

**Department of Zoology**  
Siksha Bhavana  
**Visva-Bharati**  
(A Central University)  
Santiniketan

**Ordinance of M.Sc. Course in Zoology**  
**Choice Based Credit System (CBCS) for M.Sc. course in Zoology**

Effective from Academic session: 2011-2012

**Pattern of examination in each semester**

- (i) Internal assessment (continuous): 20% of the total marks in each paper (Theory and Practical).
- (ii) Duration of each semester-end Theory examinations (80%) will be:
  - a. Three hours for each paper (40 marks)
  - b. Four hours for each paper (exceeding 40 marks)
- (iii) Duration of each semester-end Practical examinations (80%) will be: Four hours
- (iv) Setting and moderation of questions for Theory papers will be carried out jointly by internal and external members, while answer scripts will be evaluated only by internal examiners.
- (v) Practical examinations will be conducted jointly by internal and external examiners.
- (vi) The evaluation of Project work at the end of the Fourth Semester will be based on dissertations submitted by the students and Viva-voce. Assessment will be done by both internal and external examiners.

## Department of Zoology

Siksha Bhavana

Visva-Bharati

### Choice Based Credit System (CBCS) for M.Sc. course in Zoology

#### Course structure

Sl. No.	Study components	Semester component	Number of courses	Credits	Final credit	Marks	Full Marks
1	Core course	I -III	18	4	72	50	900
2	Elective course	IV	1	8	8	100	100
3	Optional course	IV	2	8 + 4	12	150	150
4	Project work	IV	1	4	4	50	50
	<b>Total</b>		<b>22</b>		<b>96</b>		<b>1200</b>

Internal Assessment – 20% (Theory and Practical)

Duration of Theory Examination : 3 hours each

Duration of Practical Examination : 4 hours each

#### Semester-wise Marks / Credit distribution

Semester	Core		Elective	Optional		Project work
	Theory	Practical		Theory	Practical	
I	200	100				
II	200	100				
III	200	100				
IV			100	100	50	50
<b>Total</b>	<b>600</b>	<b>300</b>	<b>100</b>	<b>100</b>	<b>50</b>	<b>50</b>

## Outline of M.Sc. Course: Choice Based Credit System (CBCS) Syllabus in Zoology

### Core courses

Course No.	Course type	Course title	Credits	Marks	Contact hours
<b>Semester I</b>					
<b>MZCT – 101</b>	Theory	<b>Fundamentals of Biochemistry</b>	4	50	
<b>MZCT – 102</b>	Theory	<b>Immunology</b>	4	50	
<b>MZCT – 103</b>	Theory	<b>Cell Biology</b>	4	50	
<b>MZCT – 104</b>	Theory	<b>Genetics and Molecular Biology</b>	4	50	
<b>MZCP – 105</b>	<i>Practical</i>	<b>Biochemistry and Immunology</b>	4	50	
<b>MZCP – 106</b>	<i>Practical</i>	<b>Cell Biology, Genetics and Molecular Biology</b>	4	50	
<b>Semester II</b>					
<b>MZCT – 201</b>	Theory	<b>Structure and functions of Animal Tissues</b>	4	50	
<b>MZCT – 202</b>	Theory	<b>Theoretical basis of Methods in Biology</b>	4	50	
<b>MZCT – 203</b>	Theory	<b>Ecology and Conservation Biology</b>	4	50	
<b>MZCT – 204</b>	Theory	<b>Animal Behaviour and Evolution</b>	4	50	
<b>MZCP – 205</b>	<i>Practical</i>	<b>Ecology and Animal Behaviour</b>	4	50	
<b>MZCP – 206</b>	<i>Practical</i>	<b>Preparation and Study of Animal Tissues</b>	4	50	
<b>Semester III</b>					
<b>MZCT – 301</b>	Theory	<b>Developmental Biology</b>	4	50	
<b>MZCT – 302</b>	Theory	<b>Biology of Infectious Diseases</b>	4	50	
<b>MZCT – 303</b>	Theory	<b>Comparative Endocrinology</b>	4	50	
<b>MZCT – 304</b>	Theory	<b>Comparative Animal Physiology</b>	4	50	
<b>MZCP – 305</b>	Practical	<b>Developmental Biology &amp; Biology of Infectious Diseases</b>	4	50	
<b>MZCP – 306</b>	Practical	<b>Comparative Endocrinology and Physiology</b>	4	50	
<b>Semester IV</b>					
<b>MZET – 401</b>	Theory	Any one from the list of Elective papers	8	100	
<b>MZOT – 402</b>	Theory	Any one from the list of Optional papers	8	100	
<b>MZOP – 403</b>	<i>Practical</i>	Any one from the list of Optional practical papers	4	50	
<b>MZPW – 404</b>	<i>Project</i>	<i>Based on either MZET-401 or MZOT-402 papers</i>	4	50	

