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UNIVERSITY OF MUMBAI



Program: M.Sc.

Course: Zoology **(Entomology)**

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

**M.Sc. Part II (Semester III and Semester IV): Zoology (Entomology) Syllabus
Committee Members**

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CONTENTS

1. Preface
2. Preamble
3. Pedagogy
4. Tables of Courses, Topics, Credits and Workload
5. Theory Syllabus for Semester III
(Course codes: PSZOENT301- PSZOENT304)
6. Practical Syllabus for Semester III
(Course codes: PSZOENT3P1- PSZOENT3P4)
7. References
(Course codes: PSZOENT301- PSZOENT304)
8. Theory Syllabus for Semester IV
(Course codes: PSZOENT401- PSZOENT404)
9. Practical Syllabus for Semester IV
(Course codes: PSZOENT4P1- PSZOENT4P4)
10. References
(Course codes: PSZOENT401- PSZOENT404)
11. Marking Scheme of Examination (Theory and Practical)
12. Skeleton Papers: Semester III and Semester IV

PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Study in Zoology aims to impart holistic understanding of Zoology by “redefining Zoology” to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

The course **PSZOENT301 'Taxonomy, Phylogeny and Diversity of Insects'** introduces the learner to the fascinating world of insect classification. The learner will get oriented to topics such as extinct insects, basics of insect taxonomy and useful keys. Photographic documentation during field visits and observations of museum collections will be helpful to generate interest in taxonomy. The practical course will equip the learner to designate the observed insect to its respective order and family and also understand the basic morphology of head, thorax, abdomen and the related appendages in some commonly occurring insects. It will also give an opportunity to prepare dichotomous keys for understanding classification of insects. Field visits to forests, agricultural systems, gardens, aquatic ecosystems and household areas will enable the learner to understand insect diversity and classify them using the characteristics of respective orders and families. The learners can also visit place that have taxonomic databases available for classification studies. Activities like butterfly walks can be conducted to generate interest in taxonomy. Web-based field guide can be developed to classify the insects recorded during field visits. The information about simple mobile based apps can be shared to increase motivation. This course will also allow the learner to understand basic morphology of head, thorax, abdomen and the related appendages in some commonly occurring insects.

The course **PSZOENT302 'Insect Anatomy and Physiology'** will help develop a strong foundation in Entomology, including understanding of the importance of insects' anatomy and physiology. This course will assist in understanding of the anatomical and physiological similarities and differences in various systems of insects like digestive, respiratory, reproductive, nervous, etc. Learners will get familiar with external and internal features of insects. The course will help in understanding moulting and sclerotization process, and integument formation in insects. Practical aspects of this course could be undertaken through observation of various system found in locally available insects in laboratory level, observation of life cycle of various insects that can be cultured in the laboratory as per the ethical permission granted or teachers are expected to show the video clips, photographs for the understanding of the topics.

The course **PSZOENT303** It is crucial time to explore scientifically the useful insects like lac insects, silk moths and honey bees in our country. Student community shall be given enough academic support to get indulged in bio-industries viz, lac-culture, sericulture and apiculture. Although, we are recognized as one of the leading nation in lac export, we have not generalized its natural products up to the high level. It may be due to lack of practical approach towards exploitation of these short lived insects. Credit / Choice based grading system offers wide scope to study use of renewable natural resources like lac moths and silk moths which adds to the national income. Worldwide insects as versatile living being form food in China, primary consumer or secondary consumer in ecosystems, major pollinators in agriculture, sericulture and horticulture. As an interdisciplinary trend, flesh flies life cycles enable us to investigate the time of death of an individual. So, forensic science also depends on such insects.

The course **PSZOENT304** Biological vectors like, *Glossina*, *Phlebotomus*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla*, *Periplaneta*, *Musca* species are well elaborated with reference to avoid transmission of dreadful diseases, the learners are expected to familiarize with this. The nature of damaged caused by stored grain and agricultural insect pests shall be main concerned of teaching which would probably be useful to take serious preventive and curative action against pests. Usually, insect-pests and bio-vectors population should be checked by employing Integrated Pest Management (IPM). Pest control agencies should be strictly warned not to use chlorinated carbon compounds to stop bio-magnifications and avoid subsequent ill effects on member of other trophic levels in the food chain. Lastly it is advisable to search for government and non-government funding agencies viz, DIC, NABARD, Nationalized Banks which offers subsidized loans for agriculture supporting projects. To understand, commercialization of bio-industrial projects, feasibility report shall be well understood. Students could be trained practically

to establish 'butterfly garden' in metropolitan cities.

The **course PSZOENT401** introduces the learners to classification, habit, life history, damage and control of insect pests of agriculture, and related to medical and veterinary importance. Interaction with local farmers and visit to agricultural areas will give better understanding of the life cycle of such agricultural pests and the control measures. Visit to cattle farm, horse stables and veterinary clinics and hospitals will be helpful to understand the damage caused and the treatment followed. The practical course will include the study of damage causing stages of these pests using suitable specimen or photographs. The practical course includes equip the learner to identify the economically important pests from household, agriculture, forest, medical and veterinary field. The damage causing stages of these pests can be studied from suitable specimen or photographs.

The **course PSZOENT402** has developed a strong foundation in entomology, including understanding of the importance of insects to human society. The learners expected to familiarize with identification of insect pests, vectors and their control methods. This course also provides sufficient background for those students who wish to study more advanced entomological aspects. In unit 1 learner will be able to understand the various forest pests with respect to life cycle, nature of damage and control measures. Unit 2, Forensic Entomology, learner will be able to understand the role of insects in crime investigation. In unit 3 and Unit 4 included basic principle of insect pest control such as chemical, biological and its application and limitations. The knowledge of these topics will set up ideal base for learners to move in to field of applied entomology for their interest. Teacher should arrange a visit to nearby Forest area, Forensic lab, Insect Museum, BNHS or ZSI etc. so that learners expected to understand the theoretical approach in much better way.

The course **PSZOENT403** deals with new avenues of subject Entomology of modern time in present scenario. Objective this course is to make the students in the entrepreneur approach. Today's time the insects are used as Medicine, Ornamental Entomology creates interest to visualize insects in attractive ways. In the light of insect weapon, learners will be familiarized with this new avenue. Biotechnology aspects, insect genomic an insect proteomic are advanced fields where the insects are studied in molecular level. Learners are expected to know this field, too. Computer based tool are also new avenue thereby learners are exposed on the light of Bioinformatics with reference to insect world.

