CURRICULUM
OF
ENTOMOLOGY

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

(Revised 2014)

HIGHER EDUCATION COMMISSION
ISLAMABAD
# CONTENTS

1. Introduction 6

2. Scheme of Studies for BSc (Hons) 10
   - Detail of Courses 11

3. Scheme of Studies (5th to 8th Semester) 14
   - Detail of Courses 16

4. Curriculum for MSc (Hons) and PhD 35
   - Detail of Courses 37

5. Recommendations 63

6. Details of Compulsory Courses 65
   - Annexures – A, B, C, D, E

Annexures – A, B, C, D, E
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).

(Fida Hussain)
Director General (Academics)
CURRICULUM DEVELOPMENT PROCESS

STAGE-I

STAGE-II

STAGE-III

STAGE-IV

CURRI. UNDER CONSIDERATION

CURRI. IN DRAFT STAGE

FINAL STAGE

FOLLOW UP STUDY

COLLECTION OF REC

APPRAISAL OF 1ST DRAFT BY EXP. OF COL./UNIV

PREP. OF FINAL CURRI.

QUESTIONNAIRE

CONS. OF CRC.

FINALIZATION OF DRAFT BY CRC

INCORPORATION OF REC. OF V.C.C.

COMMENTS

PREP. OF DRAFT BY CRC

APPROVAL OF CURRI. BY V.C.C.

PRINTING OF CURRI.

REVIEW

IMPLE. OF CURRI.

BACK TO STAGE-I

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations

ORIENTATION COURSES
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, Convener/
Chairman,
Department of Entomology,
The University of Agriculture, Peshawar.

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

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

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

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

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

Prof. Dr. Muhammad Faheem Malik, Member
Dean / Director
Faculty of Science,
University of Gujrat
Prof. Dr. Muhammad Naeem,  
Chairman,  
Department of Entomology,  
PMAS, Arid Agriculture University,  
Rawalpindi.  

Dr. Ehsan ul Haq,  
Principal Scientific Officer/Associate Professor,  
Department of Plant & Environmental Protection,  
Park Road, Islamabad.  
National Agricultural Research Centre (NARC).  

Dr. Abdul Ghani Lanjar,  
Associate Professor,  
Faculty of Crop Protection,  
Department of Entomology,  
Sindh Agriculture University, Tandojam.  

Dr. Muhammad Waqar Hassan,  
Assistant Professor,  
Department of Entomology,  
University College of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, Bahawalpur.  

Dr. Sumaira Afsheen,  
Assistant Professor,  
Department of Entomology, Hafiz Hayat Campus, Gujrat University of Gujrat.  

Dr. Abdul Manan Shaikh,  
Assistant Professor,  
Department of Zoology,  
Shah Abdul Latif University, Khairpur Mirs.  

Dr. Syed Basit Rasheed,  
Assistant Professor,  
Department of Zoology,  
University of Peshawar, Peshawar.  

Dr. M. Anjum Aqeel,  
Assistant Professor,  
Department of Entomology,  
University College of Agriculture,  
University of Sargodha, Sargodha.
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.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credit Hours</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+2+3+4</td>
<td>18+18+18+18</td>
<td>72</td>
</tr>
<tr>
<td>5+6+7+8</td>
<td>15+16+16+13</td>
<td>60</td>
</tr>
<tr>
<td>Total=</td>
<td>132 Credit Hours</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Credits</th>
<th>Mathematics / Biology</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistics 1 &amp; 2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Computer / IT</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Pakistan Studies</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Islamiat</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Communications Skills</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Basic Agriculture</td>
<td>3</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

One subject from each of the following disciplines

<table>
<thead>
<tr>
<th>Credits</th>
<th>Agronomy</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant Breeding &amp; Genetics</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Entomology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Plant Pathology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Food Technology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Horticulture</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Soil Sciences</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Agriculture Economics</td>
<td>3</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

Additional courses from disciplines mentioned below and above

<table>
<thead>
<tr>
<th>Credits</th>
<th>Applied Entomology (Compulsory)</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture Extension</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Forestry &amp; Range Management</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Animal Science</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Marketing &amp; Agri Business</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Agriculture Engineering</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Rural Development</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Water Management</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Any other course</td>
<td>3</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

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:
Introduction to the study of Insects. Brooks Cole. 7th Ed.