# Choice Based Credit System (CBCS) for M.Sc. course in Zoology

## *Detailed Syllabus*

### First Semester (July-December)

**Total Credits: 24**

**Marks: 300**

#### THEORY PAPERS

##### Core Theory Paper:

###### **MZCT-101 (FUNDAMENTALS OF BIOCHEMISTRY)**

**Credits: 4**

**Marks: 50**

1. Regulatory enzymes: ATCase and Glycogen phosphorylase.
2. Concepts of regulation of metabolism of
  - a. Proteins,
  - b. Carbohydrates with respect to glycolysis and TCA cycle, and
  - c. Lipids
3. Structure and function of Fo-F<sub>1</sub> ATPase
4. Primary, Secondary and tertiary structure of protein.

##### Core Theory Paper:

###### **MZCT-102 (IMMUNOLOGY)**

**Credits: 4**

**Marks: 50**

1. Basic concepts of innate and adaptive immunity
2. Complement system-activation, participation in T cell mediated immunity.
3. Antigen presenting cells, antigen presentation to T lymphocyte, MHC molecules.
4. Cell mediated immunity- Helper T cell, cytotoxic T cell, NK cell and their mode of function
5. Humoral Immunity- B cell and its activation. Origin, maturation and activation of immunoglobulin, Structural and functional variations of immunoglobulin molecules, B cell-T cell interaction

##### Core Theory Paper:

###### **MZCT-103 (CELL BIOLOGY)**

**Credits: 4**

**Marks: 50**

1. Model of membrane structure, lateral mobility of membrane components (FRAP, FLIP), mechanism of sorting and regulation of intracellular transport.
2. Structure and functions of: nucleus, peroxisomes, plastids, vacuoles, cytoskeleton and its role in motility.
3. Process of transcription, formation of initiation complex, RNA polymerases, transcription factors; transcription activators and repressors, capping, elongation and termination.
4. Ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code.
5. Unit of replication, replication origin and fork, fidelity of replication.
6. Signal transduction pathways, second messengers, regulation of signaling pathways

### Core Theory Paper:

**MZCT-104** (GENETICS AND MOLECULAR BIOLOGY)

**Credits: 4**

**Marks: 50**

1. C-value paradox; unique and repetitive sequences in eukaryotic genome; multiple gene families; significance of genomic evolution in animals.
2. Transposable elements in prokaryotes and eukaryotes.
3. The human chromosomes, chromosomal abnormalities and human disorders.
4. DNA repair mechanism- types in pro and eukaryotes.
5. Recombinant DNA technology, Polymerase chain reaction (PCR), genomic and cDNA libraries, genome analysis- Southern Blot hybridization and northern hybridization, preparation of probes, DNA sequencing, Human genome project
6. Basic idea of Genomics.

### Core Practical Paper:

**MZCP-105** (BIOCHEMISTRY AND IMMUNOLOGY)

**Credits: 4**

**Marks: 50**

1. Quantification of blood glucose, protein, RNA and DNA
2. Study of Enzyme kinetics (*Salivary amylase*)
3. Isolation of splenocytes and thymocytes from rat/mice
4. Antigen-antibody interaction

### Core Practical Paper:

**MZCP-106** (CELL BIOLOGY, GENETICS & MOLECULAR BIOLOGY)

**Credits: 4**

**Marks: 50**

1. Mitosis in rat cornea
2. Preparation of karyotypes
3. *Drosophila* genetics: Preparation of culture medium, Study of *Drosophila* Life cycle, wild and mutant flies
4. DNA Gel Electrophoresis
5. PCR