The **course PSZOENT404** consists of Instrumentations and Presentation of Scientific data which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Convener and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Entomology: Semester III						
Course Name and Code	Unit	Topic Headings	Credit	Lecture/Week	College Assessment Internal	University Assessment External
Paper I: Taxonomy, Phylogeny and Diversity of Insects						
PSZOENT301	1	Introduction, History and Classification of Insects up to Families	4	1	40	60
	2	Hemimetabola (Pterygota)		1		
	3	Holometabola - I		1		
	4	Holometabola - II		1		
Paper II: Insects Anatomy and Physiology						
PSZOENT302	1	The Integument, Digestive System and Muscles	4	1	40	60
	2	Respiration, Circulation and Excretion		1		
	3	Nervous system, Sense organs and Endocrine system		1		
	4	Reproduction		1		
Paper III: Insects Preservation, Genetics, Type study and Sericulture						
PSZOENT303	1	Insects Collection, Preservation and Culture	4	1	40	60
	2	Insect Genetics – Drosophila		1		
	3	Type animal – Butterfly		1		
	4	Industrial Entomology: Sericulture		1		
Paper IV: Insects Ecology and Economic Insects						
PSZOENT304	1	Useful Insects of Economic Importance	4	1	40	60
	2	Insects in Relation to other Organisms		1		
	3	Insect Ecology – I		1		
	4	Insect Ecology – II		1		
Total			16	16	160	240
Practicals						
PSZOENT3P1	Practicals based on PSZOENT301		2	4	–	50
PSZOENT3P2	Practicals based on PSZOENT302		2	4	–	50
PSZOENT3P3	Practicals based on PSZOENT303		2	4	–	50
PSZOENT3P4	Practicals based on PSZOENT304		2	4	–	50
Total			8	16	–	200
Grant Total			24	32	160	440

Entomology: SEMESTER IV

Course Name and Code	Unit	Topic Headings	Credit	Lecture/Week	College Assessment Internal	University Assessment External
Paper I: Agriculture, Medical and Veterinary Entomology						
PSZOENT401	1	Agricultural Entomology – I	4	1	40	60
	2	Agricultural Entomology – II		1		
	3	Medical Entomology		1		
	4	Veterinary Entomology		1		
Paper II: Forest, Forensic Entomology and Insect Toxicology						
PSZOENT402	1	Forest Entomology	4	1	40	60
	2	Forensic Entomology		1		
	3	Insect Control and Toxicology – I		1		
	4	Insect Control and Toxicology – II		1		
Paper III: Neo-Entomology, Computational Entomology and Insects Biotechnology						
PSZOENT403	1	Neo-avenues in Entomology	4	1	40	60
	2	Insect Biotechnology and Molecular Biology – I		1		
	3	Insect Biotechnology and Molecular Biology – II		1		
	4	Insect Bioinformatics		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOENT404	1	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project		2		
Total			16	16	160	240
Practicals						
PSZOENT4P1	Practicals based on PSZOENT401		2	4	–	50
PSZOENT4P2	Practicals based on PSZOENT402		2	4	–	50
PSZOENT4P3	Practicals based on PSZOENT403		2	4	–	50
PSZOENT4P4	Practicals based on PSZOENT404		2	4	–	50
Total			8	16	–	200
Grant Total			24	32	160	440

M. Sc. Part 2: Semester III (Theory)
PAPER 1: PSZOENT301
TAXONOMY, PHYLOGENY AND DIVERSITY OF INSECTS

Unit 1: Introduction, History and Classification of insects up to families (15 L)

Objective:

- *To introduce learners to the field of Entomology and the basics of Insect Classification.*

Desired outcome:

- *The learner will be able to understand the basic Taxonomic keys and its use for Classification of insects.*

- 1.1 Introduction to Entomology
- 1.2 History of Insect Classification
- 1.3 Extinct Insects
- 1.4 Taxonomic Keys of Identification
- 1.5 Classification of insects up to families: Ametabola (Apterygota) – Thysanura, Diplura, Protura, Collembola

Unit 2: Hemimetabola (Pterygota) (15 L)
(Classification of insects up to families)

Objective:

- *To familiarize learners to the classification of Hemimetabola.*

Desired outcome:

- *The learner will be able to classify the important orders of insects from Hemimetabola and understand the characteristics of important families with examples.*

- 2.1 Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea
- 2.2 Orthoptera, Phasmida, Dermaptera, Heteroptera, Hemiptera
- 2.3 Embioptera, Blattaria, Mantodea, Isoptera
- 2.4 Zoraptera, Psocoptera, Siphunculata

Unit 3: Holometabola – I (15 L)
(Classification of insects up to families)

Objective:

- *To familiarize learners to classification of insects from Holometabola.*

Desired outcome:

- *The learner will be made aware of the characteristics of some important orders of Holometabola and their important families with suitable examples.*

- 3.1 Thysanoptera, Neuroptera, Mecoptera
- 3.2 Trichoptera, Strepsiptera, Siphunculata

Unit 4: Holometabola – II

(15 L)

(Classification of insects up to families)

Objective:

- *To familiarize learners to classification of insects from Holometabola.*

Desired outcome:

- *The learner will be aware of the characteristics of four important orders of Holometabola and their important families with suitable examples.*

4.1 Diptera

4.2 Coleoptera

4.3 Lepidoptera

4.4 Hymenoptera

PAPER 2: PSZOENT302

INSECT ANATOMY AND PHYSIOLOGY

Unit 1: The Integument, Digestive System and Muscles

(15 L)

Objective:

- *To familiarize the learners with external and internal features such as digestive system of insects.*

Desired outcome:

- *The unit would allow learners to study about structure and physiology of integument, digestive system and muscle structure in insects.*

1.1 Integument

1.1.1 Structure of Integument

1.1.2 Physiology of Integument – Moulting and Sclerotization

1.1.3 Function of Integument

1.2 Digestive System

1.2.1 The Alimentary Canal and Associated Glands

1.2.2 Digestion and Absorption

1.2.3 Filter Chamber

1.3 Insect Muscles

1.3.1 Structure of Muscles

1.3.2 Muscle Physiology – Contraction and Relaxation

Unit 2: Respiration, Circulation and Excretion

(15 L)

Objective:

- *To familiarize the learners with various systems such as respiration, circulation and excretion in insects.*

Desired Outcome:

- *Learners will be able to grasp the concepts of respiratory system and its mechanism, parasitic and aquatic respiration, physiology of circulation, haemocytes, excretory system in insects, Malpighian body and osmoregulation.*

2.1 Respiratory System

2.1.1 Structure of Tracheal system

2.1.2 Types of Tracheal system

2.1.3 Mechanism of Respiration: Gaseous Exchange in Tracheal system

2.1.4 Respiration in Parasitic and Aquatic Respiration

2.2 Circulation

2.2.1 Structure of Circulatory system, Haemocoel, the dorsal vessel, Accessory Pulsatile organs

2.2.2 Haemolymph – Composition and function

2.2.3 Haemocytes – Structure and function

2.2.4 Mechanism of circulation

2.3 Excretion

2.3.1 Excretory system structure of Malpighian Tubules

2.3.2 Physiology of Excretion and Osmoregulation

Unit 3: Nervous system, Sense organs and Endocrine system

(15 L)

Objective:

- *To familiarize learners with nervous system, sense organs and endocrine system of insects.*

Desired outcome:

- *Learners would acquire knowledge of physiology of nervous system and endocrine glands and their function.*
- *Learners will gain information about insect sense organs their structure and function.*

3.1 Nervous system

3.1.1 Central Nervous system (CNS)

3.1.2 Peripheral Nervous system (PNS)

3.1.3 Autonomic Nervous system (ANS), Physiology and Neurobio-chemistry

3.2 Sense organs

3.2.1 Photoreceptor

3.2.2 Mechanoreceptor

3.2.3 Audioreceptor

3.2.4 Effectors organ- sound producing organ and light producing organ

3.3 Structure of Endocrine system

3.3.1 Endocrine system: structure, histology and function, mechanism of secretion

3.3.2 Chemical structure of Hormones, their synthesis and mode of action

3.3.3 Hormonal Regulation metamorphosis and diapauses

Unit 4: Reproduction

(15 L)

Objective:

- *To familiarize students with insect reproduction.*

Desired outcome:

- *Learners will acquire the knowledge of reproduction, development of insect, structure of larvae, pupae and adults.*

4.1 Structure of Male Reproductive system

4.2 Structure of Female Reproductive system

4.3 Physiology of reproduction

4.4 Embryonic development

4.4.1 Egg

4.4.2 Cleavage

4.4.3 Blastoderm formation

4.4.4 Gastrulation and Growth of Germ layer

4.5 Types of Larvae and Pupae

PAPER 3: PSZOENT303 INSECTS PRESERVATION, GENETICS, TYPE STUDY AND SERICULTURE

Unit 1: Insects Collection, Preservation and Culture

(15 L)

Objective:

- *To introduce branches of applied entomology and industrial entomology sericulture.*

Desired outcome:

- *It will help in learning Insects preservation techniques and also insect culture techniques.*
- *It will help in learning about versatile role of insects in Indian economy.*

1.1 Insect Collection

1.1.1 Equipment for collection of Insect

1.1.2 Insect collection kit:

- a) Killing bottles
- b) Aspirator (Suction Bottle)
- c) Suction tube (Pooter)
- d) Insect or butterfly Net
- e) Beating Tray
- f) Light Trap, Sticky trap, Water trap, Pit fall trap, Pond trap
- g) Insect setting board
- h) Cards (Triangular, Rectangular)
- i) Hand lens
- j) Pen knife or scalpel, scissors, forceps
- k) Notebook and pencil
- l) Small brushes, stoppered tubes and insect pins (Entomological pins)

1.2 Methods of Insect collection

1.2.1 Handpicking

1.2.2 Use of Insect or butterfly net

1.2.3 Sweeping

1.2.4 Beating

1.2.5 Trapping – Light traps, Sticky traps, Water traps, Pitfall traps, Bait sand bait traps

1.2.6 Pond Net

1.2.7 Insects collection from debris

1.2.8 Transferring to containers- getting the insects out of the net

1.2.9 Killing of Insects: Killing bottles, Pinching, Injecting, Hot water

1.3 Insect Preservation

1.3.1 Temporary storage

1.3.2 Permanent preservation

- a) Direct pinning
- b) Carding, Triangle carding or pointing
- c) micro pinning or staging
- d) Setting or spreading
- e) Labeling

1.3.3 Liquid Preservation technique for soft bodies Insects

1.3.4 Mounting - preparation of permanent slides

- a) Maceration
- b) Dehydration
- c) Clearing
- d) Mounting
- e) Mounting

- f) Finishing
- 1.4 Culture of Insects
 - 1.4.1 Keeping adult insects alive
 - 1.4.2 Insect Rearing
 - 1.4.3 Insect Breeding

Unit 2: Insect Genetics – *Drosophila*

(15 L)

Objective:

- *To introduce insect genetics with *Drosophila* as example to learn genetics.*

Desired outcome:

- *Learners will be able to understand insect genetics, its role in formation of new species along with closed phylogenetics relationship among insects.*

- 2.1 *Drosophila* Genetics
 - 2.1.1 Introduction to *Drosophila* Genetics
 - 2.1.2 Advantages
 - 2.1.3 Methodologies
 - 2.1.4 Balanced lethal systems
- 2.2 Polytene chromosome
 - 2.2.1 Polytenisation process
 - 2.2.2 Significance
 - 2.2.3 Features
 - 2.2.4 Puffs, regulation of puffing
 - 2.2.5 Evidences of transcriptional activity
 - 2.2.6 Induction by stress
- 2.3 Sex Determination
 - 2.3.1 Sex Determination and dosage compensation
 - 2.3.2 Chromosomal genetic and molecular aspects
 - 2.3.3 Behavioural and Neuro-Genetics
 - 2.3.4 Behavioural traits, mutants, tools & Methodologies for genetic analysis
 - 2.3.5 Genetic and molecular basis of behavioral traits in *Drosophila*
 - 2.3.6 *Drosophila* Transposons & Phenocopies

Unit 3: Type animal – Butterfly

(15 L)

Objective:

- *To study Butterfly as a model insect.*

Desired outcome:

- *Learners will understand classification and diversity of butterflies.*
- *Learners will also understand general morphological structure, anatomy, physiology, and systems of butterfly.*

- 3.1 Classification and diversity
- 3.2 Morphology
- 3.3 Digestive system
- 3.4 Circulatory system
- 3.5 Nervous system
- 3.6 Reproductive system

Objective:

- *To introduce Industrial Entomology with a special reference to sericulture industry.*

Desired outcome:

- *Learners will gain knowledge about sericulture practices like silkworm rearing, cocoon production and marketing of cocoon.*

4.1 History of Sericulture

4.2 Host plants of Mulberry and non-Mulberry Silkworm especially present in Western Ghats of Konkan Region

4.3 Life cycle of Mulberry and non-Mulberry Silkworm

4.4 Rearing of Mulberry silkworm and Tasar Silkworm

4.5 Diseases and Pests of Mulberry silkworm and Tasar silkworm

4.6 Moriculture and Marketing of sericulture products

PAPER 4: PSZOENT304

INSECT ECOLOGY AND INSECTS OF ECONOMIC IMPORTANCE

Unit 1: Useful Insects of Economic Importance

(15 L)

Objective:

- *To introduce learners to the field of Economic Entomology and its importance.*

Desired outcome:

- *Learners also gain information of lac culture, Apiculture and its importance.*
- *Learners will become oriented to nutritional role of insects.*
- *Learners will acquire the knowledge of apiculture in which they gain techniques of bee keeping extraction and marketing of honey.*

- 1.1 Types and Life history of Honey bees used in Apiculture
- 1.2 Bee Keeping Management & Prospects
- 1.3 Life History and Cropping of Lac insect
- 1.4 Lac – Utility and scope of Lac industry
- 1.5 Nutritional Entomology
 - 1.5.1 Insects as a food
 - 1.5.2 Example of Insects generally consumed
 - 1.5.3 Advantages of Eating Insects (Entomophagy) – Nutritional Value
 - 1.5.4 Entomophagy as a source of income

Unit 2: Insects in relation to other organisms

(15 L)

Objective:

- *To introduce the insect and plants association.*

Desired outcome:

- *They will also gain knowledge about insect feeding habits and role of insects in pollination.*
- *Learners will obtain the knowledge of positive and negative interaction among insects and plants as well as other animals.*

- 2.1 Insect – Plant interaction
 - 2.1.1 Types of positive and negative interaction
 - 2.1.2 Leaf eater
 - 2.1.3 Frugivory
 - 2.1.4 Bark feeders
 - 2.1.5 Galls
 - 2.1.6 Pollination
- 2.2 Insect – Animal interaction. Types of positive and negative interaction
- 2.3 Insect – Insect interaction. Types of positive and negative interaction

Unit 3: Insect Ecology – I

(15 L)

Objective:

- *To facilitate the learning of insect population ecology, its dynamics and regulatory factors important for its sustenance.*

Desired outcome:

- *This unit would allow learners to study about nature of insect population, specific factors affecting its growth and its impact on the population of other life forms.*

- 3.1 Population Ecology
 - 3.1.1 Concept of population
 - 3.1.2 Buildup of insect population,
 - 3.1.3 Population dynamics and Characteristics
 - 3.1.4 Factors affecting insect population
 - a) Abiotic factors – Photoperiod, Temperature and Humidity.
 - b) Biotic factors – Food as a limiting factor for distribution and abundance,
- 3.2 Nutritional Ecology
 - 3.2.1 Food chain, Food Web and Ecological Succession
 - 3.2.2 Interspecific interactions – Basic factors governing the interspecific Interactions
- 3.3 High altitude Ecology
- 3.4 Polymorphism in Aphids
- 3.5 Mimicry in Insects
- 3.6 Venomous Insects

Unit 4: Insect Ecology – II

(15 L)

Objective:

- *To facilitate the learning of insect behavior and factors important for its sustenance.*

Desired outcome:

- *This unit would allow learners to study about nature of insect behaviour including social, communication, migratory and reproductive.*
- *Learners will also gain the knowledge about role of insects as environmental indicator.*

- 4.1 Social life in Termites, Ants and Wasps
- 4.2 Insect Migrations
- 4.3 Communication, Instinct, Learning and Memory
- 4.4 Courtship Behaviour and Mating in Insects
- 4.5 Swarming in insects with reference to Locust
- 4.6 Insect as Indicators of Environment

M. Sc. Part 2: Semester III Practical

PRACTICAL 1: PSZOENT3P1

1. Preparation of dichotomous key for insects- at least 5 insects.
2. General classification of Insects up to families of the orders mentioned in theory: At least 2 examples, other than the pests to be studied, of each order.
3. Study of insect head and its appendages.
4. Study of types of mouth parts and antennae: Cockroach, Mosquito, House Fly, Bedbug, Butterfly (any two whichever is available).
5. Temporary Preparation of slide: Mouth parts, Legs, antennae of Cockroach/Mosquito.
6. Mounting of Tentorium (Cockroach/Mosquitoes).
7. Study of Thorax and its appendages: Cockroach, Mosquitoes, Honey bees (Any two).
8. Mounting of halteres, wings and legs: Cockroach, Mosquitoes, Honey bees and Housefly.
9. Study of abdomen and its appendages: Cockroach, Honey bees, Mosquitoes (Any two).
10. Study of types of Genitalia, Cerci, Typhanum, Pseudolegs and Sting apparatus.
11. Field visit for collection of insect.

PRACTICAL 2: PSZOENT3P2

1. Dissection of following organ system of Insects: Cockroach, Housefly, Grasshopper, Bugs, Beetles (any two)
 - a) Digestive system
 - b) Nervous system
 - c) Reproductive system
2. Study of Histology (Permanent slides) of digestive system (Midgut), Neuroendocrine system (secretory cells) and reproductive system (Testes and ovary).
3. Estimation of total proteins in Haemolymph / tissues.
4. Estimation of carbohydrates in Haemolymph / tissues.
5. Estimation of digestive enzyme by DNSA method from mid-gut (amylase / invertase / Trehalase).
6. Study of Haemocytes and their total haemocyte count.
7. Demonstration of presence of chitin by using of chitosan test.
8. Uptake of dyes by Malpighian Tubes.
9. Chromatographic analysis of amino acids in insect Haemolymph.
10. Detection of uric acid as an excretory product of terrestrial insect.

Practical 3: PSZOENT3P3

1. Collection and preservation of insect (Dry and wet preservation).
2. Preparation of permanent slide of small insects.eg. Aphids, Jassids, cow bug etc.(At least two)
3. Study of collection equipment- pit fall traps, collection net, Berlelies funnel, light trap, chemical trap, etc.
4. Study of types of silk moths.
5. Study of various host plants of silkworm especially found in Konkan region.
6. Study of Rearing appliances of Mulberry silk worm and demonstration.
7. Industrial visit and submission of report (Sericulture / Apiculture / Lac culture).
8. Problem based on Drosophila Genetics.
9. Effect of UV radiation on Drosophila cultures.
10. Submission of insect collection (minimum 5 orders).