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:

B. SPECIALIZATION IN ENTOMOLOGY

The Committee has proposed the following "TITLES" with credit hours for specialization in Entomology during 3rd 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
### 5TH TO 8TH SEMESTER

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

### 6TH SEMESTER

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

### 7TH SEMESTER

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Cr. Hr.</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENT-601</td>
<td>Integrated Pest Management</td>
<td>4(3-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-603</td>
<td>Plant Resistance to Insect Pests</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-605</td>
<td>Insecticides and their Application</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-607</td>
<td>Range and Forest Entomology</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-609</td>
<td>Agriculture and Environmental Pollution</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td><strong>Sub Total</strong></td>
<td></td>
<td><strong>16</strong></td>
<td></td>
</tr>
<tr>
<td>Course No.</td>
<td>Title</td>
<td>Cr. Hr.</td>
<td>Status</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>ENT-602</td>
<td>Scientific Writing and Presentation</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-604</td>
<td>Apiculture</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-606</td>
<td>Biological Control of Insect Pests</td>
<td>3(2-1)</td>
<td>M</td>
</tr>
<tr>
<td>ENT-608</td>
<td>Internship / Research Project</td>
<td>4(0-4)</td>
<td>M</td>
</tr>
<tr>
<td>Sub Total</td>
<td></td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

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

5TH 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:

PRINCIPLES OF INSECT TAXONOMY

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; phentoics, 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:

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:


ENT-507 INSECT PESTS OF HOUSEHOLD, MAN AND ANIMALS

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:


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, behaviour, Auditory behaviour and social behaviour in lab or in field conditions

RECOMMENDED BOOKS:

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:
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 up to family level, methods of studying biodiversity,

RECOMMENDED BOOKS:
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:
ENT-508 STORED PRODUCT PESTS AND THEIR 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:

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:

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:

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:

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:

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:

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:

31

8th 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:
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:

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:

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.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course No.</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>1.</td>
<td>ENT-701</td>
<td>Research Methods in Entomology</td>
<td>3(2-1)</td>
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<tr>
<td>2.</td>
<td>ENT-702</td>
<td>Origin and Phylogeny of Insects</td>
<td>3(3-0)</td>
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<tr>
<td>3.</td>
<td>ENT-703</td>
<td>Environmental Entomology</td>
<td>2(2-0)</td>
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<td>4.</td>
<td>ENT-704</td>
<td>Advanced Insect Morphology</td>
<td>3(2-1)</td>
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<td>5.</td>
<td>ENT-705</td>
<td>Advanced Insect Ecology</td>
<td>3(2-1)</td>
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<tr>
<td>6.</td>
<td>ENT-706</td>
<td>Numerical Taxonomy</td>
<td>3(2-1)</td>
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<td>7.</td>
<td>ENT-707</td>
<td>Advanced Insect Physiology and Embryology</td>
<td>3(2-1)</td>
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<td>8.</td>
<td>ENT-708</td>
<td>Molecular Entomology</td>
<td>3(2-1)</td>
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<td>9.</td>
<td>ENT-709</td>
<td>Insecticide Resistance and Management</td>
<td>3(2-1)</td>
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<td>10.</td>
<td>ENT-710</td>
<td>Insects in Relation to Plant Diseases</td>
<td>3(2-1)</td>
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<td>ENT-711</td>
<td>Medical and Veterinary Entomology</td>
<td>3(2-1)</td>
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<td>ENT-712</td>
<td>Acarology</td>
<td>3(2-1)</td>
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<td>ENT-713</td>
<td>Classification of Immature Insects</td>
<td>3(2-1)</td>
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<td>ENT-714</td>
<td>Insecticide Toxicology</td>
<td>3(2-1)</td>
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<td>ENT-715</td>
<td>Insect Nutrition</td>
<td>3(2-1)</td>
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<td>ENT-716</td>
<td>Insecticides and Public Health</td>
<td>3(2-1)</td>
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<tr>
<td>ENT-717</td>
<td>Advances in Biological Control of Insect Pests</td>
<td>3(2-1)</td>
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<td>ENT-718</td>
<td>Advances in Insect Behaviour</td>
<td>3(2-1)</td>
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<td>ENT-719</td>
<td>Special Problem</td>
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<td>ENT-720</td>
<td>Seminar</td>
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<tr>
<td>ENT-721</td>
<td>Pesticides Application Equipments</td>
<td>3(1-2)</td>
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<tr>
<td>ENT-722</td>
<td>Advances in Pest Management Research</td>
<td>3(2-1)</td>
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<td>ENT-723</td>
<td>Insect Cytogenetics and Cytotaxonomy</td>
<td>3(2-1)</td>
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<td>ENT-724</td>
<td>Insect Pathology</td>
<td>3(2-1)</td>
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<td>ENT-725</td>
<td>Insect Biochemistry</td>
<td>3(2-1)</td>
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<tr>
<td>ENT-726</td>
<td>Chemical Ecology of insects</td>
<td>3(3-0)</td>
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<tr>
<td>ENT-727</td>
<td>Forensic Entomology</td>
<td>3(2-1)</td>
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<td>ENT-728</td>
<td>Insect Neurobiology</td>
<td>3(2-1)</td>
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<tr>
<td>ENT-729</td>
<td>Insect Rearing Techniques</td>
<td>3(2-1)</td>
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<td>Thesis</td>
<td>MSc (Hons.) thesis</td>
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<td>Thesis</td>
<td>PhD, thesis</td>
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**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:

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:

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:

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:

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:

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/phylogenogram.

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:

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:

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 electrophoris, gene cloning and plasmid DNA extractions, DNA hybridization (Southern and northern blots); RAPD, RFLP analysis techniques, use of Bioinformatics software tools.
RECOMMENDED BOOKS:

ENT-709 INSECTICIDE RESISTANCE AND MANAGEMENT

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:
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:

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:**
9. Tyagi, B.K. 2003, Medical Entomology: A Hand book of medically Important Insects & other arthropods Scientific Publisher 262 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:

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 chaetotaxy; use of keys for identification of eggs, larvae and immature stages and construction of cladograms by using the above characters.

**RECOMMENDED BOOKS:**

**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:

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:

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:

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:

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, hygroreception, thermo-reception 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:

ENT-719 SPECIAL PROBLEMS 1(1-0)

ENT-720 SEMINAR 1(1-0)
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:

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:
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:
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:


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 kairomonoes; insect growth regulators and diapause; metabolism and role of carbohydrates, proteins and lipids; signling casdes, insecticidal effect on insect metabolism; biochemical defence in insects.
PRACTICAL:
Characteization 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:

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:
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:
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:

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:


THESIS MSc (HONS.) THESIS

THESIS PhD, THESIS
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.
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

Nota: Extensive reading is required for vocabulary building
Recommended Books:

1. **Functional English**
   a) Grammar
   b) Writing
   c) Reading/Comprehension
   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

b) Writing

c) Reading
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard Yorky.
English III (Technical Writing and Presentation Skills)

Credit Hrs: 3(0-0)

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


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 Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).
Annexure - B

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 Holy 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 Holy 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, “  
6) Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)  
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**
   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:

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:
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:
4. Thomas GB, Finney AR, Calculus (11th 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:**

**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

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 kurtosis

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
4. Basic Statistics an Inferential Approach 2nd Ed. (1986) Fran II. Dietrich-II and Thomas J. Kean
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. Interference 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 X² (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

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

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

**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**
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**


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