## Second Semester (January-May)

Total Credits: 24

Marks: 300

### THEORY PAPERS

#### Core Theory Paper:

**MZCT-201** (STRUCTURE AND FUNCTIONS OF ANIMAL TISSUES) **Credits: 4**

**Marks: 50**

1. Preparation of animal tissues for microscopic studies:
  - a. Fixation and Fixatives:
    - i) Basic principle of fixation
    - ii) Properties and classification of different fixatives
  - b. Biological Stains:
    - i) Basic principle of staining
    - ii) Sources, Chemistry and Properties of:  
Haematoxylin, Eosin, Carmine, Basic Fuchsin and Acid Fuchsin
2. Histochemical study of animal tissues (Basic principle and theoretical basis):
  - a. Reactions for *Acid and Alkaline Phosphatases*
  - b. PA-Schiff Reaction
  - c. Feulgen Reaction
  - d. Metachromasia
  - e. Immunocytochemical Reactions
3. Histophysiology of:
  - a. Stomach
  - b. Small Intestine
  - c. Large Intestine
  - d. Kidney
  - e. Liver

#### Core Theory Paper:

**MZCT-202** (THEORETICAL BASIS OF METHODS IN BIOLOGY) **Credits: 4**

**Marks: 50**

1. Microscopy: Light microscopy: structural components of compound microscope; principle and application of bright field, phase contrast and fluorescence microscope.
2. Electron microscopy: Scanning Electron Microscopy and Transmission Electron Microscopy: Methods of biological sample preparations for Electron Microscopy.
3. Colorimetry and Spectrophotometry: Basic principle and applications.
4. Different separation methods: Centrifugation, Electrophoresis (Native and SDS-PAGE), Size exclusion, affinity and ion-exchange chromatography.
5. Electrophoresis : Two dimensional gel electrophoresis, isoelectric focusing gels.
6. Basic principle and applications of: ELISA, RIA, Western blot, immunoprecipitation, flow-cytometry.
7. Fluorescent *in situ* hybridization (FISH): Basic principle and applications.

## Core Theory Paper:

**MZCT-203** (ECOLOGY AND CONSERVATION BIOLOGY)

**Credits: 4**

**Marks: 50**

1. System Ecology: Modern concepts of primary and secondary productivity, Lindeman's concept of community dynamics, Flow of energy through grazing and detritus pathways, Ecological efficiency ratios
2. Population Ecology: Properties of population, Intrinsic rate of increase, Carrying capacity, Population growth, Survivorship, Population fluctuation, Density dependent and independent factors of population regulation, Metapopulation, Population interactions, Interspecific competition, Competition theory
3. Community Ecology: Local and regional factors to structure communities, Guild and assemblage, Ecotone and habitat fragmentation, Niche pre-emption, Distributional relations of species in communities, Indicator species in communities, Diversity gradients, Factors cause diversity gradients.
4. Ecosystem health - Human impacts: Carrying capacity of Earth, Demographic transition, Ecological footprint, Basic concept of integrated ecosystem theories (emergy, exergy, ascendancy, dissipation) and their application for ecosystem health assessment
5. Environmental pollution: Types and sources of air, soil, water and sound pollution, Effects of pollution on organisms, Control measures of pollution, Smog formation, Thermal inversion, Green house gases and global warming, Ozone hole, Acid rain, Circulation of pesticides and radio-isotopes in ecosystems and biomagnification
6. Conservation Biology: concept of conservation and preservation, Principles of Conservation Biology, Strategic species concept, Biodiversity and Conservation, Wild life concept.

## Core Theory Paper:

**MZCT-204** (ANIMAL BEHAVIOUR AND EVOLUTION)

**Credits: 4**

**Marks: 50**

1. Approaches in behavioural studies, Types of behaviour, Fixed action pattern (FAP), Instinct, Motivation, Conflict and stress, Types of learning, Imprinting, Maintenance and body care activities, Forms of sleep, Escape and defense strategies, Evolutionarily stable strategy, Biological clocks, Circadian rhythm
2. Aggression and appeasement, Altruism, Eusociality, Kin selection, Territory and home range, Social dominance and hierarchy, Habitat selection and optimality of foraging, Social communication, Reproductive strategy, Significance of courtship, Female choice, Parental investment and reproductive success.
3. Hardy -Weinberg Law.
4. Factors of evolution: natural selection, genetic drift, gene migration, mutation.
5. Basic concept of speciation.
6. Isolating mechanism.
7. Polymorphism.
8. Origin of life.
9. Molecular evolution