PRACTICAL 4: PSZOENT3P4

1. Report of nectar plants and food plants of butterflies. (At least 5 species each available locally).
2. Study of insectivorous birds, spiders and other animals (Any two from each).
3. Study of myrmecophytes (Any two).
4. Study of insectivorous plants (Any two).
5. Report on feeding experiment – ants / other suitable insect including comparison of types of baits / Time for recruitment of foragers / Time for removal of food material / Competition between two species
6. Chemical analysis of Honey samples.
7. Pathogens from suitable insects.
8. Different types of gall insects.
9. Mimicry and camouflage in insects:
 - a) Batesian (Any one example).
 - b) Mullerian (Any one example).
 - c) Camouflage – leaf insect, orchid, mantis, etc.

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M. Sc. Part 2: Semester IV (Theory)
PAPER 1: PSZOENT401
AGRICULTURE, MEDICAL AND VETERINARY ENTOMOLOGY

Unit 1: Agricultural Entomology I

(15 L)

(At least two major insect pests of each host to be studied)

Objective:

- *To introduce learners to the important insect pests of cereals, oil seeds, cotton, Sugarcane and stored grains.*

Desired outcome:

- *The learner will be aware of the classification, life history, damage caused and control of few insect pests of cereals, oil seeds, cotton, sugarcane and stored grain.*
- *Study of Insect pests with special reference to their classification up to families, appearance, habit, life history, distribution, host plant damage and control measures.*

1.1 Insect Pests of cereals- Rice, Jowar, Bajra, Wheat, Maize

1.2 Insect pests of oil seeds- Ground nut, Soyabean, Sunflower

1.3 Insect pests of Cotton and Sugarcane

1.4 Stored Grain Pests - *Tenebrio, Trogoderma, Bruchus.*

Unit 2: Agricultural Entomology II

(15 L)

(At least two major insect pests of each host to be studied)

Objective:

- *To introduce learners to the important insect pests of some vegetables, fruits, spices and flowering plants*

Desired outcome:

- *The Learner will be aware of the classification, life history, damage caused and control of few insect pests of vegetables, fruits, spices and some flowering plants.*
- ❖ *Study of Insect pests with special reference to their classification up to families, appearance, habit, life history, distribution, host plant damage and control measures (at least two major insect pests of each host to be studied.*

2.1 Insect Pests of vegetables- Cabbage, Brinjal, Okra, Tomato, Red Pumpkin

2.2 Insect Pests of fruits- Mango, Citrus, Coconut, Cashew, Sapota

2.3 Insect pests of spices- Black pepper, Tumeric, Ginger

2.4 Pests of Flowering Plants - Mealy Bugs, Aphids White flies, Scale insect.

Unit 3: Medical Entomology

(15 L)

Objective:

- *To introduce learners to the important insect vectors with reference to diseases in human.*

Desired outcome:

- *The learner will be aware of the classification, life history, disease transmitted and control of important insect vectors.*
- *Study of following insects as vectors of human diseases regarding their classification up to*

family, appearance, habit, brief life history, distribution, diseases caused and control measures.

- 3.1 Mosquito
- 3.2 Flea
- 3.3 Housefly
- 3.4 Tsetse fly
- 3.5 Sand fly
- 3.6 Blow fly
- 3.7 Stable fly
- 3.8 Warble fly

Unit 4: Veterinary Entomology

(15 L)

Objective:

- *To introduce learners to the insect pests of veterinary importance*

Desired outcome:

- *The Learner will be aware of the classification, life history, damage caused and control of insect pests of domestic animals.*
- Study of following insects as pests of domestic animals with general reference of their classification up to family, habit, brief life history, damage, diseases caused and control measures.

- 4.1 Horse fly
- 4.2 Cattle blood sucking fly
- 4.3 Flesh fly
- 4.4 *Hypoderma*
- 4.5 Poultry louse
- 4.6 Screw worm fly

PAPER 2: PSZOENT402

FOREST, FORENSIC ENTOMOLOGY AND INSECT TOXICOLOGY

Unit 1: Forest Entomology

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners will grasp the concepts of Forest plants and its pest, Host-Pest relationship.*

- 1.1 Introduction to forest Entomology in relation to forests and forest produce
- 1.2 Insect pests of nurseries, natural and plantation forests, standing and felled trees
- 1.3 Insects pests of timber in storage (broad leaved and conifers)
- 1.4 Biology and ecology of the key pests of tree species of economic value and forest nurseries and their management- Gall insects. Borers, Leaf miners. Defoliators
- 1.5 Insects of mangrove forest
- 1.6 Role of insects in forest food web
- 1.7 Termites, *Eutectona macharalis*, *Hyblea purea*

Unit 2: Forensic Entomology

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*

Desired outcome:

- *Learners expected to gain the knowledge of role of insects in criminology.*

- 2.1 History, corpse-associated arthropod classes, role of arthropods in forensic entomology, examples
- 2.2 Brief mention of Common insects of Forensic importance
 - 2.2.1 Order Diptera – Calliphoridae, Sarcophagidae & Muscidae
 - 2.2.2 Order Coleoptera – Staphylinidae, Histeridae, Silphidae, Dermestidae & Cleridae
- 2.3 Collection of entomological evidence during a death investigation
 - 2.3.1 Temperature and climatic records, collection
 - 2.3.2 Preservation and handling of insects / maggots from the crime scene
- 2.4 Analysis of entomological evidence and estimating PMI (Post Mortem Index) using Maggot age and Insect succession

Unit 3: Insect Control and Toxicology – I

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners expected to acquire the knowledge about insect pest control techniques.*
- *Learner also obtained the knowledge of chemical, bio-control and used natural control agents and toxicology.*

- 3.1 Basic Principles of Insects Control
 - 3.1.1 Chemical Control
 - a) Classification and evolution of insecticides.
 - b) Different types of insecticides.
 - c) Mode of action.
 - 3.1.2 Biological Control
 - a) Principles, application, success and limitations.
 - b) Use of enemies such as predators, parasites and pathogens.
- 3.2 Natural control of insect pest- Abiotic and biotic factors
- 3.3 Cultural, mechanical, physical methods of pest control
- 3.4 The use of Antifeedent in pest management.
- 3.5 Autocidal Methods
 - 3.5.1 Chemosterillants and radiations for sterilization,
 - 3.5.2 Male sterile Theory,
 - 3.5.3 Hormones and Pheromones, Attractants and Repellants.
- 3.6 Insecticide formulations and applications, Insecticide synergists

