:**

1. Cohen, A. C. 2005. Insect Diets, Science And Technology, CRC Press Boca Raton London, New York, Washington, D.C.
2. Bernays, E.A. and Chapman, R.F. 1994. Host-Plant Selection by Phytophagous Insects. Chapman & Hall, New York.
3. Brewer, F.D. and Lindig, O. 1984. Ingredients for insect diets. Quality assurance, sources, and storage and handling, in Advances and Challenges in Insect Rearing, E.G. King and N.C. Leppla, Eds. USDA, ARS, New Orleans.
4. Bartlett, A.C. 1984. Genetic changes during insect domestication, in Advances and Challenges in Insect Rearing,
5. King, E.G. and Leppla, N.C. (Eds.) 1984. Advances and Challenges in Insect Rearing. USDA, New Orleans, L.A. USA.
6. Calkins, C.O., Bloem, K. Bloem, S. and Chambers, D.L. 1994. Advances in measuring quality and assuring good field performance in mass reared fruit flies, and the Sterile Insect Technique, C.O. Calkins, W. Klassen, and P. Liedo, Eds. CRC Press, Boca Raton, FL, 85–96.

**THESIS****MSc (HONS.) THESIS****THESIS****PhD, THESIS**

## RECOMMENDATIONS

1. The revised curricula (2014) for all degree programs in Entomology is desired to be implemented across the universities of Pakistan in true letter and spirit.
2. The universities are desired to ensure the availability of qualified faculty, supporting staff, lab equipments, recommended books, and journals etc. for the efficient outcomes. In this regards, the universities may seek help from HEC for cooperation and collaboration.
3. The universities are required to ensure human resource development for the faculty and staff through national/ international trainings, refresher courses, seminars, workshops, symposiums, etc. in the relevant fields.
4. The Quality Enhancement Cell (QEC) of respective universities can play a vital role to guide the universities for the implementation of the HEC academic rules/regulations/policies in general and to ensure desired student: teacher ratio in particular.
5. Collaboration among the Faculty Members of various universities in the field of Entomology may be encouraged to share the latest research in their specialized areas. In this regard, their collaboration through MoUs is highly required.
6. The universities are required to provide trained supporting staff to the departments for their labs and fields. Thus, the advanced training/ refresher courses etc. are also recommended for them.
7. The higher education commission may play a vital role to ensure the participation of all members in NCRC meetings.

**DETAIL OF COMPULSORY COURSES  
IN ENGLISH FOR  
UNDERGRADUATE LEVEL**

**English I (Functional English)**

**Credit Hrs. 3(3-0)**

**Objectives:**

Enhance language skills and develop critical thinking.

**Course Contents**

Basics of Grammar  
Parts of speech and use of articles  
Sentence structure, active and passive voice  
Practice in unified sentence  
Analysis of phrase, clause and sentence structure  
Transitive and intransitive verbs  
Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

*Note: Extensive reading is required for vocabulary building*



## **Recommended Books:**

### **1. Functional English**

#### **a) Grammar**

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

#### **b) Writing**

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

#### **c) Reading/Comprehension**

1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

#### **d) Speaking**

## **English II (Communication Skills)**

**Credit Hrs. 3(3-0)**

### **Objectives:**

Enable the students to meet their real life communication needs.

### **Course Contents**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

## **Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

## **Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

## **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review*

## **Recommended Books:**

### **Communication Skills**

#### a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

#### b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

#### c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan
3. Study Skills by Richard Yorky.

# English III (Technical Writing and Presentation Skills)

Credit Hrs: 3(3-0)

## Objectives:

Enhance language skills and develop critical thinking

## Course Contents

### Presentation skills

### Essay writing

Descriptive, narrative, discursive, argumentative

### Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

### Technical Report writing

### Progress report writing

*Note: Extensive reading is required for vocabulary building*

## Recommended books:

### Technical Writing and Presentation Skills

#### a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

#### b) Presentation Skills

#### c) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

**ISLAMIC STUDIES  
(Compulsory)**

**Objectives:**

**Credit Hrs: 2(2-0)**

This course is aimed at:

- 1 To provide Basic information about Islamic Studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

**Detail of Courses:**

**Introduction to Quranic Studies**

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul -Quran

**Study of Selected Text of Holly Quran**

- 1) Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
- 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- 5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

**Study of Selected Text of Holly Quran**

- 1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

**Seerat of Holy Prophet (S.A.W) I**

- 1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah
- 3) Important Lessons Derived from the life of Holy Prophet in Makkah

## **Seerat of Holy Prophet (S.A.W) II**

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important Events of Life Holy Prophet in Madina
- 3) Important Lessons Derived from the life of Holy Prophet in Madina

## **Introduction to Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

## **Selected Study from Text of Hadith**

### **Introduction to Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quran & Science

### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty

- 3) Basic Institutions of Govt. in Islam

### **Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

### **Social System of Islam**

- 1) Basic Concepts of Social System of Islam
- 2) Elements of Family
- 3) Ethical Values of Islam

### **Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, 'Introduction to Islam
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

## Pakistan Studies (Compulsory)

### Introduction/Objectives

Credit Hrs: 3(3-0)

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

### Course Outline:

#### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

### Recommended books:

1. Burki, Shahid Javed. *State & Society in Pakistan*, The MacMillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.

4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.