## Core Practical Paper:

**MZCP-205** (ECOLOGY AND ANIMAL BEHAVIOUR)

**Credits: 4**

**Marks: 50**

1. Estimation of major chemical parameters of water and soil samples: Dissolved oxygen (Winkler), GPP & NPP (light and dark bottle), Total hardness (EDTA), C.O.D. (Chromic acid digestion), Organic carbon in soil (Walkley & Black)
2. Determination of requisite size of quadrat by species area curve method, Application of Standard deviation and Standard error to experimental data, Analysis of growth rate in animals using Correlation coefficient, Estimation of biomass by Bomb calorimeter
3. Demonstration of basic behavioural mechanisms (habituation to light stimulus in earthworm, aggregation in woodlouse, phototactic and geotactic responses in housefly, maintenance behaviour in white rat, insight learning in animals)
4. Study of common behaviour patterns in animals using visual aids, Study of specific behaviour sequences in field condition and submission of photographs, Demonstration of home range patterns, escape and defense mechanisms in animals

## Core Practical Paper:

**MZCP-206** (PREPARATION AND STUDY OF ANIMAL TISSUES) **Credits: 4**

**Marks: 50**

1. Preparation of animal tissues for microscopic studies:
  - i. Fixation,
  - ii. Dehydration,
  - iii. Infiltration
  - iv. Embedding
2. Microtomy of paraffin sections.
3. Hematoxylin-Eosin staining and permanent preparation of animal tissues.
4. Microscopic study of:
  - i. Stomach
  - ii. Small Intestine
  - iii. Large Intestine
  - iv. Liver
  - v. Kidney
  - vi. Testis
  - vii. Ovary



## Third Semester (July-December)

Total Credits: 24

Marks: 300

### THEORY PAPERS

#### Core Theory Paper:

##### MZCT-301 (DEVELOPMENTAL BIOLOGY)

Credits: 4

Marks: 50

1. Introduction and overview of animal development: developmental control of gene expression, cell signaling.
2. Cell behaviour, fate, determination and commitment.
3. Embryonic induction in vertebrates: mesoderm induction, neural induction, organizer concept.
4. Genomic equivalence and nuclear differentiation, nuclear transplantation in unicellular organisms and amphibians, nuclear cloning and its significance, embryonic stem cells.
5. Germplasm and determination of primordial germ cells.
6. Genetics of axis specification in *Drosophila* and *Caenorhabditis*. Vulva formation in *Caenorhabditis*.
7. Infertility, assisted reproductive techniques, developmental syndromes in human, teratogens in embryonic development.
8. Regeneration.

#### Core Theory Paper:

##### MZCT-302 (BIOLOGY OF INFECTIOUS DISEASES)

Credits: 4

Marks: 50

1. Emerging and re-emerging infectious diseases- Polio, Tuberculosis, Dengue Fever, Influenza, Hepatitis.
2. Vector pathogen interactions and the role of vector behavior and life style on the transmission of pathogens -Mosquitoes, Ticks, Fleas.
3. Food and water borne diseases- (Giardiasis, Amoebiasis, Cholera and Typhoid)
4. Prevention and management of infectious diseases.
5. Vaccines and virulence.

#### Core Theory Paper:

##### MZCT-303 (COMPARATIVE ENDOCRINOLOGY)

Credits: 4

Marks: 50

1. Characteristic features of endocrine system. Chemical nature and classification of animal hormones.
2. Anatomy, cellular characteristics, hormonal biosynthesis and functions of:  
(a) Adenohypophysis, (b) Thyroid, (c) Pancreas, (d) Adrenal, (e) Pineal, (f) Testis, and (g) Ovary
3. Molecular mechanism of hormone actions at cellular level: Mechanism of actions of steroid and peptide hormones emphasizing the role of second messengers.
4. Bio-assay of hormones.
5. Neuroendocrine system in:
  - (a) Insects: Components, chemical nature of different hormones, role in the regulation of different physiological and behavioural activities.
  - (b) Vertebrates:
    - (i) Hypothalamo-hypophysial system: Components, comparative anatomy and evolution of hypothalamic neuro-secretory nuclei and neurohypophysial hormones.
    - (ii) Chemical nature, site of synthesis and functions of hypothalamic hormones.