Unit 4: Insect Control and Toxicology II

(15 L)

Objective:

- *To develop a strong foundation in entomology, including understanding of the importance of insects to human society.*
- *To familiarize the students with identification of insect pests, vectors and their control methods.*

Desired outcome:

- *Learners expected to acquire the knowledge about insect pest control development of resistance to Insecticides.*
- *Learners also gain the knowledge of impact of insecticides on human health and environment and IPM.*

- 4.1 Microbial and Environmental degradation of pesticides. Metabolism of pesticides
- 4.2 Integrated Pests Managements
- 4.3 Dynamics of Environmental Pollution by Insecticides and impact on human health and ecosystem
- 4.4 Plants origin, synthetic (organic and inorganic) insecticides, chemistry, mode of action and application
- 4.5 Fungicides – Definition, classification and application
- 4.6 Organizational Biological pest control
 - 4.6.1 Definition and History
 - 4.6.2 Methods
 - 4.6.3 Bio-control agent
 - 4.6.4 Aspects of biological organization
 - 4.6.5 Bio-control programme in Maharashtra and in India
- 4.7 Microbial control
 - 4.7.1 Introduction
 - 4.7.2 Pathogens used in microbial control (fungi, bacteria, viruses, protozoan, nematodes) toxins produced
 - 4.7.3 Mode of action and application
- 4.8 Recent trends in pest management
 - 4.8.1 Global scenario
 - 4.8.2 India
 - 4.8.3 Maharashtra
 - 4.8.4 Traditional pest management techniques

PAPER 3: PSZOENT403

NEO-ENTOMOLOGY, COMPUTATIONAL ENTOMOLOGY AND INSECTS BIOTECHNOLOGY

Unit 1: Neo-avenues in Entomology

(15 L)

Objective:

- *To learn neo-avenues and prospective in Insects study (Entomology).*

Desired outcome:

- *Learner should acquire the knowledge of insects use as a medicine, weapons.*
- *They will also learn role of insect in textile industry, ornamental use.*

- 1.1 Insect as a medicine (Entomotherapeutics)
- 1.2 Insect as weapons (Entomological warfare's)
- 1.3 Ornamental Entomology: Ornamental products from insects
- 1.4 Use of Insect in textile Industry : Fashion designing

Unit 2: Insect Biotechnology and Molecular Biology – I

(15 L)

Objective:

- *To introduce the insect Biotechnology and Molecular Biology.*

Desired outcome:

- *Learners get the knowledge of central dogma process in insects.*
- *They will also learn about insect cell lines, role of baculoviruses, marker genes use to detect sex.*
- *They will also get the knowledge of Bt toxins, neurohormones secreted in insect.*

- 2.1 DNA and RNA analysis in insects
 - 2.1.1 Transcription and translocation mechanisms.
 - 2.1.2 DNA recombinant technology,
 - 2.1.3 Identification of genes / nucleotide sequences for characters of interest.
- 2.2 Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi
- 2.3 Genes of interest in entomological research
 - 2.3.1 Marker genes for sex identification
 - 2.3.2 Neuropeptides, JH esterase, St toxins and venoms, chitinase
 - 2.3.3 CPTI; lectins and proteases. Peptides and Neuropeptides, J Hesterase,
 - 2.3.4 Toxins and venoms, chitinase, Bt toxin, CPTI; trypsin inhibitors, lectins and proteases, Neuropeptides

Unit 3: Insect Biotechnology and Molecular Biology – II

(15 L)

Objective:

- *To introduce insect biotechnology and molecular biology.*

Desired outcome:

- *Learners have learn the application and principles of DNA finger printing and its role in development of transgenic insect, improvement in silk quality and honey with the help of biotechnology.*

- 3.1 Insect gene transformation; biotechnology in relation to silkworms and honey bees
- 3.2 DNA finger printing for taxonomy and phylogeny.
- 3.3 Genetic improvement -tolerance of natural enemies.
- 3.4 DNA-based diagnostics;
- 3.5 Insect immune systems in comparison to vertebrates
- 3.6 Molecular basis of metamorphosis
- 3.7 Sf transgenic technology and implications

Unit 4: Insect Bioinformatics

(15 L)

Objective:

- *To introduce the principles and application of insect bioinformatics.*

Desired outcome:

- *Learner should gain the knowledge the insect genomics, silkworm gene sequencing, insect proteomics, develop gene sequencing by using application of bioinformatics.*

4.1 Insect Genomics

- 4.1.1 *Drosophila melanogaster* (Fruit fly)
- 4.1.2 *Anopheles gambiae* (Mosquito – the vector for malaria),
- 4.1.3 *Bombyx mori* (Domestic silk worm) and *Apis mellifera* (Honeybee)
- 4.1.4 Dipteran and Hymenopteran insects.
- 4.1.5 Lepidoptera, Butterflies, Diamondback moth
- 4.1.6 Coleoptera (Beetles) Hemiptera (Pea Aphid)
- 4.1.7 Phthiraptera (Head louse)

4.2 Insect Proteomics

- 4.2.1 A proteomic approach for studying insect phylogeny
- 4.2.2 Proteomic Analysis of Interaction between a Plant Virus and Its Vector Insect
- 4.2.3 Proteomic and Bioinformatics Analysis on Endocrine Organs of Domesticated Silkworm, *Bombyx mori*.