## COMPULSORY MATHEMATICS COURSES FOR BSc (Hons) AGRICULTURE

### 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 (3-0)

#### **Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

#### **Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

#### **Recommended Books:**

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)
2. Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3(3-0)

### **Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

### **Course Outline:**

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

*Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

*Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

### **Recommended Books:**

1. Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley, New York
2. Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)
3. Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
4. Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA

### 3. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)

**Credit Hrs: 3(3-0)**

#### **Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

#### **Course Outline:**

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle:* Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections:* Parabola, ellipse, hyperbola, the general-second-degree equation

#### **Recommended Books:**

1. Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

#### **Note:**

1. ***Two courses will be selected from the above three courses of Mathematics.***
2. ***Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.***

**Statistics-I**

**Credit 3 (2-1)**

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantities and Mode in grouped and ungrouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

**PRACTICAL:**

- a. Frequency Distribution
- b. Stem-and-Leaf diagram
- c. Various types of Graphs
- d. Mean, Geometric mean Harmonic Mean,
- e. Median, Quartiles Deviation, mean Deviation.
- f. Standard Deviation, Variance, Coefficient of variation,
- g. Skewness and kenosis

**RECOMMENDED BOOKS:**

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crawshaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomes J. Keans

## Statistics-II

Credit 3 (2-1)

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Inference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using  $\chi^2$  (chi-square) Testing hypothesis about variance.

### PRACTICAL:

- a. Sampling random sampling
- b. Stratified random sampling.
- c. Sampling distribution of mean
- d. Testing of hypotheses regarding population mean
- e. Testing of hypotheses about the difference between population means
- f. Chi-square test
- g. Testing of Correlation Coefficient
- h. Fitting of simple linear regression
- i. One-way ANOVA
- j. Two-way ANOVA

### RECOMMENDED BOOKS:

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-metrial approach, 2<sup>nd</sup> Edition, 1980 by R.G.D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K.A. Gomez and A.A. Gomez

***Note: Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.***

Course Name: **Introduction to Information and Communication Technologies**

**Course Structure:** Lectures: 2 Labs: 1

**Credit Hours: 3(2-1)**

**Pre-requisite: None**

**Semestre: 1**

### **Course Description:**

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and world wide web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

### **Course Contents:**

- : Basic Definitions & Concepts
- : Hardware: Computer Systems & Components
- : Storage Devices, Number Systems
- : Software: Operating Systems, Programming and Application Software
- : Introduction to Programming, Databases and Information Systems
- : Networks
- : Data Communication
- : The Internet, Browsers and Search Engines
- : The Internet: Email, Collaborative Computing and Social Networking
- : The Internet: E-Commerce
- : IT Security and other issues
- : Project Week

: Review Week

### **Text Books/Reference Books:**

Introduction to Computers by Peter Norton, 6th International Edition  
(McGraw HILL)

Using Information Technology: A Practical Introduction to Computer &  
Communications by Williams Sawyer, 6th Edition (McGraw HILL)

Computers, Communications & information: A user's introduction by Sarah  
E. Hutchinson, Stacey C. Swayer

Fundamentals of Information Technology by Alexis Leon, Mathewsleon Leon  
Press.

## **Functional Biology-I**

*Credit Hours 3(3-0)*

### **Biological Methods**

Principles of Cellular Life

Chemical Basis

Structure and Function

Principles of Metabolism

Energy Acquisition

### **Principles of Inheritance**

Mitosis and Meiosis

Chromosomes

Observable Inheritance Patterns

DNA Structure and Function

RNA and Proteins

Genes

Genetic Engineering and Biotechnology

### **Biodiversity**

Fundamental Concept of Biodiversity

One or two examples of each of the following from commonly found  
organism

Prions

Viruses

Bacteria

Protistans

Algae

Fungi

Plants

Crops

Animals

Invertebrates

Vertebrates

***Reading***

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.



# Functional Biology-II

**Credit Hours 3(3-0)**

## **Myths and Realities of Evolution**

Microevolution

Speciation

Macroevolution

## **Level of Organization**

### **Plants**

Tissues

Nutrition and Transport

Reproduction

Growth and Development

### **Animals**

Tissue, Organ System and Homeostasis

Information Flow and Neuron

Nervous System

Circulation and Immunity

Nutrition and Respiration

Reproduction and Development

### **Ecology and Behavior**

Ecosystems

Biosphere

Social Interactions

Community Interactions

Human Impact on Biosphere

Environment Conservation

## **Reading**

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.

2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

*Note: Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*