## Core Theory Paper:

**MZCT-304** (COMPARATIVE ANIMAL PHYSIOLOGY) **Credits: 4** **Marks: 50**

1. Composition and functions of blood in vertebrates and invertebrates
2. Mechanism of blood coagulation in vertebrates and invertebrates
3. Chemistry and functions of respiratory pigments in vertebrates and invertebrates
4. Autonomic nervous system: Classification, Anatomy and Functions in vertebrates
5. Role of photoperiod and other environmental factors in the regulation of annual reproductive cycles in sub-mammalian vertebrates
6. Physiology and regulation of osmoregulation in vertebrates
7. Endocrine regulation of spermatogenesis and oogenesis
8. Hormonal regulation of Estrous and Menstrual cycles

## Core Practical Paper:

**MZCP-305** (DEVELOPMENTAL BIOLOGY & BIOLOGY OF INFECTIOUS DISEASES) **Credits: 4** **Marks: 50**

1. Microscopic study of immature fish eggs and identification of cellular inclusions
2. Germinal vesicle breakdown (GVBD) and ovulation in fish
3. Whole mount preparation of chick embryo
4. Microscopic observation of transverse sections of chick embryo at various hours of incubation
5. Study of regeneration.
6. Study of pathogens from permanent slides.
7. Examination and assessment of the intensity of infection of pathogens from faecal, blood and sputum samples.
8. Detection of presence of bacteria in milk
9. Determination of antibiotic sensitivity.

## Core Practical Paper:

**MZCP-306** (COMPARATIVE ENDOCRINOLOGY AND PHYSIOLOGY) **Credits: 4** **Marks: 50**

1. Dissection of pituitary, thyroid, para-thyroid, pancreas, adrenal, pineal from rat.
2. Surgical procedures in white rat for:
  - a. Orchidectomy
  - b. Ovariectomy
  - c. Adrenalectomy
3. Study of vaginal smear of adult female rat for identification of different stages of estrous cycle
4. Bio-assay of LH: Ovarian ascorbic acid depletion test
5. Hormonal control of pigment dispersal in catfish.

## Fourth Semester (January-May)

Total Credits: 24

Marks: 300

### THEORY PAPERS

#### Elective Theory Paper:

(Choose any one Elective Theory paper from the following list: I to V)

#### I. Elective Theory Paper:

**MZET-401** (POPULATION AND COMMUNITY ECOLOGY)

**Credits: 8**

**Marks: 100**

Group: A

1. Population Ecology:

Mechanism of population regulation; a simple model of population regulation; Modern synthesis of population regulation; the Allee principle of aggregation and refuging; meta-population dynamics; Variation of life history patterns according to the growth rate of the population.

2. Species Interactions:

Resource and consumers; Mathematical model of host-disease interaction; Theories on competition and resources and Lotka-Volterra model; Models of predation (discrete generation); Niche width and overlap; Fundamental and realized niche; Resource partitioning; Character displacement.

Group B:

1. Community Ecology:

Community structure – Composition, abundance, relative abundance, dominance index, community attributes, edges and ecotones; Patterns of distribution of fauna and flora; Floral and faunal similarity between two habitats

2. Wild life management:

Wild life concept, cause of extinction, wild life protection act; Measure of conservation strategies; Red data book, green book, national park, wild life sanctuaries; Indian case studies on conservation / management strategy (project tiger, biosphere reserves)

#### II. Elective Theory Paper:

**MZET-401** (ENTOMOLOGY)

**Credits: 8**

**Marks: 100**

Group: A

1. Classification of insects up to families of selected orders: Coleoptera, Hemiptera, Orthoptera, Diptera, Hymenoptera and Lepidoptera, Integument: Structure and functions of cuticle, Moulting and Sclerotization.