PAPER 4: PSZOOCN404

INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation

(15 L)

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:

- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:

- Principle
- Structural components
- Applications

1.3 Chromatography:

- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:

- Principle
- Applications

1.5 pH meter

- Principle
- Applications

1.6 Microscopy

- Binocular
- Trinocular

Unit 2: Presentation of Scientific data

(15 L)

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project

(30 L)

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

- 1. Dissertation 60 Marks**
- 2. Examinations 50 Marks**

Guidelines to the Project:

- 1. The Project shall include:**
 - Title of the Project
 - Aims, Objectives and Rationale
 - Materials and Methods
 - Observation and / Results
 - Interpretation of Observation / Results and Discussion
 - Conclusion and / Recommendation
 - Relevance of Work / Justification of Work with Project title
 - Relevant References
- 2. The project must be type-written using computer and printed for binding.**
- 3. No minimum or maximum limit of the number of pages is defined since the volume of the proposal is dependent on the scope of the selected topic.**
- 4. Name of the mentor may be reflected on the first page of the project along with the student's names.**
- 5. The hard copy of proposal must be retained and submitted along with the dissertation in the examination for the reference of the external examiner/s.**
- 6. Student should prepare individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.**
- 7. The project will be prepared individually by students.**

M. Sc. Part 2: Semester IV

Practical 1: PSZOENT4P1

1. Identification of economic importance of following insect pests;
 - a) Household Pest- Termite, Carpet moth, Cockroach
 - b) Pests of medical importance- Sand fly, Tsetse fly, rat flea
 - c) Veterinary pest- Horse fly, Stable fly, screw worm, Cattle warble fly,
 - d) Forest pest-Teak defoliater, Polyphagous dry wood borer- *Sinoxylon sp.*
 - e) Pest of cereals- Paddy grasshopper, Sorghum shoot fly
 - f) Pest of pulses-Greasy cutworm (*Agrotis sp.*), Plume moth (*Exelastis sp.*)
 - g) Pest of fiber crops- Red cotton bug, Pink Bollworm
 - h) Pest of fruits and fruit trees- Lemon butterfly (*Papilio demoleus*), Oriental fruit fly (*Dacus dorsalis*)
 - i) Pest of oil seed crop – Castor semilooper (*Achaea janata*), Groundnut stem borer – (*Sphenoptera sp.*)
 - j) Pest of vegetable crops – Hadda beetle (*Epilachna sp.*), cabbage caterpillar (*Pieris brassicae*)
 - k) Pest of spices – turmeric shoot borer – *Conogethes punctiferalis*, Pest of black pepper – Pollu beetle (*Longitarsus nigripennis*)
 - l) Pest of narcotic crops- Leaf eating caterpillar- *Spodoptera litura* Fab., Tobacco aphid – *Myzus nicotianae* Black.
2. Field visit to agricultural area / fruit plantation / forest to study the pests and submission of report based on it.
3. Visit to cattle farm / Veterinary center to study the pests of cattle/ other pet animals and submission of report based on it.

Practical 2: PSZOENT4P2

1. Study of insecticide appliances
 - a) Simple sprayer
 - b) Hydraulic sprayer
 - c) Rocker sprayer
 - d) Duster
2. Identification and economic importance of parasitoids (Biocontrol agents).
 - a) *Trichogramma spp.*
 - b) *Aphytis melinus*
 - c) *Cryptolaemus montrouzeri*
 - d) *Crysoperia carnea*
 - e) *Isotima javensis*
 - f) *Xanthopimpla punctata*
 - g) *Apanteles spp.*
3. Identification and economic importance of insect predators:
 - a) Birds
 - b) Reptiles
 - c) Amphibians
 - d) Mammals
 - e) Pisces
 - f) Coelenterates
 - g) Arachnids (spider)
 - h) Insect
4. Identification and economic importance of vertebrate pest bio-control agents. *Bufo marinus*, Giant toad, Indian mynah (*Acridotheres tristis*), Indian crow.
5. Study of weed controlling insects.
 - a) Beetles (*Octotoma scabripennis*, *Uroplata giraldi*)
 - b) Scale insect (*Dactylopius tomentosus*)
 - c) Flea beetle (*Agasicles hygrophyla*)
6. Whole mount preparations of parasitic insects and microscopic pest.
 - a) Thrips
 - b) Aphids
 - c) Jassids
 - d) Cow bug
 - e) Termites
 - f) Pentatomid bug
7. Symptomology of following different types of insecticide treatment in Cockroach.
 - a) Contactpoison
 - b) Stomachpoison
 - c) Fumigant.
8. Bioassay of insecticides in a suitable insect for; (LC50)
 - a) Contact poison.
 - b) Stomach poison.
 - c) Fumigant.
9. Estimation of synergistic ratio using suitable insect model.

Practical 3: PSZOENT4P3

1. Isolation and estimation of DNA from *Chironomus* larvae or suitable insects.
2. Isolation and estimation of RNA from *Chironomus* larvae or suitable insects
3. Visit to suitable nearby institute for demonstration of PCR, RFLP and RAPD techniques and submission of report on it.
4. Problems based on molecular biology with reference to insects.

Practical 4: PSZOENT4P4

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.

Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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University of Mumbai
M.Sc. ZOOLOGY (Entomology)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60Marks

- Duration – These examinations shall be of two and half hours duration for each paper.
- Theory Question Paper Pattern:
 - ❖ There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
 - ❖ All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 marks with options.
 - ❖ Question may be subdivided into sub questions a, b, c... and the allocation of marks depend on the weightage of the topic.

b. Practicals: 50Marks

- c. Project in Semester IV: Internal Examination 40Marks
Dissertation: 60 Marks
External Evaluation: 50 Marks

University of Mumbai
M.Sc. ZOOLOGY (Entomology) Paper Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination
Maximum Marks: 60 Duration:2.5 Hours Marks Option:90

Question 1. Based on Unit I to IV (Mixed Questions)

Question 2. Based on Unit I

Question 3. Based on Unit II

Question 4. Based on Unit III

Question 5. Based on Unit IV

Instructions:

- a. All questions are compulsory.
- b. All questions carry equal marks.
- c. Draw neat and labelled diagrams wherever necessary.

1. Answer any **four questions** from the following: (Based on all4 Units) **(12)**
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)
2. Answer any **two questions** from the following: (Based onUnitI) **(12)**
 - a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based onUnitII) **(12)**
 - a)
 - b)
 - c)
4. Answer any **two questions** from the following: (Based onUnitIII) **(12)**
 - a)
 - b)
 - c)
5. Answer any **two questions** from the following: (Based onUnitIV) **(12)**
 - a)
 - b)
 - c)

Semester IV Examination
Paper IV: Instrumentations and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOENT404

Maximum Marks: 40

Duration: 1.15 Hours

Marks Option: 60

Instructions:

- a) All questions are compulsory.
 - b) Draw neat and labeled diagrams wherever necessary.
1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units)
Four sub-questions from each unit. **08**
2. Answer any **two questions** from the following: (Based on Unit I) **16**
- a)
 - b)
 - c)
3. Answer any **two questions** from the following: (Based on Unit II) **16**
- a)
 - b)
 - c)

Skeleton of Practical Examination Question Paper

Practical 1: PSZOENT3P1

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification and Classification of given specimen/photo up to family level (with reasons).
15 Spot A, B, C, D, E **15**
 - a) One spot from Ametabola
 - b) One spot from Hemimetabola.
 - c) One spots from Holometabola
 - d) One spots from Holometabola
 - e) One spots from Holometabola

2. Identification. **09**
 - a) Mouth parts / antenna
 - b) Thoracic appendages
 - c) Abdominal appendages

3. Temporary Mounting: Any two of the following: **10**
Mouth parts, legs, antenna, Tentorium, halteres, wings, legs, abdominal appendages.