2. Structure and modification of Mouthparts, Legs, Antennae and wings in insects; Colouration in insects.

Group B:

1. Importance of insects in nature and human life, Co-evolution of insects and human civilization, Insect-plant interactions (Pollination, Gall formation, Feeding and defense strategies), Sensory organs in insects

2. Comparative idea about structure and physiology of circulatory, nervous and reproductive systems, Haemolymph, Neuroendocrine system, Unusual types of development, Factors affecting fecundity and fertility in insects

### III. Elective Theory Paper:

**MZET-401** (ENVIRONMENTAL TOXICOLOGY)

**Credits: 8**

**Marks: 100**

Group A:

1. Toxicants in the environment: Food additives and contaminants; air pollutants, Water pollutants and Soil pollutants
2. General principles of Toxicology: Toxicologic evaluation; Absorption, distribution and excretion of toxicants; Metabolism of toxic substances; Factors influencing toxicity

Group B:

1. Systemic Toxicology: Brief analyses of toxic responses of the Liver, Kidney, Central Nervous System, Blood, Reproductive System
2. Applications of Toxicology: Forensic Toxicology; Occupational Toxicology; Regulatory Toxicology

### IV. Elective Theory Paper:

**MZET-401** (FISH BIOLOGY)

**Credits: 8**

**Marks: 100**

Group A:

1. Classification of fish up to living order.
2. Food and feeding habits; Digestive system and physiology of digestion; Fish bioenergetics.
3. Aquatic and aerial respiration.
4. Age and growth of fish.
5. Biology and importance of Indian Major Carps, exotic carps, *Heteropneustes fossilis*, *Anabas testudineus*, oil sardine, mackerel, Bombay duck.

Group B:

1. Excretion and osmoregulation.
2. Swim bladder and maintenance of buoyancy.
3. Olfactory and gustatory system and chemoreception; mechanoreception.
4. Electric organ, electroreceptors and electroreception.
5. Bioluminescence in Fish.
6. Endocrine system (Pituitary, thyroid and interrenal).
7. Reproductive system: Structure of gonads, gametogenesis, vitellogenesis; Hormonal and environmental control on reproduction.

### IV. Elective Theory Paper:

**MZET-401** (MOLECULAR CELL BIOLOGY & GENETICS)

**Credits: 8**

**Marks: 100**

Group A:

1. Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, control of cell cycle
2. Control of gene expression at transcription and translation levels: regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing
3. Cellular Communication: general principles of cellular communication, cell adhesion and roles of different adhesion molecules, gap junctions, extra cellular matrix, integrins, neurotransmission and its regulation

Group B:

1. Biology of Cancer: Normal and cancer cells, cell transformation, DNA and tumour viruses, chromosomal basis of human cancer, Regulation of cell cycle in cancer progression
2. Cell Proliferation and Death: Factors for cell proliferation, different types of cell death ( apoptosis, necrosis and autophagy)

## Core (Optional) Theory Paper:

(Choose any one Optional Theory paper from the following list: I to V)

### I. Core (Optional) Theory Paper:

#### **MZOT-402 (APPLIED AND THEORETICAL ECOLOGY)**

**Credits: 8**

**Marks: 100**

Group A:

Ecosystem Health and Human impacts:

Concepts of ecosystem health; Human impacts on resources and ecosystem; land use planning; soil and its use; agricultural methods and pest management; water management; Risk and cost: elements of decision making – measuring risk, risk assessment, risk management; Global warming; Ozone depletion; El Nino and southern oscillation

Group B:

Theoretical Ecology:

Complexity of ecosystem; cybernetics in ecology; Models in ecology – modeling elements, modeling procedure, types of models, modeling constraints and recent development in ecological modeling, Network and hierarchical concepts of ecosystems;

Integrated ecosystem theories – steady state and stability, local and global stability, limit cycle, phase doubling, chaos, catastrophe theory, Goal functions, ecological indicators and orientors.

### II. Core (Optional) Theory Paper:

#### **MZOT-402 (APPLIED ENTOMOLOGY)**

**Credits: 8**

**Marks: 100**

Group A:

1. Classification and properties of pesticides (organochlorine, cyclodiene, organophosphate, carbamate, botanical insecticides), Modern pest control techniques (microbial, hormonal and genetic control of pests), Concept of biomarkers and Bioassay
2. Conventional pest control practices (cultural, mechanical, physical, chemical and biological methods, fumigation), Green revolution and its impact in agroecosystem, Pesticide resistance and outbreak of pests, Integrated Pest Management

Group B:

1. Crop Husbandry and Forest Entomology: Biology and control of Paddy and Sugarcane pests; Biology of termites in relation to environment: i. Odontotermes sp. ii. Microtermes sp. iii. Macrotermes sp.; Recent trends and strategies in termite management; Eco-friendly management of forest insects pests: i. Defoliators ii. Xylophagous insects iii. Canker forming insects.
2. Industrial, Medical and Veterinary entomology: Potentials of Silkworm and Sericulture, Bees and Apiculture, Lac-insects and Lac culture; Insects of Medical and Veterinary importance, Human lice and rat fleas, Bot-flies and Mosquitoes (Diseases and control).

### III. Core (Optional) Theory Paper:

**MZOT-402** (ECOTOXICOLOGY AND ENVIRONMENTAL MANAGEMENT) **Credits: 8** **Marks: 100**

Group A:

1. Classification and properties of pesticides (organochlorine, cyclodiene, organophosphate, carbamate, botanical insecticides), Modern pest control techniques (microbial, hormonal and genetic control of pests)
2. Conventional pest control practices (cultural, mechanical, physical, chemical and biological methods, fumigation), Pesticide resistance and outbreak of pests, Integrated Pest Management

Group B:

1. Concept of Ecotoxicology, General principles and types of ecotoxicity tests, Brief idea about Environmental Impact Assessment using bioassay models, Biodegradation and bioremediation
2. Natural resources and their management, Renewable energy sources, Green revolution and its impact in agroecosystem, Sustainable agriculture, Organic farming, Green belt, Vermicomposting as a model of organic waste recycling

### IV. Core (Optional) Theory Paper:

**MZOT-402** (FISHERIES AND AQUACULTURE) **Credits: 8** **Marks: 100**

Group A:

1. Marine fisheries resources in India: EEZ; Potentiality and scope of exploitation.
2. Major open estuarine and riverine systems in India and their fisheries potential.
3. Conservation of fisheries resources.
4. Fishing crafts and gears
5. Broodstock development and maintenance; Induced breeding of cultivable species; Hybridization; Hatchery management.
6. Preparation and management of nursery, rearing and grow out ponds.
7. Role of soil and water quality in productivity of ponds.
8. Composite fish culture, air breathing fish culture and integrated fish farming.

Group B:

1. Aquatic weeds and their control.
2. Fish diseases and their control.
3. Brackish water Prawn farming.
4. Molluscan fisheries: Culture of edible oyster and Pearl culture technology.
5. Aquafeed formulation and their evaluation.
6. Role of probiotics in aquaculture.
7. Sex manipulation, monosexculture, production of sterile stock, selective breeding; transgenic fish.
8. Spoilage, processing and preservation of fish and prawn.
9. Fish by products.

### IV. Core (Optional) Theory Paper:

**MZOT-402** (MOLECULAR GENETICS) **Credits: 8** **Marks: 100**

Group A:

1. Molecular mutagenesis: Site directed mutagenesis. Sequence tagged sites, DNA microarrays, chromosome painting
2. Restriction mapping: RFLP, RAPD, AFLP, SSCP, SNP mapping. DNA Fingerprinting

Group B:

1. Developmental Genetics: Determination and differentiation, genetic basis of pattern formation in *Drosophila*, homeotic loci
2. Cancer Genetics: Oncogenes, tumour suppressor genes and their role in cancer, genes for apoptosis

#### IV. Core (Optional) Practical Paper:

(Choose any one Optional Practical paper from the following list; I to V)

##### **MZOP-403**

**Credits: 8**

**Marks: 100**

##### *Core (Optional) Practical Paper:*

##### **I. MZOP-403 (ECOLOGICAL MODELLING)**

**Credits: 4**

**Marks: 50**

1. Spatial pattern analysis (SPA) of population:  
Natural sampling – Piosson, Negative Binomial, indices of dispersion  
Quadrat variance method – Block quadrat and Paired variance  
Points and distance methods
2. Species diversity measures – Richness, Heterogeneity and Evenness.
3. Niche Measures and Resource Preference-Niche breadth, Niche overlap, Measurement of habitat and dietary preference
4. Dynamic modeling - Building of conceptual ecological models, transformation of mathematical models from conceptual ecological models, Running of the mathematical model, Calibration, Sensitivity analysis and validation.