4. Report of Field visit. **06**

5. Viva-Voce based on theory. **05**

6. Journal. **05**

Practical 2: PSZOENT3P2

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its digestive system. **10**
OR
1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its Reproductive system. **10**
OR
1. Dissect Cockroach/Housefly/Grasshopper/bugs/beetles so as to expose its Nervous system. **10**
OR
1. Dissect Cockroach so as to expose its Endocrine glands/ Retro cerebral nervous system. **10**
2. Demonstrate the presence of chitin by using of chitosen test. **06**
OR
2. Uptake of dyes by Malpighian Tubes. **06**
OR
2. Detect uric acid as a excretory product of terrestrial insect. **06**
3. Identifications. **09**
 - a) Identify and describe (T.S. of midgut/ foregut).
 - b) Identify and describe (T.S. of Testis/Ovary).
 - c) Identify and describe (Brain/Endocrine gland/neurosecretory cells.)
4. Assay/Experiment. **15**

Perform Differential and Total Haemocyte count.

OR

Chromatographic analysis of amino acids from insect Haemolymph. **15**

OR

Estimate digestive enzyme by DNSA method from midgut. (amylase / invertase/ Trehalase) **15**

OR

Estimate total proteins/carbohydrates from the given Haemolymph/tissues. **15**
5. Viva voce based on theory. **05**
6. Journal. **05**

Practical 3: PSZOENT3P3

Time: 10:00 am to 3:00pm

Total Marks: 50

- | | |
|----------------------------------------------------------------------------------------|-----------|
| 1. Identification. | 08 |
| a) Insect collection equipment/preservation techniques | |
| b) Types of silk moths | |
| c) Host plants of silk moth | |
| d) Rearing techniques in sericulture. | |
| 2. Problem based on Drosophila genetics. | 04 |
| 3. Effect of UV radiation on drosophila culture- submission of report. | 08 |
| 4. Submission of permanent slides. (Aphids / Jassids / Cow bug / others) Any two. | 05 |
| 5. Industrial visit and submission of report (Sericulture / Apiculture / Lac culture). | 05 |
| 6. Submission of insect collection. (At least five orders). | 10 |
| 7. Viva voce based on theory. | 05 |
| 8. Journal. | 05 |

Practical 4: PSZOENT3P4

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification. **18**
 - a) Identify and describe insectivorous animals.
 - b) Identify and describe insectivorous animals.
 - c) Identify and describe myrmecophytes.
 - d) Identify and describe insectivorous plants.
 - e) Identify and describe mimicry in insect.
 - f) Identify and describe mimicry in insect.

2. Evaluate the physico-chemical characteristics of given honey sample and make a report. **08**

3. Make a temporary preparation stained if necessary of pathogens from the given insect. (minimum four) **10**
- OR**
3. Make a temporary preparation stained if necessary of gall insects. Make a report. **10**

4. Submission of the report on feeding experiments on ants/suitable insects. **04**

5. Viva voce based on theory. **05**

6. Journal. **05**

Practical 1: PSZOENT4P1

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Identification and description of economic importance of given specimen/photo. **12**
Four spots from Household/Medical/Veterinary/Forest pest (Not more than one from each group).
2. Identification and description of economic importance of given specimen/photo. **10**
Five spots from pests of cereals / pulses / fiber crop / fruit and fruit trees / oil seeds / vegetables / spices / narcotic crops (Not more than one from each group).
3. Visit to agricultural area/fruit plantation/forest to study insect pests and submission of report based on it. **10**
4. Visit to cattle farm/Veterinary center to study pests of cattle/ other pet animals and submission of report based on it. **08**
5. Viva-voce based on theory. **05**
6. Journal. **05**

Practical 2: PSZOENT4P2

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Assay/Experiment. 15
Assess LC50 for given insecticide (Mosquito larvae / *Chironomous* larvae).
OR
 - a) Identify and give economic importance of vertebrate pest bio-control agents. 10
 - b) Preparation of whole mount of microscopic pest. 05

2. Identification. 10
 - i. Identify and describe the insecticide appliances.
 - ii. Identify and describe economic importance of parasitoids.
 - iii. Identify and describe insect predators.
 - iv. Identify and describe weed control insects.
 - v. Identify the Symptomology of given insecticides treatment on cockroach (Contact poison/Stomach poison /Fumigant).

3. Submission. 05
 - a) Insect pest collection and observation report. 10
 - b) Report of Field visit or visit to Agricultural University or visit to veterinary Institute. 05

4. Viva voce based on theory. 05

5. Journal. 05

Practical 3: PSZOENT4P3

Time: 10:00 am to 3:00pm

Total Marks: 50

1. Isolate and estimate DNA from *Chironomous* larva or suitable insect sample. **15**
OR
1. Isolate and estimate RNA from *Chironomous* larva or suitable insect sample. **15**
2. Problems based on molecular biology with reference to insects. **08**
3. Demonstrate the use of bioinformatics tools with reference to insects BLAST for nucleotide sequence comparison. **07**
OR
3. Databases of NCBI with querying a nucleotide/protein sequence from insects. **07**
4. Submit visit report of academic/research institute for demonstration of PCR / RFLP /RFLD and submission of report. **10**
5. Viva voce based on theory. **05**
6. Journal. **05**

Skeleton of Practical Examination Question Paper: Practical 4 PSZOENT4P4

Evaluation of Project of Paper IV Project: 60 Marks

1. Title of the Project	01
2. Aim, Objectives and Rationale	04
3. Materials and Methods	05
4. Observations and / Results	10
5. Interpretation of Observations / Results and Discussion	10
6. Conclusion and / Recommendation	10
7. Relevant work / Justification of work with Project title	10
8. Relevant References	05
9. Certified Dissertation	05

External Evaluation: 50 Marks

1. Content of Presentation	10
2. Quality of Presentation	10
3. Presentation Skill	10
4. Quality of Work	10
5. Viva based on Proposal / Question Answer Session	10