##### *Core (Optional) Practical Paper:*

##### **II. MZOP-403 (ENTOMOLOGY)**

**Credits: 4**

**Marks: 50**

1. Insect biodiversity: collection, and submission of locally available harmful insects
2. Identification of orders: Coleoptera, Hemiptera, Orthoptera, Hymenoptera, Lepidoptera and Diptera up to family characters
3. Permanent slide preparation of whole insects and body parts of insects of applied importance ;  
Detection of chitin in integument
4. Bioassay of pesticides (LC<sub>50</sub>, LT<sub>50</sub>) using aquatic and soil insects
5. Probit analysis and interpretation of toxicological data
6. Collection and laboratory rearing of soil Collembola for toxicity studies

##### *Core (Optional) Practical Paper:*

##### **III. MZOP-403 (ENVIRONMENTAL TOXICOLOGY)**

**Credits: 4**

**Marks: 50**

1. Determination of LD<sub>50</sub> of a suitable toxicant in white rat
2. In vitro toxicity assay in isolated hepatocytes: Hoechst assay, MTT assay, Trypan Blue Exclusion, Neural Red Uptake, DNA laddering
3. In vitro inhibition of rat brain Acetylcholinesterase by an organophosphate pesticide
4. Distribution of <sup>203</sup>Hg in different tissues in white rat
5. Estimation of B.O.D. and C.O.D. values of polluted water samples
6. Bioassay of pesticides (LC<sub>50</sub>, LT<sub>50</sub>) using aquatic and soil invertebrates
7. Probit analysis and interpretation of toxicological data

*Core (Optional) Practical Paper:*

**IV. MZOP-403 (FISH AND FISHERIES)**

**Credits: 4**

**Marks: 50**

1. Identification of fish and prawn.
2. Identification of aquatic weeds.
3. Plankton study: Volumetric estimation and counting; staining and identification of some common Zooplanktons and phytoplanktons.
4. Feeding habit study: Study of buccopharynx and alimentary canal and gut content analysis.
5. Study of fish gonads: GSI and Fecundity and oocyte culture.
6. Study of digestive enzymes of fish.
7. Hypophysation of carps.
8. Implantation of nucleus for artificial pearl culture.
9. Dissection: Urinogenetal system of any bony fish, Air breathing Organs, Weberian ossicles of carp and olfactory organ of *Channa*.
10. Whole mount of fish parasites.

*Core (Optional) Practical Paper:*

**V. MZOP-403 (MOLECULAR CELL BIOLOGY & GENETICS)**

**Credits: 4**

**Marks: 50**

1. Cell fractionation of hepatocytes
2. DNA isolation.
3. Restriction digestion of DNA.
4. RFLP/ RAPD/ SSCP / SNP analysis.

**PROJECT PAPER (DISSERTATION & VIVA VOCE)**

**Total Credits: 4**

**Marks: 50 (30+20)**

**Project Paper: MZPW-404**

Based on either MZET-401 or MZOT-402 papers (Topic to be selected in consultation with Supervisor)

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| I. Paper: <b>MZPW-404</b> (ECOLOGY-IV)<br>Dissertation and Viva-Voce                           | Full Marks -50 |
| II. Paper: <b>MZPW-404</b> (ENTOMOLOGY-IV)<br>Dissertation and Viva-Voce                       | Full Marks -50 |
| III. Paper: <b>MZPW-404</b> (ENVIRONMENTAL TOXICOLOGY-IV)<br>Dissertation and Viva-Voce        | Full Marks -50 |
| IV. Paper: <b>MZPW-404</b> (FISH AND FISHERIES-IV)<br>Dissertation and Viva-Voce               | Full Marks -50 |
| V. Paper: <b>MZPW-404</b> (MOLECULAR CELL BIOLOGY & GENETICS-IV)<br>Dissertation and Viva-Voce | Full Marks -50 |